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MASSACHUSETTS AGRICULTURAL COLLEGE.

JANUARY, 1907.

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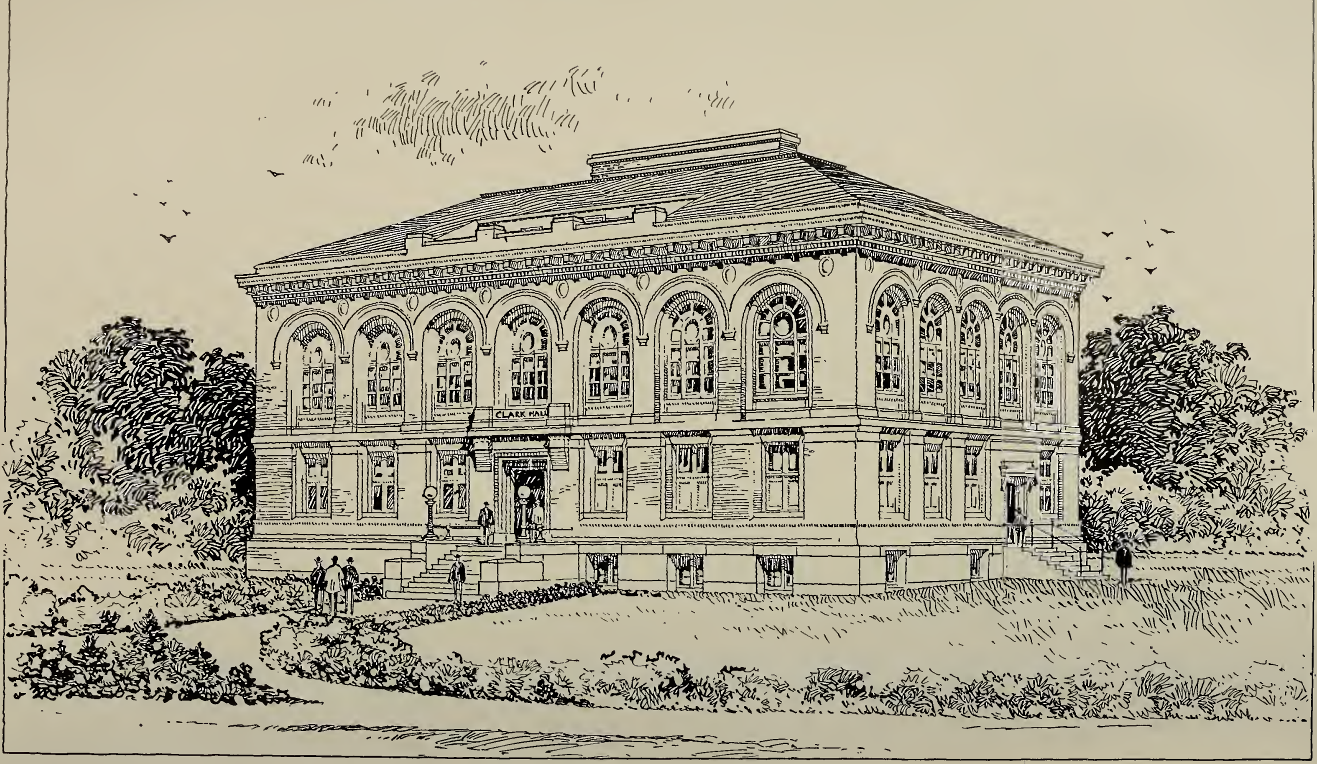
Approved by

The State Board of Publication.

·CLARK·HALL· ·MASSACHVSETTS·AGRICVLTVRAL·COLLEGE·
·COOPER & ·BAILEY ARCHITECTS · BOSTON



Commonwealth of Massachusetts.

Massachusetts Agricultural College,
Amherst, Dec. 1, 1906.

To His Excellency Curtis Guild, Jr.

Sir: — I have the honor to transmit herewith, to Your Excellency and the Honorable Council, the forty-fourth annual report of the trustees of the Massachusetts Agricultural College, for the fiscal year ended Nov. 30, 1906.

I am, very respectfully, your obedient servant,

KENYON L. BUTTERFIELD,
President.

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CALENDAR FOR 1907-1908.

Jan. 2, 1907, Wednesday, fall semester resumed, at 8 A.M.
February 6, Wednesday, fall semester ends.
February 7, Thursday, spring semester begins, at 8 A.M.
March 27, Wednesday, to April 3, Wednesday, } spring recess.
April 3, Wednesday, spring semester resumed, at 8 A.M.
June 15, Saturday, Grinnell prize examination of the senior class in agriculture.
June 16, Sunday, Baccalaureate address.
June 17, Monday, { Burnham prize speaking. Flint prize oratorical contest.
June 18, Tuesday, { Class-day exercises. Meeting of the alumni. Reception by the president and trustees.
June 19, Wednesday, commencement exercises.
June 20, 21, Thursday and Friday, examinations for admission, at 9 A.M., Botanic Museum, Amherst; at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; at Pittsfield; and at Horticultural Hall, Worcester.
September 17, 18, Tuesday and Wednesday, examinations for admission, at 9 A.M., Botanic Museum.
September 19, Thursday, fall semester begins, at 8 A.M.
December 19, Thursday, to Jan. 2, 1908, Thursday, } winter recess.
January 2, Thursday, fall semester resumed, at 8 A.M.
February 5, Wednesday, fall semester ends.
February 6, Thursday, spring semester begins, at 8 A.M.
March 26, Thursday, to April 2, Thursday, } spring recess.
April 2, Thursday, spring semester resumed, at 8 A.M.
June 17, Wednesday, commencement exercises.

Report of the President of the College.

Gentlemen of the Corporation of the Massachusetts Agricultural College.

In presenting my first report as president of the college, I shall content myself with a very brief survey of the work of the year. The term of Prof. William P. Brooks, as acting president, expired June 30. I am indebted to him for the data on which the report for the first part of the year is based.

In this connection I desire to express formally my personal appreciation of the services of Professor Brooks as acting president. He occupied with great credit a difficult office. No one can appreciate this more fully than he who comes to an institution at a time when a considerable interim has been filled by an acting president. Such a man will find himself either seriously handicapped or wonderfully assisted by the way in which the acting president has carried on the task. With this fact in mind, I desire to give cordial recognition to Professor Brooks's work, and to his courtesy to me personally at the time of my assuming the office of president.

Changes in the Faculty.

Early in the year the resignation of Dr. Charles S. Walker, who was on leave of absence during the year, was received and accepted by the trustees. Dr. Walker had served as professor of political science and as chaplain since 1886, and for part of that period was secretary of the faculty. He was a forceful writer on themes connected with his favorite subjects. He had long had a special interest in the development of the agricultural phases of economics.

Dr. Richard S. Lull, associate professor of zoölogy, resigned at the end of the college year, to accept an unusually flattering position in Yale University. Dr. Lull had been connected with the college since 1894, and was recognized as a teacher of exceptional power. The position thus made vacant was filled by the appointment of Clarence E. Gordon, A.M. Professor Gordon is a graduate of the Massachusetts Agricultural College in the class of 1901, and secured his Master's Degree at Columbia University.

The trustees also accepted the resignation of Prof. Herman Babson, assistant professor of English and instructor in German. Professor Babson resigned in order to pursue his studies in the German language and literature abroad. He had served the college since 1893. His place was filled by the appointment of Robert W. Neal, A.M., a graduate of the University of Kansas. Professor Neal has done advanced work in both Yale and Harvard, and has the degree of A.M. from the latter institution; he has also had successful and important editorial experience.

During the last college year instruction in history was carried on most acceptably by Prof. Herbert P. Gallinger of Amherst College. This year Mr. Holcomb was given, in addition to his other duties, the position of instructor in history.

Maurice A. Blake resigned as instructor in horticulture, to accept the position of horticulturist of the New Jersey Experiment Station, and severed his connection with the college November 30. Mr. Blake had served with great credit as instructor, and had been particularly useful in the practical work of the department.

The State Forester of Massachusetts is also lecturer in forestry in this college. Mr. Alfred Akerman resigned this office last summer, and has been succeeded by Prof. F. William Rane, who has been for eleven years professor of horticulture and forestry at the New Hampshire College of Agriculture and Mechanic Arts.

Mr. C. P. Halligan takes the position of instructor in drawing, made vacant by the resignation of Mr. Walter D. Hatch.

Miss Gertrude E. Stratton, secretary to the president, resigned during the summer, after a constant service of some eighteen years, and the vacancy was filled by the appointment of Miss Grace M. Knowles, a graduate of the private secretarial course of Simmons College in the class of 1906.

Attendance.

The total attendance for the college year ended June 30, 1906, was as follows: —

Graduate students,	7	
Special students,	1	
Senior students,	27	
Junior class,	28	
Sophomore class,	61	
Freshman class,	90	
Short course, 1905,	41	
		255
Counted twice,		1
Total,		254

This shows an increase in total registration over the previous college year of 28. The registration Nov. 30, 1906, is 225, as compared with 214 at the same date a year ago.

Director of the Experiment Station.

By vote of the trustees, the office of the director of the experiment station was separated from that of the president of the college, and Prof. William P. Brooks was made director of the station, in which capacity he had already been serving while acting president of the college. Professor Brooks brings to this work long years of preparation and service, and an intimate acquaintance, not only with experimental work, but with the needs of Massachusetts agriculture.

Appropriations.

The last Legislature was asked to make appropriations as follows: —

New building and plant house for the botanical department,	$75,000
New greenhouse for the horticultural department,	20,000
Duplicate engine and generator for lighting plant,	5,000
Maintenance and repairs,	4,500
Barn, stables, piggery, silos and farm dairy building,	63,000
For maintenance of the horticultural building, annually,	1,000

The items completely cut out were the new greenhouse, duplicate engine and generator, and maintenance of the horticultural building. The appropriation for the botanical building was not made sufficiently large to cover a plant house nor to provide for equipment. The appropriation for the barn, stables, etc., was largely reduced. The appropriation for maintenance and repairs was increased $500.

The Legislature made extraordinary appropriations amounting to $75,300, as follows: —

For Clark Hall,	$45,000
For barns and silos,	21,300
For farm dairy building,	3,000
For piggery,	1,000
For repairs,	3,000
For maintenance,	2,000

In addition to legislative provision for barns and silos, about $12,000 of the total of about $17,300 received for insurance was made available by vote of the trustees.

New Buildings.

The destruction of the dairy building by fire in November made necessary some provisions for the practical work of the short course in dairy farming. Rooms formerly used for heating apparatus and cold storage in the basement of south college were fitted for this purpose, and equipped with a very complete line of dairy machinery. The number of students enrolled for the dairy course was 29, — a smaller number than in recent years. Some students, as was learned later, decided on going elsewhere, on seeing the newspaper reports of the destruction of the old dairy building.

Wilder Hall was completed early in the year, and occupied at the beginning of the second semester.

The new barn, with attached silos, stables and milk room, is nearing completion. The same is true of the new building for the department of botany and vegetable pathology. The latter building has been named "Clark Hall," in honor of William S. Clark, president of the college from 1867 to 1879. A brief description of this structure, together with the plan of the architects, will accompany this report.

Master's Degree.

A change was made in the conditions under which graduate study for the degree of Master of Science may be carried on. This change will permit graduates of the Massachusetts Agricultural College, or other approved institutions, who may be employed in the college or the experiment station, to pursue studies for a degree in connection with any work done in discharge of the duties held which has a recognized value in fitting a man for the degree, and may be counted as a part of the work for the degree.

Annual Commencement.

At the annual commencement, held June 20, 27 persons received the degree of Bachelor of Science, and 1 the degree of Master of Science. The address of the day was given by Prof. L. H. Bailey, dean of the College of Agriculture of Cornell University. The subject was "Leadership in Country Life." It was an inspiring presentation of the opportunities now arising for educated young men to be of effective service in the country community.

"Better Farming Special" Train.

One event of the past year deserving of especial mention was the equipment and manning of a "Better Farming Special" train, — the first of its kind in New England. This train, consisting of an engine, a baggage car and three passenger coaches, was furnished, entirely without charge either for rolling stock, train crew or operation, by the Boston & Maine Railroad. The material which was used in furnishing the train was jointly supplied by the agricultural colleges and experiment stations of New Hampshire, Vermont and Massachusetts, and the train passed over a considerable proportion of the lines of the Boston & Maine Railroad system in these States, beginning in Massachusetts on Tuesday, April 3, in Amherst, and ending in this State on Saturday, April 7, in Haverhill. As the trip was to be begun in Massachusetts, and as the trolley line extension into the college grounds connecting with the Boston & Maine Railroad afforded such advantages for the work, the cars were fitted and equipped for their trip in Amherst. The general expenses incurred in preparing the train were shared equally by the three States above mentioned.

The baggage car was fitted with special benches, and was used largely for the display of material of interest in connection with forestry and orcharding. It also contained a case of general views of the Massachusetts Agricultural College. The plan followed in the passenger cars was first to remove about one-third of the seats in each car. The space thus cleared was furnished with benches and shelves, the benches, the shelves and the walls being used for the display of the illustrative material. The exhibits were classified, those in one car being designed to illustrate especially some of the problems connected with the selection and use of fertilizers and the general management of farm crops. The material in the second car was illustrative of animal husbandry and dairying. In the third passenger coach the material was selected with reference to illustrating some of the subjects in horticulture and the insect pests of the farm. Each of the four cars bore a banner on either side, extending the full length of the car. The first, attached to the baggage car, bore the words "Better Farming Special." The passenger coaches were marked, respectively: "Farm Crops and Fertilizers;" "Animal Husbandry and Dairying;" "Horticulture and Insect Pests."

A careful schedule had been planned beforehand, and had been given wide publicity, chiefly through the agency of the "New England Homestead." The time of arrival and departure from each station had been extensively advertised, and at every station a goodly number of people was in waiting. The places at which stops were made and talks given in Massachusetts were the following: Amherst, Mt. Hermon, Bernardston, Greenfield, South Deerfield, Hatfield, Northampton, Hadley, Belchertown, Barre Plains, Rutland, Hubbardston, Gardner, Fitchburg, North Leominster, Ayer, Lancaster, Hudson, Wayland, Weston, Wakefield, Reading, Tewksbury, Andover, Georgetown and Haverhill.

The stops at stations averaged about fifty minutes each, and the schedule as planned was carried out almost to the minute.

The speakers in Massachusetts were mainly from the college and station; but the college staff was ably assisted by A. D. Shamel, the tobacco expert of the United States Department of Agriculture, in towns where tobacco growing was of importance; by E. A. Start, secretary of the Massachusetts Forestry Association; P. M. Harwood, agent of the Dairy Bureau; W. D. Rudd, poultry expert; and S. H. Abbott and W. A. Hunter, of the Co-operative Milk Producers Company; while Secretary Ellsworth of the State Board of Agriculture, who accompanied the train throughout its entire trip in Massachusetts, proved invaluable in making the announcements and handling the crowds in attendance at the different stations.

The following, written shortly after the trip in Massachusetts was completed, and published in the "Homestead," is of interest: —

The smallest number of visitors at any station was 150 to 175. As many as 700 visited the train in some places, and the average number at the different stations was probably 350 to 400. The quality of the visitors was equally as satisfactory as the numbers. The crowds were composed of the most intelligent and progressive, and included young men, women and children, as well as the older men who so often make up the majority of those in attendance at ordinary farmers' institutes. The attention paid to the short talks and the questions asked made clear the fact that the majority of those in attendance had come to learn. On every hand were constantly heard expressions of approval.

It was estimated that fully 8,000 people in Massachusetts alone inspected the exhibits and listened to the talks. This is a conservative estimate, based upon an actual count from town to town by an editorial representative of the "New England Homestead." The visitors to the train often came from long distances. Incidents were occasionally brought to the notice of those on the train of parties who had driven fourteen or fifteen miles to visit it.

The progress of the train and its work were given the widest possible publicity by the newspapers. Representatives of a large number of the newspapers of the State accompanied the train, and the accounts published both in city and country papers were full and enthusiastic.

The total cost to the Massachusetts Agricultural College amounted to $246.45. Of this sum, $65.55 was paid to students from the endowed labor fund; the balance, $180.90, was paid in equal parts by the college and the experiment station.

It is believed that the effort and the money expended were well repaid by the results. There can be no doubt that much valuable instruction was conveyed to many interested persons; but in still larger degree the train proved useful in arousing interest in the work of the college and station, and in bringing the people into closer touch with these institutions. Not only must this closer touch and keener appreciation have been felt by the few thousands who actually visited the train, but to no inconsiderable degree also by the many thousands who read the accounts of its progress and its work.

The success of the movement was most gratifying to all concerned, and was due to the heartiest possible co-operation of every one taking a part in the work. To the "New England Homestead" was due in the first place the suggestion, and to the "Homestead" also belongs the credit of having aroused the interest of the Boston & Maine Railroad; and the success of the movement was still further enormously promoted by the widespread publicity given to the movement through the columns of the "Homestead" and the earnest work of members of its editorial staff. The Boston & Maine Railroad also deserves mention. Its generosity and courtesy left nothing to be desired. Everything that could be done to promote the success of the movement on the part of the railroad was done; and it is believed that all who took part in this work, "Homestead" staff, college and station staff, students and railroad, felt that the work had proved its value and had been well worth while.

Commission on New Buildings and Arrangement of Grounds.

The following vote was passed by the trustees at the meeting of Jan. 3, 1905: —

Voted, That a commission, to consist of the committee on new buildings and arrangement of grounds, and two of the faculty to be appointed by that committee, consider the location of future buildings on the grounds of the Massachusetts Agricultural College and all other permanent improvements on the campus, and report to the Board thereon; this commission to be authorized to hold public hearings on the question involved, and so far as they think practicable to ask the advice of experts.

In accordance with this vote, Prof. William P. Brooks and Prof. Frank A. Waugh of the faculty have been added to your standing committee on new buildings and arrangement of grounds, and thus the commission is constituted. I commend this as a most important step in the future development of the college, and trust that this commission may be able to report to your Board in the not distant future a permanent plan for the development of the grounds and for the type and location of buildings which will enable us to proceed systematically and confidently in the evolution of an establishment which shall be, on its material side, an exemplification of all that is artistic and convenient in an institution of this character.

Anniversaries.

In May, 1882, the Legislature passed an act creating the Massachusetts Experiment Station. Massachusetts was one of the leaders of research work in agriculture, and I recommend that some appropriate way be found for celebrating and reviewing the work of the quarter-century.

On Oct. 2, 1907, the college is entitled to celebrate the fortieth anniversary of its opening to students. It is my recommendation, which has been endorsed officially by the faculty of the college and unofficially by numerous alumni, that steps be taken adequately to celebrate this event. The time has arrived when the college should demonstrate its fitness to become a leader in all forms of rural betterment in Massachusetts, and I can think of no way in which this assumption of leadership can be announced, nor of any way in which the fortieth anniversary of the opening of the college can be celebrated, better than that of holding a "Massachusetts Conference on Rural Progress," at the college, during the week of October 2. The object of this conference should be to bring together, for discussion of all phases of rural betterment in this Commonwealth, representatives of the farmers' organizations and societies, rural educators, rural religious workers and members of village improvement societies. I would recommend that a sufficient sum be set apart to enable us to prepare a strong program, and to bring to our aid speakers of large reputation and of thorough knowledge of the problem.

Department of Agricultural Education.

The Massachusetts Commission on Industrial Education, appointed by Governor Douglas, in the bill which they recommended to the Legislature and which was enacted into law, outlined the following provision, which has become section 7 of the Law: —

Section 7. The trustees of the Massachusetts agricultural college are hereby authorized to establish a normal department for the purpose of giving instruction in the elements of agriculture to persons desiring to teach such elements in the public schools, as provided in sections three and four: *provided,* that the cost of such department shall not exceed the sum of five thousand dollars in any one year, and that at least fifteen candidates present themselves for such instruction.

The money for carrying out this provision of the law was not furnished by the last Legislature, but the sum of $5,000, in accordance with the advice of the State Auditor, has been included in the annual estimate made through that office to the Legislature. It is fortunate that, at the very time when the educational leaders of the State are becoming deeply interested in the development of agricultural teaching in the various grades of schools in the Commonwealth, this college should be recognized as the natural leader in this movement, and given the machinery to make good the leadership.

Extension Teaching.

It is now clearly recognized by agricultural educators that an agricultural college has three distinct functions to perform, each of which is equal in importance to the others, and none of which can safely be neglected.

1. The first business of the college is the work of research. We must find out the truth about nature, — how she works, and how her processes may be utilized by man in the production of plants and animals. This task is at present committed to the agricultural experiment station. It should be the first and sole business of the station.

2. The second great task of the college is to instruct resident students. This is the accepted function of the ordinary college, and in the minds of many is the only function. But the experiment station work is really the college hunting for the truth; the academic work is the college imparting the truth to those who have access to its halls for a period of years.

3. It may be argued that when the college has performed these two functions its mission is fulfilled. But we are coming to see that this is by no means true. The facts obtained and the principles educed by the experiment station are intended not solely for the benefit of the resident students of the college. It is expected that the body of knowledge acquired by the experiment station, and worked over into pedagogical form by the college teachers of agriculture, shall find its way out in free measure to the people who till the soil. The fundamental interests and duties of the college, therefore, lead to the development of its third function, namely, that of extension teaching. The information and the inspiration which are supposed to abide in the atmosphere of the experiment station and the college class room must be taken out to the people. Agriculture progresses not merely through the highly trained expert and the thoroughly educated leader, but ultimately through the increasing knowledge of the working farmer.

This threefold organization of the college is now pretty fully accepted. It is the foundation upon which we must build our work for the future. It is the logical and necessary basis for that leadership in rural matters which we expect the agricultural college to maintain.

The Massachusetts Agricultural College has from its foundation rendered a large service to the people of the State by means of lectures, correspondence, bulletins, and perhaps in other ways. This work has never been classified. It has always been considered a part of the service of the institution. When we come to analyze it, we discover that it is extension teaching. As I understand it, everybody believes that the college should do this sort of thing. I have never heard the college criticised for doing it. The legitimate question is, whether the college is doing enough of this work; whether it is really reaching the people as it ought to reach them, by the methods that have been in vogue and others that may be organized. I do not think it is. We have done well, but we must do better. But it is clearly out of the question for us to enlarge this work further with our present force. It is undoubtedly desirable for station workers to keep in touch with the farmers and their problems; but, in justice to station work, they can spend very little time in any other way than by direct application to the task in hand. So with the college instructors; they also must keep in the atmosphere of the farmer, but they cannot afford to neglect their duties as teachers. It seems to me, therefore, that the time has arrived when we must organize our extension work, bringing the various forms of it together, placing it under the charge of a competent man, and expanding it as rapidly as the demands for such work develop. There can be no question but the movement for extension teaching in this country is gaining force with great rapidity. Several agricultural colleges have already organized departments of college extension, and others are taking steps towards the same end. Shall Massachusetts be in the van, or shall she lag in the rear?

It may be well to define a little more explicitly what extension work is. The definition of extension work adopted by the committee on extension work of the Association of American Agricultural Colleges and Experiment Stations, is as follows: "Extension teaching in agriculture embraces those forms of instruction, in subjects having to do with improved methods of agricultural production and with the general welfare of the rural population, that are offered to people not enrolled as resident pupils in educational institutions." Or, as Professor Bailey phrases it: "Extension work comprises all those teaching enterprises that are not of academic kind, and that aim to reach the people and their problems in places where the problems are." An investigation by the above committee reveals an astonishing development of extension work among colleges of agriculture. Without an attempt to go into great detail, we may roughly classify some of these forms of extension teaching. The classification will help illustrate the scope of possible work.

I. *Itinerant Lectures.* — These may embrace such endeavors as: (1) extension lectures to miscellaneous audiences and organizations; (2) courses of extension lectures given to small groups of people who wish to study somewhat carefully; (3) travelling schools, which attempt to give instruction for a considerable period of time to people desiring to specialize, as in fruit, etc.; (4) special railway trains for educational purposes; (5) conferences of teachers, for the purpose of taking up the study of elementary agriculture, etc.; (6) farmers' institutes. In Massachusetts the farmers' institutes are managed by the Board of Agriculture, and we do not need to consider them in connection with this problem, except to suggest that the college should co-operate cordially with the development of institute work.

II. *Literature.* — This embraces: (1) the large correspondence of the station and the college: (2) publication of bulletins, pamphlets, etc., that are not reports of experimentation, but definite statements of agricultural truth, intended to reach the man who wants to have a brief and concise presentation; (3) correspondence courses; (4) reading courses; (5) travelling libraries.

III. *Object Lessons.* — These may comprise: (1) a large number of field demonstrations, given to small audiences, which endeavor to show people just how to perform such operations as may help them in their practical work; (2) co-operative tests and demonstrations which are not so much for the purpose of experimentation as for education; (3)

educational exhibits at fairs, made by the college and station, which are not for advertising, but for educational purposes.

There are other forms of extension teaching that are already being developed, but the above will serve to illustrate what is meant by extension teaching in agriculture, and will show the methods by which an agricultural college may perform its great function of reaching the people, of bearing to them the gospel of better agricultural conditions.

So far as I can see, there are only three legitimate objections to the development of extension teaching at a college like ours; for we can hardly give credence to the idea that the work is not needed or demanded. So far as the need is concerned, I feel quite sure that no one will attempt to argue that even in the most progressive agricultural States there is not need of the most constant vigilance in placing before the working farmers the latest agricultural information. And one of the best evidences of the need of this work is the demand for it on the part of the farmers so soon as they understand what it proposes to do for them.

1. It may of course be argued that this extension teaching is not the function of the agricultural college. It must be remembered that every agricultural college has performed this sort of work for years, not only without criticism, but with cordial approval on the part of the farmer. It is now a generally accepted function of the college to do this; and, indeed, not to do it means shutting up the college for the benefit of the relatively few students who can enroll themselves with it. It means damming up the great fountains of agricultural knowledge, and permitting them to trickle out in faucets reserved for the elect, rather than letting the healing waters flow down through the plains, carrying blessing to the world at large. To prohibit the college from doing extension work means ultimately to stifle the college. The college lives not merely because it teaches students; it lives permanently only as it clasps hands with the farmer himself.

2. It may be objected that this sort of work can better be done by other agencies. It is true that the agricultural college is not the only means by which agricultural knowledge may be disseminated. The agricultural press renders a mar-

vellous service in this capacity. The farmers' institutes, even if not conducted by the college, are great educational institutions, and cannot be dispensed with. The grange, the horticultural societies, the agricultural fairs, the dairy associations and all the host of voluntary organizations, and particularly official bodies like boards of agriculture, have rendered for years and are now rendering a most important service in disseminating agricultural information. The college never can take the place of these agencies, but it can mightily supplement their work. And the reasons why it can and should supplement their work are these: (1) There is an increasing need of expert teachers, who, while keeping close to the practical problems of the farmers, are also constantly studying the new developments of agriculture. To be a successful farmer is only one of many qualifications of a successful teacher of farmers, and the day has arrived when we need experts to give all their time to the work. (2) The experiment station is the great source of new knowledge of agriculture. Our agricultural teachers therefore must be in closest possible touch with the men who are prosecuting agricultural research. Men closely connected with the station have the best opportunities for keeping that touch. (3) But the great reason is that of usefulness. In all the agencies already enumerated, — valuable as they are in giving suggestions, in stimulating the farmers to think, — after all, the work is more or less superficial. Agricultural educators now believe that we are at the dawn of an era in agricultural work when definite, continued, expert instruction of the masses of the people is not only necessary, but feasible. It is clear that the college should not attempt to duplicate or interfere with the work of these other agencies; it should rather build upon their work. It should take the raw materials, so to speak, which they have produced and work them up into finer products. Thus there would be not only no conflict between the extension teaching of the college and the dissemination work performed by other agencies, but the two will happily supplement one another. For ultimately our extension teaching must *teach,* — teach with system and persistency.

3. If the suggestion just made is a pertinent one, it dis-

poses of perhaps the most serious objection to the development of an extension division of the Massachusetts Agricultural College, namely, unnecessary duplication of work. It seems to me that this is a question that can be settled without the slightest friction. It should be understood that the college purposes not to interfere with nor encroach upon the work of the State Grange nor of the Board of Agriculture. Our extension teachers should be placed at the disposal of the Board of Agriculture for farmers' institutes, for demonstration meetings, or for any other work the Board is now doing or may wish to do. We shall expect to co-operate heartily with the grange. I firmly believe that if we go at the matter in this spirit the college can be of great assistance, to the Board of Agriculture particularly. If we secure good extension teachers, they would certainly add to the prestige of the institutes, if the Board chooses to utilize the men for that purpose. Our extension workers may also be able to reach many of the smaller places, many small groups of people, and possibly a great many individuals, that are not now reached and never will be reached by the large institute or field meeting.

There is another consideration that should not be omitted from a discussion of this subject. I am firmly convinced that it is the duty of the Agricultural College, just as soon as it has adequate facilities to do so, to develop much more largely the opportunity which may be given to mature young people through the prosecution of both short winter and summer courses at the college. This work is not true extension teaching, because it is work given to resident students; and yet, because of its character and because of the difficulty of developing it through the regular instructors of the college, already hard pressed for time, I am quite inclined to think that it might well be made a part of our extension work.

As a definite conclusion to this prolonged discussion of extension teaching, I would recommend that the Legislature be asked to appropriate a sum of money sufficient to establish at the Massachusetts Agricultural College a "Division of Extension Teaching;" and that a competent man, with if possible a small corps of assistants, be put in charge of this division.

I have taken pains to elaborate this recommendation, partly because of its great significance in our future policy, and partly also because of the apparent misunderstanding, in some quarters, of the proposal. I feel quite sure that when this plan is once comprehended, not only will it be found unobjectionable, but that it will be welcomed as a great power for good in the building up of a better Massachusetts agriculture. There is no ulterior purpose back of the proposition; it is a frank, open attempt to make our college of larger service. I believe that enlarged extension work at the Massachusetts Agricultural College will not only not weaken the forces of the Board of Agriculture, or of the grange, or of rural societies generally, but, on the contrary, that it will in a few years prove to be the greatest ally which has been brought to their assistance in many a long day. We must not deal with this matter in the light of who shall get the credit for work done; we must keep forever in mind the question, How can the rural people of Massachusetts be given the largest possible assistance?

In view of all the conditions which gather about this proposition, I recommend that your Board appoint a committee of its own members to confer with the executive committee of the State Board of Agriculture, and with the executive committee of the State Grange, in regard to a united effort in behalf of this movement.

Finances.

It is evident that the institution is in need of larger amounts which may be used for maintenance, equipment, and repairs and minor improvements. Estimates covering these items, sent in by the heads of departments, will total some $20,000. It also seems the part of wisdom to ask once more for a new greenhouse. The question of whether we shall ask for an addition to the electric lighting plant will depend very largely upon the success of a possible arrangement for summer and reserve lighting with the Amherst Gas Company. If certain additions to, and increases in the payment of, the faculty and other instructors are made, we shall during the next college year need from $6,000 to $8,000 more than we now have available for salaries. I have not been able as yet to make a thorough study of the financial needs of the college, but I am convinced that we must soon face the duty of endeavoring to secure a larger current annual appropriation. For the present, I would make the following recommendations with respect to immediate appropriations from the Legislature: —

1. That we ask for a sum sufficient to establish extension teaching; the form of this work and the amount needed I leave to the judgment of your Board.

2. That the following items be incorporated into one bill, as a special appropriation: —

a. For equipping barn, stables and milk room, ...	$3,000
b. For purchase of live stock for barn, ...	7,000
c. For equipping and furnishing Clark Hall, ...	25,000
d. For boiler for heating and lighting plant, ...	2,000
e. For greenhouse, workrooms and equipment, ...	22,000
Total, ...	$59,000

It is also recommended that there be added to this list an item for such an amount as may be determined by your finance committee after a thorough consideration of the reports of the heads of departments, this item to include additional salaries, equipment, maintenance, repairs and minor improvements.

3. That your committee on finance be authorized to study with some care (1) all the financial needs of the college at the present time, (2) such probable demands as will be made upon the college in the near future which must be provided for by increased annual income, and (3) the amount and form which these necessary increases in the budget should take; the committee to make a full report to your Board at a subsequent meeting.

All of which is respectfully submitted.

KENYON L. BUTTERFIELD,
President.

Nov. 30, 1906.

LEGISLATIVE BUDGET.

[As adopted by the committee on finance, Jan. 10, 1907.]

The committee on finance, acting under authority conferred by the Board of Trustees of the college, at a meeting held at the college Jan. 10, 1907, voted to request of the Legislature the following appropriations for the year 1907: —

I. The annual appropriation for instruction ($13,000) to be increased by $7,000 (for miscellaneous salary items), making a total of $20,000 per year.

II. Special appropriations, $73,000.

a. For equipping barn, stables and milk room,	$3,000
b. For purchase of live stock for barn,	7,000
c. For equipping and furnishing Clark Hall,	25,000
d. For boiler for heating and lighting plant,	2,000
e. For greenhouse, workrooms and equipment,	22,000
f. For equipment, maintenance, repairs and minor improvements for the college as a whole and for various departments specifically,	14,000
Total,	$73,000

THE CORPORATION.

	TERM EXPIRES
NATHANIEL I. BOWDITCH of Framingham,	1908
WILLIAM WHEELER of Concord,	1908
ARTHUR G. POLLARD of Lowell,	1909
CHARLES A. GLEASON of New Braintree,	1909
JAMES DRAPER of Worcester,	1910
SAMUEL C. DAMON of Lancaster,	1910
MERRITT I. WHEELER of Great Barrington,	1911
CHARLES H. PRESTON of Danvers,	1911
CARROLL D. WRIGHT of Worcester,	1912
M. FAYETTE DICKINSON of Boston,	1912
WILLIAM H. BOWKER of Boston,	1913
GEORGE H. ELLIS of Boston,	1913
J. HOWE DEMOND of Northampton,	1914
ELMER D. HOWE of Marlborough,	1914

Members ex Officio and Officers.

His Excellency Governor CURTIS GUILD, Jr.,
President of the Corporation.

KENYON L. BUTTERFIELD, *President of the College.*

GEORGE H. MARTIN, *Secretary of the Board of Education.*

J. LEWIS ELLSWORTH, *Secretary of Board of Agriculture.*

CHARLES A. GLEASON of New Braintree,
Vice-President of the Corporation.

J. LEWIS ELLSWORTH of Worcester, *Secretary.*

GEORGE F. MILLS of Amherst, *Treasurer.*

CHARLES A. GLEASON of New Braintree, *Auditor.*

Standing Committees of the Trustees.[1]

Committee on Finance.

GEORGE H. ELLIS, J. HOWE DEMOND,
ARTHUR G. POLLARD, CHARLES H. PRESTON,
CHARLES A. GLEASON, *Chairman.*

Committee on Course of Study and Faculty.

WILLIAM H. BOWKER, ELMER D. HOWE,
M. FAYETTE DICKINSON, CARROLL D. WRIGHT,
GEORGE H. MARTIN, WILLIAM WHEELER,
Chairman.

Committee on Farm and Horticulture.

Farm Division.

GEORGE H. ELLIS, CHARLES A. GLEASON,
MERRITT I. WHEELER, N. I. BOWDITCH, *Chairman,*
and Chm. Joint Committee.

Horticultural Division.

JAMES DRAPER, ELMER D. HOWE,
J. LEWIS ELLSWORTH, *Chairman.*

Committee on Experiment Department.

J. LEWIS ELLSWORTH, JAMES DRAPER,
WILLIAM H. BOWKER, SAMUEL C. DAMON,
CHARLES H. PRESTON, *Chairman.*

Committee on Buildings and Arrangement of Grounds.

WILLIAM WHEELER, WM. H. BOWKER,
M. FAYETTE DICKINSON, N. I. BOWDITCH,
JAMES DRAPER, *Chairman.*

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[1] The president of the college is *ex officio* member and secretary of standing committees. The director of the experiment station is a member of the committee on experiment department, without vote.

Examining Committee of Overseers.

JOHN BURSLEY (*Chairman*), . . . of WEST BARNSTABLE.
W. C. JEWETT, ... of WORCESTER.
CHARLES H. SHAYLOR, . . . of LEE.
ISAAC DAMON, ... of WAYLAND.
A. H. NYE, ... of BLANDFORD.

The Faculty.

KENYON L. BUTTERFIELD, A.M., *President.*

WILLIAM P. BROOKS, PH.D.,
Professor of Agriculture.

CHARLES A. GOESSMANN, PH.D., LL.D.,
Professor of Chemistry.

CHARLES WELLINGTON, PH.D.,
Associate Professor of Chemistry.

CHARLES H. FERNALD, PH.D.,
Professor of Zoölogy.

GEORGE F. MILLS, M.A.,
Professor of English and Latin.

JAMES B. PAIGE, D.V.S.,
Professor of Veterinary Science.

GEORGE E. STONE, PH.D.,
Professor of Botany.

JOHN E. OSTRANDER, M.A., C.E.,
Professor of Mathematics and Civil Engineering.

HENRY T. FERNALD, PH.D.,
Professor of Entomology.

FRANK A. WAUGH, M.S.,
Professor of Horticulture and Landscape Gardening.

GEORGE C. MARTIN, Captain, Eighteenth U. S. Inf.,
Professor of Military Science and Tactics.

PHILIP B. HASBROUCK, B.S.,
Associate Professor of Mathematics.
Adjunct Professor of Physics.

FRED S. COOLEY, B.Sc.,
Assistant Professor of Agriculture.
(Animal Husbandry and Dairying.)

SAMUEL F. HOWARD, B.Sc.,
Assistant Professor of Chemistry.

CLARENCE E. GORDON, A.M.,
Assistant Professor of Zoölogy.

ROBERT W. NEAL, A.M.,
Assistant Professor of English and Instructor in German.

LOUIS R. HERRICK, B.Sc.,
Instructor in French and Spanish.

FRANCIS CANNING,
Instructor in Floriculture.

GEORGE N. HOLCOMB, A.B.,
Instructor in Political Science and History.

A. VINCENT OSMUN, M.Sc.,
Instructor in Botany.

SIDNEY B. HASKELL, B.Sc.,
Instructor in Agriculture.

CHARLES G. BARNUM, A.B.,
Instructor in Chemistry.

MAURICE A. BLAKE, B.Sc.,
Instructor in Horticulture.

HENRY J. FRANKLIN, B.Sc.,
Instructor in Botany.

NATHAN J. HUNTING, B.Sc.,
Instructor in Dairying.

CHARLES P. HALLIGAN, B.Sc.,
Instructor in Drawing.

ERWIN S. FULTON, B.Sc.,
Instructor in Babcock Test.

E. BRINTNALL, B.S.,
Instructor in Butter Making.

ROBERT W. LYMAN, LL.B.,
Lecturer on Farm Law.

FRANK W. RANE, M.S.,
Lecturer on Forestry.

E. FRANCES HALL,
Librarian.

PHILIP B. HASBROUCK, B.S.,
Registrar.

ELWIN H. FORRISTALL, M.Sc.,
Farm Superintendent.

GRACE M. KNOWLES, B.S.,
Secretary to the President.

Graduates of 1906.[1]

Master of Science.

Ballou, Henry Arthur,	St. Michael, Barbadoes.

Bachelor of Science.

Carey, Daniel Henry,	Rockland.
Carpenter, Charles Walter,	Monson.
Craighead, William Hunlie (Boston Univ.),	Boston.
Filer, Harry Burton,	Palmer.
French, George Talbot,	Tewksbury.
Gaskill, Edwin Francis,	Hopedale.
Hall, Jr., Arthur William (Boston Univ.),	North Amherst.
Hastings., Jr., Addison Tyler,	Natick.
Hood, Clarence Ellsworth,	Millis.
Kennedy, Frank Henry,	Ashmont.
Martin, James Edward,	Brockton.
Moseley, Louis Hale,	Glastonbury, Conn.
Mudge, Everett Pike,	Swampscott.
Peakes, Ralph Ware,	Newtonville.
Pray, Fry Civille (Boston Univ.),	Natick.
Rogers, Stanley Sawyer,	Brookline.
Russell, Harry Merwin,	Bridgeport, Conn.
Scott, Edwin Hobart (Boston Univ.),	Cambridge.
Sleeper, George Warren (Boston Univ.),	Swampscott.
Strain, Benjamin,	Mt. Carmel, Conn.
Suhlke, Herman Augustus,	Leominster.
Taft, William Otis,	East Pepperell.
Tannatt, Jr., Willard Colburn,	Dorchester.
Tirrell, Charles Almon,	Plainfield.
Wellington, Richard,	Waltham.
Wholley, Francis Dallas,	Cohasset.
Wood, Alexander Henry Moore,	Easton.
Total,	28

[1] The annual report, being made in January, necessarily includes parts of two academic years, and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1906.

Senior Class.

Alley, Harold Edward,	Gloucester.
Armstrong, Arthur Huguenin,	Hyde Park.
Bartlett, Earle Goodman,	Chicago, Ill.
Caruthers, John Thomas,	Columbia, Tenn.
Chace, Wayland Fairbanks,	Middleboro.
Chadwick, Clifton Harland,	Cochituate.
Chapman, George Henry,	Wallingford, Conn.
Chapman, Joseph Otis,	East Brewster.
Clark, Jr., Milford Henry,	Sunderland.
Cutter, Frederick Augustus,	Lawrence.
Dickinson, Walter Ebenezer,	North Amherst.
Eastman, Jasper Fay,	Townsend.
Green, Herbert Henry,	Spencer.
Hartford, Archie Augustus,	Westford.
Higgins, Arthur William,	Westfield.
King, Clinton,	Dorchester.
Larned, Joseph Adelbert,	Amherst.
Lincoln, Ernest Avery,	Fall River.
Livers, Susie Dearing,	Boston.
Parker, Charles Morton,	Newtonville.
Peters, Frederick Charles,	Lenox.
Pierce, Henry Tyler,	West Millbury.
Shaw, Edward Houghton,	Belmont.
Summers, John Nicholas,	Brockton.
Thompson, Clifford Briggs,	Halifax.
Walker, James Hervey,	Greenwich Village.
Watkins, Fred Alexander,	West Millbury.
Watts, Ralph Jerome,	Littleton.
Wood, Herbert Poland,	Hopedale.
Total,	29

Junior Class.

Allen, Charles Francis,	Worcester.
Anderson, John Albert,	North Brookfield.
Anderson, Kenneth French,	Roslindale.
Bailey, Ernest Winfield,	Worcester.
Bangs, Bradley Wheelock,	Amherst.
Barry, Thomas Addis,	Amherst.

Bartholomew, Persis, ...	Melrose Highlands.
Bates, Carleton, ...	Salem.
Browne, Marcus Metcalf, . . .	Malden.
Chapman, Lloyd Warren, . . .	Pepperell.
Chase, Henry Clinton, . . .	Swampscott.
Clark, Orton Loring, ...	Malden.
Cobb, George Robert, ...	Amherst.
Coleman, William John, . . .	Natick.
Cummings, Winthrop Atherton, . .	Auburn, Cal.
Curtis, Jesse Gerry, ...	South Framingham.
Cutting, Roy Edward, ...	Amherst.
Daniel, John, ...	Osterville.
Davenport, Stearnes Lothrop, . .	North Grafton.
Davis, Paul Augustin, ...	Lowell.
Dolan, Clifford, ...	Hudson.
Eastman, Perley Monroe, . . .	Townsend.
Edwards, Frank Laurence, . . .	Somerville.
Farley, Arthur James, . . .	Waltham.
Farrar, Allan Dana, ...	Amherst.
Farrar, Parke Warren, . . .	Springfield.
Flint, Clifton Leroy, ...	Amesbury.
Gillett, Chester Socrates, . . .	Southwick.
Gillett, Kenneth Edward, . . .	Southwick.
Gold, Frank Lyman, ...	Amherst.
Gowdey, Carlton Cragg, . . .	St. Michael, Barbadoes.
Hayes, Herbert Kendall, . . .	North Granby, Conn.
Howe, William Llewellyn, . . .	Marlborough.
Hyslop, James Augustus, . . .	Rutherford, N. J.
Ingalls, Dorsey Fisher, . . .	Cheshire.
Jackson, Raymond Hobart, . . .	Amherst.
Jennison, Harry Milliken, . . .	Millbury.
Johnson, Frederick Andrew, . .	Westford.
Jones, Thomas Henry, . . .	Easton.
Larsen, David, ...	Bridgeport, Conn.
Liang, Lai-Kwei, ...	Tientsin, China.
Miller, Danforth Parker, . . .	Worcester.
Paige, George R., ...	Amherst.
Parker, John Robert, ...	Poquonock, Conn.
Philbrick, Edwin Daniels, . . .	Somerville.
Reed, Horace Bigelow, . . .	Worcester.
Regan, William Swift, . . .	Northampton.
Sawyer, William Francis, . . .	Sterling.

Shattuck, Leroy Altus,	Pepperell.
Thurston, Frank Eugene,	Worcester.
Turner, Olive May,	Amherst.
Turner, William Franklin,	Reading.
Verbeck, Roland Hale,	Malden.
Warner, Theoren Levi,	Sunderland.
Waugh, Thomas Francis,	Worcester.
Wellington, Joseph Worcester,	Waltham.
Wheeldon, Albert James,	Worcester.
Wheeler, Hermon Temple,	Lincoln.
White, Herbert Linwood,	Maynard.
Whiting, Albert Lemuel,	Stoughton.
Whitmarsh, Raymond Dean,	Amherst.
Wright, Samuel Judd,	South Sudbury.
Total,	62

Sophomore Class.

Adams, William Everett,	Chelmsford.
Alger, Paul Edgar,	Somerville.
Barnes, Jr., Benjamin Franklin,	Haverhill.
Bartlett, Oscar Christopher,	Westhampton.
Bean, Thomas Webster,	South Hadley Falls.
Beebe, John Cleaveland,	Hampden.
Bennett, Ernest Victor,	Malden.
Blake, Rodman Ruggles,	East Pepperell.
Briggs, Orwell Burlton,	Egremont.
Brown, Jr., George Murray,	Cambridge.
Burke, Edward Joseph,	Holyoke.
Caffrey, Donald John,	Gardner.
Cardin, Patricio Penarredonda,	Artemesia, Cuba.
Chase, Edward Irving,	Somerville.
Codding, George Melvin,	Taunton.
Coleman, Leon Nelson,	Gardner.
Corbett, Lamert Seymour,	Jamaica Plain.
Cox, Jr., Alfred Elmer,	Malden.
Cox, Leon Clark,	Boston.
Cronyn, Theodore Reid,	Bernardston.
Crosby, Harold Parsons,	Lenox.
Crossman, Samuel Sutton,	Needham.
Curran, David Aloysius,	Marlboro.

Cutler, Homer,	Westboro.
Eddy, Roger Sherman,	Dorchester.
French, Horace Wells,	Pawtucket, R. I.
Fulton, Gordon Russell,	Lynn.
Gates, Clarence Augustus,	Worcester.
Geer, Myron Francis,	Springfield.
Geer, Wayne Emory,	Springfield.
Hathaway, Elmer Francis,	Cambridge.
Hayward, Warren Willis,	Millbury.
Hsieh, En-Lung,	Tientsin, China.
Hubbard, Arthur Ward,	Sunderland.
Ide, Warren Leroy,	Dudley.
Jen, Huan,	Tientsin, China.
Kenney, Walter James,	Lowell.
Knight, Harry Orrison,	Gardner.
Learned, Wilfred Hill,	Florence.
Lindblad, Rockwood Chester,	North Grafton.
Lull, Robert Delano,	Windsor, Vt.
Lyman, Arthur Densmore,	Springfield.
MacGown, Guy Ernestus,	South Britain, Conn.
Maps, Charles Hulick,	Long Branch, N. J.
Martin, Jr., Nelson Lansing,	Sharon.
Monahan, James Valentine,	South Framingham.
Neale, Harold Johnson,	Worcester.
Noble, Harold Gordon,	Springfield.
Noyes, John,	Roslindale.
O'Donnell, John Francis,	Worcester.
O'Grady, James Raphael,	Holliston.
Oliver, Joseph Thomas,	Boston.
Paddock, Harold Charles,	West Claremont, N. H.
Pearce, Ernest Edwin,	Worcester.
Phelps, Harold Dwight,	West Springfield.
Potter, Richard,	Concord.
Putnam, Charles Sumner,	Princeton.
Richardson, George Tewksbury,	Middleboro.
Sexton, George Francis,	Worcester.
Shamiæ, George Mansoor,	Damascus, Syria.
Smith, Alexander Halliday,	Nyack, N. Y.
Smulyan, Marcus Thomas,	New York, N. Y.
Stewart, Eri Shepardson,	Royalston.
Thompson, Myron Wood,	Halifax.
Thomson, Jared Brewer,	Monterey.

Trainor, Owen Francis,	Worcester.
Treat, Carlton Eddy,	Chelsea.
Tucker, Horace Northrop,	Waterbury, Conn.
Turner, Henry William,	Trinidad, Cuba.
Warner, Frederick Chester,	Sunderland.
Webb, Charles Russell,	Worcester.
Whaley, James Sidney,	East Orange, N. J.
Whelpley, Walter Merton,	Winthrop.
White, Charles Howard,	Providence, R. I.
Willis, Luther George,	Melrose Highlands.
Wilson, Jr., Frank Herbert,	Nahant.
Total,	76

Freshman Class.

Allen, Rodolphus Harold,	Fall River.
Annis, Ross Evered,	Natick.
Bailey, Justus Conant,	Wareham.
Bartlett, Leslie Clarke,	South Hadley Falls.
Beeman, Francis Stone,	West Brookfield.
Bigelow, Windsor Howe,	Princeton.
Blaney, Jonathan Phillips,	Swampscott.
Brandt, Louis,	Everett.
Brooks, Henry Alvan,	Holliston.
Brooks, Sumner Cushing,	Amherst.
Brown, Eben Hermon,	Bridgewater.
Brown, Louis Carmel,	Bridgewater.
Burrill, Ralph Parker,	South Weymouth.
Call, Almon Eugene,	Lynn.
Cary, William Ernest,	Gansevoort, N. Y.
Chaffee, Alfred Brown,	Oxford.
Chase, George Bancroft,	North Adams.
Clarke, Walter Roe,	Milton-on-Hudson, N.Y.
Cloues, William Arthur,	Warner, N. H.
Cowles, Henry Trask,	Worcester.
Curtis, William Edward,	Worcester.
Damon, Edward Farnham,	Concord Junction.
Dickinson, Lawrence S.,	Amherst.
Drohan, Joseph Chauncey,	Belchertown.
Eldridge, Cecil Vernon,	Harwichport.
Everson, John Nelson,	West Hanover.

Faelten, Willibald Carl, . . .	Roxbury.
Fisk, Raymond John, ...	Stoneham.
Folsom, Josiah Chase, ...	Billerica.
Francis, Henry Russell, . . .	Dennisport.
Gould, Harold Alvin, ...	Cambridge.
Hastings, David Beard, . . .	New York Mills, N. Y.
Hatch, William Marcus, . . .	Springfield.
Haynes, Frank Tuttle, . . .	Sturbridge.
Hazen, Myron Smith, ...	Springfield.
Holland, Arthur Witt, . . .	Shrewsbury.
Howe, Chester LeRoy, . . .	Watertown.
Huang, Chen-Hua, ...	Tientsin, China.
Johnson, William Clarence, . . .	South Framingham.
Kelley, Albert Crittenden, . . .	Harwichport.
Kelly, Edward Nicholas, . . .	Globe Village.
Lambert, Marjorie Willard, . . .	W. New Brighton, N. Y.
Leonard, Leavitt Edwin, . . .	Pittsford Mills, Vt.
Leonard, William Edward, . . .	Belmont.
Lightbody, Winfred Curran, . .	South Framingham.
Lipman, Isaac Birkhahn, . . .	Woodbine, N. J.
McGraw, Frank Dobson, . . .	Fall River.
McLaine, Leonard Septimus, . .	New York, N. Y.
Mendum, Samuel Weis, . . .	Roxbury.
Moore, Harold Ithiel, ...	Leominster.
Newcomb, Raymond Wallace, . .	Fitchburg.
Nickless, Fred Parker, . . .	Carlisle.
Nielsen, Gustaf Arnold, . . .	West Newton.
Oertel, Charles Andrew, . . .	South Hadley Falls.
Orr, Lewis Jordan, ...	Portland, Me.
Orr, Philip Eastman, . . .	Portland, Me.
Partridge, Frank Herbert, . . .	Cambridge.
Prouty, Frank Alvin, ...	Worcester.
Robb, Allen James, ...	Wilbraham.
Rockefeller, Harlan Victor, . .	Germantown, N. Y.
Schermerhorn, Lyman Gibbs, . .	Kingston, R. I.
Smith, Halliday Spencer, . . .	Nyack, N. Y.
Smith, Stanley Sawyer, . . .	Athol.
Stalker, William Alexander, . .	Framingham.
Stockwell, Chellis Wheeler, . . .	Athol.
Sullivan, Arthur James, . . .	Dalton.
Taylor, Israel Houston, . . .	Leverett.
Thomas, Frank Lincoln, . . .	Concord.

Titus, Willard McCready Snow,	New Braintree.
Turner, Edward Harrison,	Reading.
Urban, Otto Velorous Taft,	Upton.
Vinton, George Newton,	Sturbridge.
Waldron, Ralph Augustus,	Hyde Park.
Wallace, William Newton,	Amherst.
Whitney, Raymond Lee,	Brockton.
Woodward, Walter Francis,	Worcester.
Total,	76

Short Winter Course, Dairy Farming, 1906.

Arnold, Hewett Fields,	Salisbury, Vt.
Bardwell, Jr., Charles Edward,	Ashland.
Beaubien, Joseph,	Montague.
Bisbee, Fred,	Barre.
Bump, Arthur Cyrus,	Salisbury, Vt.
Clark, George Arthur,	East Charlemont.
Corbin, Leslie Rogers,	Springfield.
Cowern, Herbert George,	Southborough.
Curry, Francis,	Cranston, R. I.
Filley, Oliver Dwight,	Hartford, Conn.
Fillion, George,	South Hadley.
Fuller, Albert Gladstone,	Holyoke.
Heath, Lester Gifford,	Springfield.
Hillman, Arthur Joseph,	Hardwick.
Hilton, Frederick Herbert,	Barre.
Hobbs, Walter Frederick,	Amherst.
Holmes, Helen,	Kingston.
La Fleur, Horace Charles F.,	Northampton.
Leonard, Jr., John Wood,	Plymouth.
Mackenzie, Frank David,	Boston.
Martin, Jr., Nelson Lansing,	Sharon.
Newhall, John Anson,	Newburyport.
Plumb, Harold Edgar,	Readsboro, Vt.
Randall, George Ashley,	Amherst.
Scott, Walter,	East Lyme, Conn.
Strong, Anson Loomis,	Colchester, Conn.
Taylor, Raymond William,	Tyringham.
Trask, Howard Weston,	Peabody.

Wilder, Frank Everett, . . .	Petersham.
Wise, Lewis Henry, ...	Boston.
Total, ...	30

Course in Bee Culture, 1906.

Beebe, Katherine Smith, . . .	Holyoke.
Bullard, Harriett Cox, . . .	Franklin.
Cunningham, Minnie, ...	Holyoke.
Hutchinson, William Ford, . . .	Sutton.
Lambert, Marjorie Willard, . .	West New Brighton, Staten Island, N. Y.
Rand, Jean C., ...	Holyoke.
Total, ...	6

Graduate Students.

For Degrees of M.S. and Ph.D.

Back (B.Sc., M. A. C., '04), Ernest Adna, ...	Florence.
Franklin (B.Sc., M. A. C., '03), Henry James, ...	Bernardston.
Hooker (B.A., Amherst, '06), Charles Worcester, ...	Amherst.
Ladd (B.Sc., M. A. C., '05), Edward Thorndike, ...	Winchester.
Lancaster (A.B., Harvard, '84; M.D., Harvard, '89), Walter Brackett, .	Boston.
Monahan (B.Sc., M. A. C., '03), Niel Francis, ...	Amherst.
Osmun (M.S., M. A. C., '05), Albert Vincent, ...	Danbury, Conn.
Russell (B.Sc., M. A. C., '06), Harry Merwin, ...	Bridgeport, Conn.
Smith (B.Sc., M. A. C., '97), Philip Henry, ...	Amherst.
Tottingham (B.Sc., M. A. C., '03), William Edward, ...	Bernardston.

Tower (B.Sc., M. A. C., '03), Winthrop Vose,	Roxbury.	
Walker (B.Sc., M. A. C., '05), Lewell Seth,	Natick.	
Total,		12

Special Students.

Macaulay, Mrs. John,	New York, N. Y.	
Turner, James Arthur,	Springfield.	
Total,		2

Summary.

Graduate course: —		
For degrees of M.S. and Ph.D.,	12	
Four-years course: —		
Graduates of 1906,	28	
Senior class,	29	
Junior class,	62	
Sophomore class,	76	
Freshman class,	76	
Winter courses,	30	
Special students,	8	
Total,		321
Entered twice,		3
Total,		318

OBJECT.

The leading object of the Massachusetts Agricultural College is "to teach such branches of learning as are related to agriculture and the mechanic arts, . . . in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life." That this result may be secured by those for whom it is intended, the college invites the co-operation and patronage of all who are interested in the advanced education of the industrial classes in the Commonwealth.

The instruction here given is both theoretical and practical. The principles of agriculture are illustrated on the extended acres of the farm belonging to the college estate. Nature's work in botany and in horticulture is revealed to the eye of the student in the plant house and in the orchards accessible to all, while the mysteries of insect life, the diseases and the cure of domestic animals, the analysis of matter in its various forms, and the study of the earth itself, "the mother of us all," may engage the attention of the student during the years of his college course.

GRADUATE COURSES.

In response to the increasing demand for advanced work in various directions, the college has arranged for courses of study leading to the degrees of Master of Science and Doctor of Philosophy.

Honorary degrees are not conferred.

Applicants are not eligible to the degree of Master of Science or Doctor of Philosophy until they have received the degree of Bachelor of Science or its equivalent.

The fee for the degree of Master of Science is ten dollars and for the degree of Doctor of Philosophy twenty-five dollars, to be paid to the treasurer of the college before the degree is conferred.

Courses for the Degree of Master of Science.

A course of study is offered in each of the following subjects: mathematics and physics, chemistry, agriculture, botany, horticulture, entomology, veterinary medicine. Upon the satisfactory completion of any two of these, the applicant receives the degree of Master of Science.

Candidates for the degree of Master of Science must devote not less than one year and a half after graduation to the prosecution of two of the above courses. At least one full academic year must be passed in residence at the Massachusetts Agricultural College.

When a graduate student is working for a Master's Degree, and at the same time is, or has been, employed with or without pay in some department of this college or of the experiment station in the same kind of work as his major or minor studies, or both, the teacher in charge of his graduate work in the subject or subjects concerned may allow for so much of this work as in his judgment would be legitimate graduate work were the student not so employed. This rule shall not, however, be regarded as modifying any rule now in force as to residence while working for a Master's Degree.

Courses for the Degree of Doctor of Philosophy.

The establishment of courses leading to this degree is the result of many calls for advanced study along certain economic lines neglected in most American universities, and is given only by those departments especially equipped for this grade of study, to graduates of this college or other colleges of good standing. The work required for the degree is intended to be so advanced in its character as to necessitate the greatest industry to complete it, with the belief that such severe requirements will result in the greatest credit to those who are successful. Four courses of study only are therefore open, viz., botany, chemistry, entomology and horticulture as major subjects, though a minor in zoölogy is also available.

At least three years are necessary to complete the work required; twenty hours per week to be devoted to the major subject, while from twelve to sixteen hours per week are required for each of the two minor subjects during one and a half years.

The work in the major and minors will necessarily differ with the previous training and needs of different students, but a general outline of the major in each subject is as follows: —

Botany. — Vegetable physiology, vegetable pathology, mycology, œcology, taxonomy, phylogeny, the history of botany, and the history and theory of evolution. The above subdivisions of botany will be, to a greater or less extent, pursued as necessitated by the previous training of the student and nature of the original problem undertaken. In this course it is also recommended that the student take, in addition to this prescribed minor work, a brief course in the history of philosophy and psychology, which at present will have to be obtained elsewhere. Extensive reading of botanical literature, of both a general and specific nature, will be required in certain subjects, and occasional lectures will be given. A botanical conference is held monthly, wherein various new problems touching upon botanical science are considered by graduate students and those of the senior class electing botany. A thesis dealing with some economic problem in plant physiology or pathology, or both, and containing a distinct contribution to knowledge, will also be required.

Chemistry. — Advanced work in the following subjects: inorganic analysis, qualitative, of the rarer elements, and quantitative; crystallography, physical chemistry; descriptive and determinative mineralogy; chemical geology; soil formation; soil physics and chemistry; gas analysis; synthetic inorganic work; chemical theory and history; general organic chemistry; special topics in organic chemistry; elementary quantitative organic analysis; proximate qualitative and quantitative organic analysis, including determination of organic radicles; organic synthesis of aliphatic and aromatic compounds; problems in chemical manufacture; recent chemistry of plant nutrition; animal physiological and pathological chemistry, including foods, standards for feeding of all kinds, and, among secretions, milk and milk industries; and, among excretions, urine and urinalysis; toxicology; insecticides and fungicides; frequent examinations on current chemical literature.

Early in the course original work on some chemical subject pertaining to agriculture must be begun. The history and results of this work must be submitted before graduation, in the form of a thesis containing a distinct contribution to knowledge.

Entomology. — General morphology of insects; embryology; life history and transformations; histology; phylogeny and relation to other arthropods; hermaphroditism; hybrids; parthenogenesis; pædogenesis; heterogamy; chemistry of colors in insects; luminosity; deformities of insects; variation; duration of life.

Œcology: dimorphism; polymorphism; warning coloration; mimicry; insect architecture; fertilization of plants by insects; instincts of insects; insect products of value to man; geographical distribution in the different faunal regions; methods of distribution; insect migrations; geological history of insects, insects as disseminators of disease; enemies of insects, vegetable and animal, including parasitism.

Economic entomology: general principles; insecticides; apparatus; special cases; photography of insects and their work; methods of drawing for illustrations; field work on insects, and study of life histories; legislation concerning insects.

Systematic entomology: history of entomology, including classifications and the principles of classification; laws governing nomenclature; literature, — how to find and use it; indexing literature; number of insects in collections and existence (estimated); lives of prominent entomologists; methods of collecting, preparing, preserving and shipping insects; important collections of insects.

Journal club: assignments of the literature on the different groups of insects to different students, who report at monthly meetings summaries of all articles of value which have appeared during the month.

Required readings of the best articles on the various topics named above, and on the different orders of insects. This reading covers from 15,000 to 20,000 pages in English, French and German, and the candidate is examined on this, together with his other work, at the close of his course.

Thesis: a thesis with drawings, which shall consist of the results of original investigations along one or several lines, and which shall constitute a distinct contribution to knowledge, must be completed and accepted before the final examinations are taken.

Horticulture. — The work in horticulture necessarily varies considerably with different candidates, since its most important features are specialization, original investigation, and the development of individual initiative in dealing with new questions. Each candidate must select some special field of horticultural study, and devote himself continuously to it. He will be required to attend lectures, conferences and seminars dealing with horticulture in its broader aspects. Advanced work will be required in the following subjects: systematic pomology, pomological practice, commercial pomology; systematic, practical and commercial olericulture; greenhouse plants and problems; floriculture; landscape gardening; plant breeding and general evolution; and questions of a physiological nature connected with propagation and pruning.

Other requirements and opportunities are: (1) periodical seminars with special lectures, by prominent men from outside the college; (2) extensive and systematically planned readings; (3) frequent visits to orchards, gardens, greenhouses, estates and libraries outside the college grounds, always with some definite purpose in view; (4) and, finally, the preparation and publication of a thesis setting forth the results of the candidate's major study, which shall be an original and positive contribution to horticultural knowledge.

Zoölogy, offered as a minor for the degree of Doctor of Philosophy. This course deals with the larger problems and aspects which the subject presents, and with which the student in any department of zoölogy should be familiar. Zoölogy 3, or its equivalent, is prerequisite. The aim is to give the student a liberal equipment for further work, to introduce him to some fields outside his specialty, as well as to meet his more imperative needs as a specialist.

Lecture attendance and collateral reading, and laboratory and seminar work are required. The student is early set to work upon some problem of practical importance in the study of which he may learn the inseparable relationship of the pure and the practical in scientific inquiry.

FOUR-YEARS COURSES.

Degree.

Those who complete the four-years course receive the degree of Bachelor of Science, the diploma being signed by the governor of Massachusetts, who is the president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni, provided that the candidate, in addition to the college course, shall have mastered in a preparatory school a three-years preparatory course in studies beyond those commonly presented in the grammar schools of Massachusetts.

Admission.

Every candidate for admission must be at least sixteen years of age, and must present a testimonial of good character from the principal of the last school that he attended.

Certificates. — Certificates of schools and academies approved by the faculty of the college are accepted in place of examinations. These certificates must be made out on blanks furnished on application to the registrar, and must be signed by the principal of the school making such application.

A student admitted on certificate may be dropped from college at any time during freshman year when his work is not satisfactory; and the privilege implied in the acceptance of a certificate may be revoked whenever, in the judgment of the faculty, it is not properly exercised.

Examinations. — Candidates for admission to the freshman class will be received on certificate, as explained above, or on examination in the following subjects: algebra (through quadratics), plane geometry, English, general history, civil government (Mowry's "Studies in Civil Government"), physiology

(Martin's "The Human Body," briefer course), physical geography (Guyot's "Physical Geography," or its equivalent).

This examination may be oral or written; the standard required for admission is 65 per cent. in each subject. Knowledge of the principles of arithmetic is presupposed, although an examination in this subject is not required. Teachers are urged to give their pupils such drill in algebra and geometry as shall secure accuracy and readiness in the application of principles to practical examples.

A candidate will not be accepted in English whose work is notably deficient in point of spelling, punctuation, idiom or division into paragraphs. The candidate will be required to present evidence of a general knowledge of the subject matter of the books named below, and to answer simple questions on the lives of their authors. The form of examination will usually be the writing of a paragraph or two on each of several topics to be chosen by the candidate from a considerable number — perhaps ten or fifteen — set before him in the examination paper. The treatment of these topics is designed to test the candidate's power of clear and accurate expression, and will imply only a general knowledge of the substance of the books. The books set for the examination in 1907 and 1908 are: Shakespeare's "The Merchant of Venice;" Irving's "Life of Goldsmith;" Coleridge's "The Ancient Mariner;" Scott's "Ivanhoe" and "The Lady of the Lake;" Tennyson's "The Passing of Arthur;" Lowell's "The Vision of Sir Launfal;" George Eliot's "Silas Marner."

Examinations in one or more of the required subjects may be taken a year before the candidate expects to enter college, and credit for successful examination in any subject will stand for two years after the examination.

Candidates for classes more advanced than the freshman class will be examined in the studies gone over by the class to which they desire admission.

The examinations for admission in 1907 will be held at the Botanic Museum of the Agricultural College in Amherst on Thursday and Friday, June 20 and 21, and on Tuesday and Wednesday, September 17 and 18, as follows: —

First Day.	*Second Day.*
8.30 A.M. — Registration.	9 A.M. — Civil government.
9 A.M. — English.	10 A.M. — Algebra.
11 A.M. — General history.	2 P.M. — Physiology.
2 P.M. — Geometry.	3 P.M. — Physical geography.

Entrance examinations in June will be held on the same days and in the same order as in Amherst: at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; at Horticultural Hall, Worcester; and at Pittsfield, but candidates may be examined and admitted at the convenience of the examiners, at other times in the year, but not during the summer vacation.

ENTRANCE EXAMINATION PAPERS USED IN 1906.

The standard required is 65 per cent. on each paper.

Algebra.

1. Factor: (*a*) $a^{-2}x^{-m}+14a^{-1}x^{-\frac{m}{2}}+49$.
   (*b*) $2ax-3bx+2a-3b$.
   (*c*) $a^4+a^2y^2-a^2b^2-b^2y^2$.

2. Clear of negative exponents, and simplify the result in the expression $\left\{\dfrac{a^{-2}b^{-2}}{a^{-2}+b^{-2}}\right\}\ \left\{\dfrac{a^2+b^2}{a^{-1}-b^{-1}}\right\}$.

3. Find the square root of the expression

$$x^{\frac{5}{3}}-4x^{\frac{4}{3}}+2x+4x^{\frac{2}{3}}+x^{\frac{1}{3}}.$$

4. Expand $(\sqrt{-2}+\sqrt{-3})^3$ and reduce to simplest form.

5. Find the square root of the binomial surd $4\frac{1}{2}x-1+2\sqrt{2}$.

6. $\sqrt{3+x}+\sqrt{3-x}=2\sqrt{x}$. Solve for x.

7. $\left\{\begin{array}{l} x^{-3}+y^{-3}=152 \\ x^{-1}+y^{-1}=8 \end{array}\right\}$ Solve for x and y.

8. $\left\{\begin{array}{l} x^2+xy=12 \\ xy-2y^2=1 \end{array}\right\}$ Solve for x and y.

Geometry.

1. Prove: If the two sides of a triangle are unequal, the angles opposite are unequal, and the greater angle lies opposite the greater side.

2. Prove: The angle between two secants, intersecting without the circumference, is measured by one-half the difference of the intersected arcs.

3. Two triangles, having an angle of one equal to an angle of the other, are to each other as the product of the sides including the equal angles. Prove.

4. If the radius of a circle is $3\sqrt{3}$, what is the area of a sector whose central angle is $152°$?

5. Find the area of a square inscribed in a circle whose area is 196π.

Physical Geography.

1. Describe in detail the general physical features of the continent of North America; its form, coast line, mountains, river systems and lakes.

2. Describe at least three methods of mountain formation. What do you mean by youth, maturity and old age of a mountain? Illustrate.

3. Describe the Sahara; its climate, vegetation and inhabitants. What was the probable cause of its present condition?

4. Describe Mount Vesuvius and the recent eruption. What were its causes and effects? Is such an eruption likely to occur again?

5. What are the principal races of mankind? Give the main characteristics of each, with the state of civilization and geographical distribution.

Civil Government.

1. What was the government of Massachusetts before the revolution? State its principal features. What was the government of the United States during the revolution? When did the constitution of the United States go into effect? Write its preamble.

2. What three "powers" of government are defined in the constitution? What duty belongs to each of these powers?

3. Write on the following subjects, developing them as fully as you can: —

(*a*) The United States Senate.

(*b*) The Legislature of Massachusetts.

(*c*) The government of any city or town of Massachusetts.

4. Name the coins of the United States. What is the distinction between a mint and an assay office? Where is the principal mint of the United States located? Where the branch mints?

5. Describe the national bank system of the United States. What are treasury notes?

6. Define *naturalization*. State the principal points in the

"uniform rules of naturalization" established by Congress. What classes of persons are included in the term, "citizens of the United States"?

Physiology.

1. Describe the chemical constitution of the body, with the elements, and the organic and the inorganic compounds found therein.

2. Name and locate the bones of the skull, bounding each bone as you would the countries on a map. Describe with a diagram the histology of bone.

3. What three forms of energy are manifest in the human body? How is this energy produced, and what is its ultimate source?

4. What do you mean by nutrition? What is its purpose? Name and define the several steps in the nourishing of the human body.

5. Describe the brain carefully; its protective envelopes, and the relative size, form and proportions of its various parts. What are the probable functions of each of the principal parts?

General History.

1. The Hebrew religion and literature: relation of this religion to the Christian world of to-day, and the great works of Hebrew literature which have been used by the Christians and the Jews as sources of teaching.

2. Greek character and Greek history as influenced by: (*a*) mountains, (*b*) surrounding sea and islands.

3. Greek oratory: (*a*) influence of the public assembly; (*b*) Demosthenes, and how he prepared himself to be an orator.

4. Give in a few words the part played in Roman history by Julius Cæsar, mentioning: (*a*) his work as a subduer of barbarians, (*b*) his struggle with Pompey, (*c*) his career as a statesman.

5. Explain clearly the relation which existed during the middle ages between Church and State.

6. Explain the term, "The Reign of Terror," as used in French history.

English.

Note. — "A candidate will not be accepted in English whose work is notably deficient in point of spelling, punctuation, phraseology or division into paragraphs." (From the college catalog.)

1. State in a general way, yet fully and clearly, what work you have done in the high school: —

(*a*) In the study of rhetoric.

(*b*) In composition writing.

(*c*) In the study of literature.

2. Have you read all the books assigned for examination in entrance English? Were these books read in connection with class work, or as outside work?

3. Choose any two names from the following list, and write an interesting, brief account of the authors' lives: —

(*a*) Shakespeare, (*b*) Scott, (*c*) Irving, (*d*) Lowell.

4. What can you say of Tennyson's love of retirement?

5. Choose from among the following topics any four; write interestingly upon them: —

(*a*) Is Shylock to be pitied, or to be hated?

(*b*) Is Irving a sympathetic biographer of Goldsmith?

(*c*) The underlying value of Scott's "Ivanhoe."

(*d*) The opening scene in the "Lady of the Lake."

(*e*) Tennyson's view of woman's place in society, as given in "The Princess."

(*f*) Carlyle's estimate of Burns' sincerity, and his (Burns') choice of subjects.

(*g*) The center-thought of the "Vision of Sir Launfal."

(*h*) A brief outline of the chief characters in "Silas Marner."

COURSES OF INSTRUCTION FOR THE DEGREE OF BACHELOR OF SCIENCE.

Agriculture.

Introductory: relations of federal and State governments to agriculture, four lectures; history of agriculture, tenure of land, rents, holdings, etc., six lectures.

Freshman year, first semester, three hours a week, required. Animal breeding. Shaw's "Breeding Animals," lectures and discussion of principles of breeding. — Assistant Professor Cooley.

Sophomore year, seven weeks, first semester, four exercises a week in class room, required. Breeds of farm live stock: sheep, cattle. Lecture syllabus by Cooley, and Curtis's "Horses, Cattle, Sheep and Swine." — Assistant Professor Cooley.

Sophomore year, nine weeks, first semester, four exercises a week in class room, required. Horses and swine. Lecture syllabus by Cooley, and Curtis's "Horses, Cattle, Sheep and Swine." — Assistant Professor Cooley.

Sophomore year, eight weeks, second semester, three hours a week, required. Dairying. Lectures on dairy farming, milk production, handling and marketing of milk, milk preservation and modification, and products of milk. Text-book, Wing's "Milk and its Products." — Assistant Professor Cooley.

Sophomore year, ten weeks, second semester, required. Soils: formation, classification, composition; physical and chemical characteristics, and their relations to maintenance and increase in productiveness. Brooks's "Agriculture," Vol. I., supplemented by lectures and laboratory work. — Professor Brooks.

Junior year, ten weeks, first semester, elective. Methods of soil improvement, including tillage, drainage and irrigation. Brooks's "Agriculture," Vol. I., supplemented by lectures, laboratory work and practical exercises. — Professor Brooks.

Junior year, four weeks, first semester, elective. Manures: production, composition, properties, adaptation and use. Brooks's "Agriculture," Vol. II., supplemented by lectures and practical exercises. — Professor Brooks.

Junior year, four weeks, first semester, elective. Stock judging. — Assistant Professor Cooley.

.Junior year, second semester, elective. Fertilizers, including a critical study of their production, composition, properties, adaptation and use; and green manuring. Brooks's "Agriculture," Vol. II., supplemented by lectures, laboratory work and practical exercises. — Professor Brooks.

Senior year, four weeks, first semester, four hours a week, elective. Silos and ensilage: historical development; the merits and methods of construction of the different kinds of silos; the crops suited for ensilage; ensilage machinery; the methods of filling the silo; and the nature and extent of the changes taking place in ensilage as affecting food value. Lectures, books of reference and practical exercises. — Professor Brooks.

Senior year, seven weeks, first semester, four hours a week, elective. Feeding animals: principles of digestion and animal nutrition, a study of feeding stuffs (coarse and concentrated). The relation of food to product; compounding rations. Armsby's "Cattle Feeding," lectures and discussion. — Assistant Professor Cooley.

Senior year, seven weeks, first semester, four hours a week, elective. Dairying: selection and management of the dairy farm, dairy cattle, chemical and physical properties of milk, etc., cream, butter, cheese and by-products. — Assistant Professor Cooley.

Senior year, first semester, four exercises a week for eight weeks. Dairy practice: use of separators, Babcock tester, butter making, etc. — Specialists.

Senior year, second semester, elective. The crops of the farm and crop rotation; including a study of the origin and agricultural botany of all the leading crops of the farm, — annual forage crops, grasses and legumes, cereals, root crops, vegetables, tobacco and other special commercial crops: the production and uses of each; the varieties and methods of improvement; the adaptation to soil; the special manurial requirements and the methods of raising and harvesting are considered. Lectures, reference books and field work. — Professor Brooks.

Senior year, second semester, elective. Agricultural experimentation: objects, methods, sources of error; interpretation of results. Lectures and study of reports, bulletins, etc. — Professor Brooks.

Senior year, second semester, elective. Farm management: selection of the farm, its subdivision and equipment, buildings, fences, roads, water supply; farm capital, permanent, perishable and floating; the labor of the farm and its management; farm power and farm machinery. Lectures and practical exercises. — Professor Brooks.

Seminar courses, by arrangement, for advanced students.

Special problems requiring experiment or other research investigation will be assigned to students fitted for and desiring such work.

Training and practice in the use of farm implements and machines by arrangement when desired.

Horticulture.

This department endeavors to give the student a working knowledge of horticulture on its practical and on its scientific side. The attempt is made to inculcate a taste and an enthusiasm for horticultural pursuits, in place of distaste and dislike for the drudgery of farm life. On these things success and further progress chiefly depend.

The courses now offered are as follows, though others will be added as occasion requires: —

1. Sophomore class, second semester. The fundamental operations of horticulture, — propagation, pruning and cultivation, — as related to the physiology of the plant. During the first half of this course Bailey's "Nursery Book" is used as a text. — Mr. Blake.

2. Junior year, first semester. Pomology: this course covers the three natural divisions of the subject, viz.: (*a*) systematic pomology, or the study of the fruits themselves; (*b*) practical pomology, or the practice of fruit growing; (*c*) commercial pomology, or the principles underlying the marketing of fruits. The course is pursued by means of text-book, lectures, laboratory and field exercises. — Mr. Blake.

3. Junior year, first semester, four periods weekly. Plant breeding: based on a thorough examination of the laws of heredity and of variation, and of the principal theories of evolution. Lectures, accompanied by practice and direct experiments in crossing and hybridizing plants. — Professor Waugh.

4. Junior year, second semester, four periods weekly. Market gardening, including vegetables and small fruits; locations, soils, methods of cultivation and marketing. Text-book, lectures and field exercises. — Mr. Blake.

5. Individual problems will be assigned to seniors who elect horticulture. This gives the student an opportunity for specialization in various lines of fruit growing, vegetable culture, greenhouse management, landscape gardening, etc. — Professor Waugh, Mr. Blake and Mr. Canning.

A seminar, made up of all students electing advanced work in horticulture or landscape gardening, meets weekly for the discussion of any matters pertaining to the subject. Successful and noted horticulturists from outside the college are frequently present at these meetings, to speak on the topics with which they are especially identified.

Landscape Gardening.

The college wishes to promote the work in landscape gardening in every way possible. The aim of the courses is to give the general student an understanding of the fundamental principles of design and of good taste as applied to gardening, and to prepare advanced students for the practice of landscape gardening in its various branches.

Although a variety of other work along related lines is available, the courses now definitely offered are as follows: —

1. Junior year, first and second semesters, four hours a week. Elements of landscape design: the fundamental principles underlying the artistic development of parks, estates, gardens and other areas, together with some of the simpler applications to practical conditions. — Professor Waugh and Mr. Halligan.

2. Junior year, first semester, three periods weekly. Arboriculture: trees, shrubs and other ornamental plants; their propagation, planting and care. Field and laboratory exercises and lectures. — Professor Waugh, Mr. Canning and Mr. Halligan.

3. Senior year, first and second semesters, four laboratory periods weekly. Advanced landscape gardening: lectures, conferences, field exercises and extensive practice work with criticism. The student is given definite problems to solve, these problems being arranged in such an order as to develop the subject logically in the student's mind. — Professor Waugh.

Chemistry.

This course aims to inculcate accurate observation, logical thinking, systematic and constant industry, together with a comprehensive knowledge of the subject. Instruction is given by text-book, lectures and a large amount of laboratory work under adequate supervision. The laboratory work at first consists of a study of the properties of elementary matter, analysis of simple combinations and their artificial preparation. This is followed by a quantitative analysis of salts, minerals, soils, fertilizers, animal and vegetable products. The advanced instruction takes up the chemistry of various manufacturing industries, especially those of agricultural interest, such as the production of sugar, starch and dairy products; the preparation of animal and plant foods, their digestive assimilation and economic use; the official analysis of fertilizers, fodders and foods; and the analysis of soils, waters, milk, wine and other animal and vegetable products.

The courses are as follows: —

Freshman year, second half of second semester, four hours a week. General chemistry, part 1, principles of chemistry, non-metals. Newth's "Inorganic Chemistry." — Assistant Professor Howard.

Sophomore year, first semester, six hours a week. General chemistry, part 2, metals. — Assistant Professor Howard.

Second semester, five hours a week. Subject continued; dry analysis. — Assistant Professor Howard.

Junior year, first semester, eight hours a week. Qualitative and quantitative analysis; organic chemistry. Four hours a week, special subject. — Professor Wellington.

Second semester, ten hours a week. Organic chemistry. Remsen's "Organic Chemistry." Five hours a week, special subject. — Professor Wellington.

Senior year, elective, first semester, three hours a week. Chemical industries. — Professor Goessmann.

Eight hours a week, quantitative analysis and physical chemistry. Reychler-McCrae's "Physical Chemistry." — Professor Wellington and Assistant Professor Howard.

Second semester, eight hours a week. Advanced work, with lectures. — Professor Wellington.

Geology.

1. Mineralogy, junior year, second semester, six weeks, three hours a week. A course of systematic determinative mineralogy, based on Brush's "Manual." This work is carried on in the laboratory, and consists in determining the minerals by a study of lustre, fusibility, hardness, color, streak, specific gravity, etc., and by some of the simpler chemical tests. — Assistant Professor Howard.

2. Geology, elective in junior year, second semester, three hours a week. Petrography; the rock-forming minerals, rocks, rock characters. Structural geology. Dynamic geology; the agents of rock disintegration are emphasized. Surface geology; soils, erosion, transportation, reconstructive processes, land making. Historic geology. — Assistant Professor Gordon.

Zoölogy.

1. Anatomy and physiology, freshman year, one-half second semester, four hours a week. The body is dealt with largely as a mechanism. Hygiene, sanitation as related to sewer and garbage disposal, water supply, construction of habitations and hygiene of transmissible diseases are emphasized. — Assistant Professor Gordon.

2. Zoölogy, sophomore year, first semester, two periods a week. This forms the zoölogical part of an introductory course in biology. The aim is to familiarize the student with the

structure of a number of typical forms, representative of the chief phyla of the animal kingdom, to train him to more precise habits of observation, and to lay the foundation for a more thorough understanding of laboratory technique. Lectures, amply illustrated by specimens, charts and lantern slides, supplement and render orderly the knowledge gained in the laboratory. — Assistant Professor Gordon.

3. Zoölogy. For this course zoölogy 2 or its equivalent is prerequisite. Elective for the junior year, four periods a week. This course attempts an introduction to each group. In those groups which are of economic importance the emphasis is placed on that aspect. As the final work of some students and as the ground work of others who plan to go farther, the course is made as thorough as the time available, in and out of the class room, will permit. The student is not led to believe that any text-book represents the sum total of human knowledge on all the biological problems of the day, but is rather encouraged to think and ponder. To this end the discussion of the origin of one or two morphological features in those groups in which these features present themselves, or the discussion of a morphological series as suggestive of an evolutionary one, is consistently carried through. Other fields for investigation are continually suggested. The lectures are illustrated by the complete museum collections. — Assistant Professor Gordon.

Economics and Government.

The aim of this department is to introduce the student to such studies as may enable him to deal with economic problems and to fulfill his social and political duties. In all work of the department the text-book and lecture systems are combined.

1. History, freshman year, two hours a week, both semesters. In this course the history of England to the close of the middle ages is studied; then the history of England and the American colonies, in conjunction, to the year 1783; and then the modern history of England and the United States. Emphasis is laid on social and economic conditions, but the more important political, religious and other phases of English and American history are treated in the lectures. Cheyney's "Social and Industrial History of England" and Coman's "Industrial History of the United States" are used as text-books. This course is preparatory to courses 2 and 3. — Mr. Holcomb.

2. Economics, junior year, first semester, four hours a week.

Ely's "Outlines of Economics" and Taylor's "Introduction to Agricultural Economics" are used as text-books. The lectures on general economics are intended to supplement Ely's book, with emphasis on present-day problems. The lectures on agricultural economics treat of the history of the agricultural industry, and existing agricultural economic conditions and tendencies in the United States. Such subjects as the resources of the various geographical divisions of our country in land and labor, the application of division of labor to agriculture, specialized and diversified farming, the large and small farm systems, tenure of farm lands, the transportation of farm products, tendencies toward agricultural co-operation, and those characteristics of agriculture which make it especially attractive to the liberally educated mind, are briefly treated. Special papers on subjects selected by the individual students from an assigned list are read and discussed in the class room.

3. Government, senior year, four hours a week, during the last half of the first semester and the whole of the second. Woodburn's "The American Republic" is used as a text-book, supplemented by assigned readings in Hart's "Actual Government" and Buchanon's "Massachusetts Town Officers." The lectures treat of general sociology, the theory and forms of the State, the origin and history of American political institutions, political parties and movements in the United States, and eminent political leaders and interpreters of the Constitution. Special attention is given to the United States Department of Agriculture, State Board of Agriculture, agricultural education and the organization of the New England country town. — Mr. Holcomb.

Lectures on law, second semester, one hour a week. This course treats of laws relating to business, especially to business connected with rural affairs, citizenship, domestic relations, farming contracts, riparian rights, real estate and common forms of conveyance. Practical work is required, such as may fit one to perform the duties of a justice of the peace. — Mr. Lyman.

English.

This department aims to secure: (*a*) ability to give written and oral expression of thought in correct, effective English; (*b*) acquaintance with the masterpieces of American and English literature; (*c*) ability to present logically and forcibly, oral and written arguments on propositions assigned for debate.

The following courses are offered: under (*a*) rhetoric and oratory; under (*b*) American literature and English literature; under (*c*) argumentation. The elective course in senior year is in language and literature.

1. *Rhetoric.* — This course extends through the two semesters of freshman year and through the second semester of sophomore year. In the first semester of freshman year work is confined to essay writing and to personal criticism, by the instructor, of the student's compositions. This criticism is offered at stated intervals to each student individually, according to a posted schedule of appointments. At the beginning of the semester necessary information with regard to the preparation of essays is furnished each student. In the second semester of freshman year the study of literary types is undertaken in the form of class room work in prose composition, including exposition, persuasion, narration, description and in prose diction, including usage and style. Special attention is given to the training of the inventive ability of the student. The text-book used is Baldwin's "College Manual of Rhetoric." In the second semester of sophomore year individual work in essay writing is again taken up, largely based upon the previous work of the class in American literature (see 3, below). Here also personal criticism is offered. — Assistant Professor Neal.

2. *Oratory.* — Individual drill in declamation, first in private and then before the class, is given during the second semester of freshman year. The choice of speakers for the Burnham prizes is based upon this work. In the junior year, during the first semester, at least two orations, upon subjects assigned or chosen, are written, and delivered before the class. Every oration is criticised by the instructor before it is committed to memory by the student. The choice of speakers for the Flint prizes in oratory is based upon this work. — Professor Mills and Assistant Professor Neal.

3. *Literature.* — American literature is studied in the first semester of sophomore year, three hours a week. The course comprises, first, the careful study of a text-book (Newcomer's "American Literature"), together with recitations based upon the same; secondly, the taking of notes from lectures, dwelling upon topics not fully treated in the text-book; and, thirdly, the reading outside of the class room of assigned selections from the prose and poetical works of standard American authors. — Assistant Professor Neal.

The history of English literature is studied during the second semester of sophomore year, four hours a week. The work is based upon a text-book, this year Johnson's "History of English and American Literature." The topical method is followed in recitation, and, instead of formal lectures, there are discussions of points requiring a fuller development than the text-book gives. Collateral readings of literature are required. Frequent written tests are given, in which particular attention is given to (*a*) the definition of words used in the text-book; (*b*) the use of English in the development of the topics unfolded in the text-book or discussed in the class room. — Professor MILLS.

4. *Argumentation.* — Four hours a week during the first semester of junior year are given to written and oral argumentation. The course is outlined as follows: (*a*) principles of argumentation as laid down in a text-book or by lecture; (*b*) briefs and brief-making; (*c*) briefs developed into forensics and submitted for personal criticism: (*d*) debates. — Professor MILLS.

Senior elective course, two semesters, four hours a week. The work in this course is upon the following subjects: (*a*) English language, its origin, history and development, with particular attention to the study of words as outlined in Anderson's "A Study of English Words;" (*b*) English literature, principally of the eighteenth and nineteenth centuries. — Professor MILLS.

VETERINARY SCIENCE.

The course of instruction in veterinary science has been arranged to meet the demands of the students who, after graduation, purpose following some line of work in practical agriculture. Particular stress is laid upon matters relating to the prevention of disease in animals. In addition, the interests of prospective students of human and comparative medicine have been taken into account in the arrangement of the course of study. The subject is taught by lectures, laboratory exercises, demonstration and clinics.

Senior year, elective, first semester, four hours a week. Veterinary hygiene, comparative (veterinary) anatomy, general pathology. — Professor PAIGE.

Second semester, four hours a week. Veterinary materia medica and therapeutics; theory and practice of veterinary medicine; general, special and operative surgery; veterinary bacteriology and parasitology; medical and surgical clinics. — Professor PAIGE.

Bacteriology.

The instruction in bacteriology is given by means of lectures, recitations and laboratory exercises. The object of this course of study is to acquaint the student with the various organisms found in air, water, soil, milk and the body, and their relation to such processes as decomposition, fermentation, digestion and production of disease. The toxic substances resulting from the growth of organisms are considered, as well as the antitoxin used to counteract their action.

Senior year, first half of the first semester, four laboratory exercises, of two hours each a week, required. — Professor Paige.

Botany.

The object of the course in botany is to teach those topics pertaining to the science which have a bearing upon economic and scientific agriculture. The undergraduate work extends through six semesters. The first two semesters are required. An outline of the course follows: —

Freshman year, first semester, five hours a week. Laboratory work and lectures; histology and physiology of the higher plants. This includes a study of the minute structure of the plant organism, such as stems, roots, leaves, seeds, etc., and of their functions and chemical and physical properties. This course extends into the next semester. — Mr. Osmun.

Freshman year, second semester, three hours a week. Laboratory work, lectures and text-book; outlines of classification and morphology of the higher plants. This course follows the preceding one, and commences about the first of March. It is devoted to a study of the relationship of plants, their gross structure, together with extensive individual practice in flower analysis. An herbarium of two hundred species of plants is required. — Mr. Osmun.

Junior year, first semester, five hours a week. Two laboratory exercises and one lecture period a week. Cryptogamic botany. This includes a study of the lower forms of plant life, and is necessary for a comprehension of the following courses. — Mr. Osmun.

Junior year, second semester, five hours a week. Two laboratory exercises and one lecture period a week. Elements of vegetable pathology and physiology. This course includes a study of the common fungous disease of crops, and consideration of the method of prevention and control of the same. The plant's function as related to susceptibility to disease is also taken up. All of the junior botany is included in four of the junior elective courses. — Professor STONE.

Senior year, elective, both semesters. Three laboratory exercises and one lecture period a week. (*a*) Plant physiology; (*b*) plant pathology. Both courses are optional. These courses are adapted to students who desire a more detailed knowledge of plant diseases and plant physiology. Extensive use is made of the valuable and constantly increasing experiment station literature. — Professor STONE.

MATHEMATICS, PHYSICS AND ENGINEERING.

This department has charge of the instruction in mathematics, physics, civil engineering and drawing. The aim is to secure thorough work in the fundamental principles, and train the mind in clear and logical thinking. The application of the subjects to practical problems is given special attention. The work of the department extends over the four years, as outlined below.

Mathematics.

Freshman year, first semester, five hours a week. Higher algebra, including ratio and proportion, progressive binomial theorem, series, undetermined coefficients, logarithms, continued fractions, permutations. Wells' "College Algebra." — Professor OSTRANDER and Professor HASBROUCK.

Second semester, two hours a week. Solid geometry. Wells' "Solid Geometry." — Professor HASBROUCK.

Plane trigonometry, two hours a week. Lyman and Goddard's "Trigonometry." — Professor OSTRANDER.

Junior year, for mathematical and chemical students, first semester, four hours a week. Analytic geometry of the line, circle, conic sections and higher plane curves. Nichols' "Analytic Geometry." — Professor HASBROUCK.

Second semester, four hours a week. Differential and integral calculus. Osborne's "Calculus." — Professor HASBROUCK.

Physics.

Sophomore year, first semester, four hours a week. Elementary mechanics of solids, liquids and gases, heat and sound. Merriman's "Elements of Mechanics," Carhart's "University Physics." — Professor HASBROUCK.

Second semester, four hours a week. Electricity, magnetism and light. Carhart's "University Physics." — Professor Hasbrouck.

Senior year, elective for those students who have taken junior mathematics; first semester, four hours a week. Analytic mechanics. Peck's "Analytic Mechanics." — Professor Hasbrouck.

Second semester, four hours a week. Laboratory work. — Professor Hasbrouck.

Civil Engineering and Surveying.

Sophomore year, second semester, two exercises of two hours a week. Plain surveying with field work, including the use of the usual surveying instruments. Text-book and lectures. — Professor Ostrander.

Instruction in civil engineering will be given in two distinct courses of one year each, the courses alternating. They will be open to students of the junior and senior classes as indicated below. The course for 1906–07 will be for students in mathematics only. First semester, three hours' recitation and two hours' draughting a week. Stresses in roofs, bridges and graphic statics. Merriman and Jacoby's "Roofs and Bridges," Parts I. and II.

Second semester, four hours a week. Strength of materials and masonry construction. Merriman's "Mechanics of Materials." — Professor Ostrander.

The course of 1907–08 will be required of juniors and seniors taking the courses in mathematics and landscape gardening.

First semester, four hours a week. Hydraulics and sanitary engineering. Text-book and lectures. — Professor Ostrander.

Second semester, three hours' recitation or lectures and two hours' field work or draughting a week. Topographic and higher surveying, highway construction, the measurement of earth work, pavements and railroad construction. Text-book and lectures. — Professor Ostrander.

Drawing.

Junior year, first semester, two two-hour sessions a week for students in mathematics and landscape gardening; free-hand drawing.

Second semester, two two-hour sessions a week. Mechanical and topographic drawing.

Entomology.

The importance of a knowledge of insects in every department of life is recognized by placing an introductory course in this subject as a required study in the junior elective courses: (1) agriculture, (2) horticulture, (3) biology, (4) landscape gardening. For those who desire a further knowledge of it, because of its importance to their future occupations, a senior elective is offered, so shaped as to be of especial value for those who expect to take up agriculture, horticulture, landscape gardening, forestry or science teaching as life occupations.

Junior year, second semester, four exercises a week, of two hours each. Lectures, laboratory and field work; general consideration of insect structure and life histories; systematic study of the groups of insects, with particular reference to those of economic importance; methods for preventing or checking their ravages; insecticides and apparatus for their use; the collecting, mounting and naming of insects, and examination of the work of insects in the field and laboratory. — Professor H. T. Fernald.

Senior year, elective, open to those who have taken the junior entomology, first and second semesters, three laboratory exercises of two hours each, and one lecture, a week. Lectures, laboratory and field work; advanced morphology of insects; economic entomology; training in the determination of insects; use of literature on entomology; study of life histories; value and application of insecticides; thesis on insects most closely related to future occupation of the student. — Professors C. H. Fernald and H. T. Fernald.

Modern Languages.

French. — Course I.: required, four hours a week for both semesters of the freshman year. The special aim of this course is to enable the student to lay the foundation of an ability to read modern French fluently, special reference being had to scientific journals and treatises. The object of the grammar drill is to give not only instruction in the broader and more general topics, but also a thorough drill in the idiomatic peculiarities of the language, a thorough comprehension of which is held to be absolutely necessary to a correct and accurate translation. Great stress is laid upon the acquisition of a good vocabulary, and absolute accuracy in translation is insisted upon. The course is further strengthened by drill in pronunciation, exercises and composition, and, in general, in whatever tends to increase interest, facility and ability in translation.

Course II. is given, upon demand, as a supplement to Course I., and is an elective requiring four hours a week for both semesters of senior year. Its aim is, primarily, to furnish by an additional year's training a greater practical efficiency in translation than can be attained merely by the completion of Course I.; and, secondarily, to equip the student with a general knowledge of scientific French literature. Constant advanced drill is furnished along the general lines of Course I., with the object of attaining such mastery of the language that it may be easily used as a tool in scientific pursuits and investigations of any nature. Students who have not attained a good rank in Course I. are not encouraged to elect Course II.

Though the main object of both courses is practical, a general attempt is constantly made, by the comparison of French and English and by occasional lectures on French life and customs, to interest the student in the study and better comprehension of the genesis of his own language, and to encourage a desire for a broad and general culture.

Spanish. — Given at present as an elective for four hours a week during both semesters of the year. This course is open as a regular study to seniors, and to freshmen who upon entering college have passed off French or German (Course I.), and also as an extra to any student in good and regular standing. It is offered in response to the recognized demand in Spanish-speaking countries for graduates of agricultural colleges who have made a specialty of agriculture, entomology, horticulture, engineering, etc. Students planning future fields of work in such countries are thus enabled to acquire sufficient facility in reading, writing and speaking the Spanish language to start them to the best advantage. The earlier work is based upon some such grammar as Marion and Garennes' "*Introducción á la Lengua Castellana.*" The course is strengthened by writing from dictation, and by the reading of books characteristic of Spanish life and customs.

German. — Course I.: required for both semesters of sophomore year, three hours a week first semester, three hours a week second semester. An understanding of the rudiments of grammar, facility in translation and an ability to pronounce the language and to understand simple spoken German are the main objects in view. — Assistant Professor Neal.

Course II.: elective for both semesters of senior year, four hours a week. Special attention is given to the reading of German, particularly to German of a scientific nature. Work is also required in prose composition throughout the year. Accuracy in pronunciation, the ability to understand German as spoken in the class room, and to converse within reasonable limits, are also features of this course. Students electing Course II. must have a good record in Course I., or must pass a satisfactory examination therein. — Assistant Professor NEAL.

MILITARY SCIENCE.

In compliance with the provisions of an act of Congress of July 2, 1862, military instruction under a regular army officer, detailed for this purpose, is required of all able-bodied male students. Men are excused from attendance upon the exercises of this department only on a surgeon's certificate, given by a resident physician.

The object of such instruction is clearly to disseminate the elements of military knowledge throughout the country, that, in case of sudden emergency, a sufficient number of well-trained educated men may be found to command and properly to instruct volunteer troops. Military drill also has the object in view of giving the student physical exercise, teaching respect and obedience to those in authority without detracting from pride of manhood, and developing a military bearing and courtesy becoming in a citizen as in a soldier.

In order to further stimulate the study of military science in colleges, the War Department issued General Orders, No. 101, dated Washington, D. C., June 29, 1905, as follows: —

The reports of the regular inspections of the colleges and schools to which officers of the Army are detailed, in pursuance of law, as principals or instructors, will annually hereafter be submitted to the general staff for its critical examination, and the chief of staff will report to the Secretary of War, from the institutions which have maintained a high standard, the six institutions whose students have exhibited the greatest interest, application and proficiency in military training and knowledge. The President authorizes the announcement that an appointment as second lieutenant in the regular army will be awarded to an honor graduate of each one of the six institutions, provided sufficient vacancies exist after caring for the graduates of the military academy at West Point and the successful competitors in the annual examination of enlisted men. . . .

By order of the Secretary of War,

ADNA R. CHAFFEE,
Lieutenant-General, Chief of Staff.

Course I.: out of doors, an exercise of one hour, three times a week, Mondays, Tuesdays and Thursdays; infantry drill by squad, company, and battalion; guard mounting, dress parade, inspection and review; artillery drill by detachment; target practice.

All drills are in the drill hall during the winter months and inclement weather.

Students assigned to the college band are given instruction and practice in band music and band evolutions, in place of drills and recitations.

Course II.: theoretical instruction for freshmen, one hour a week for both semesters, comprises recitations, "Infantry Drill Regulations," "Manual of Guard Duty and Firing Regulations for Small Arms;" "United States Service Manual."

Course III.: theoretical instruction for seniors for both semesters, one hour a week, embraces drill and army regulations; duties of sentinels and guard duty, elements of military science, preparation of necessary reports and returns pertaining to a company of infantry, and a thesis on some military subject; Wagner's "Elements of Military Science," "Field Service Regulations." — Captain MARTIN.

SYNOPSIS OF THE COURSES OF INSTRUCTION.

[The figures indicate the number of exercises a week; light-faced type, recitation periods of one hour each; heavy-faced type, laboratory periods of two hours each.]

FRESHMAN YEAR.

First Semester.

Language,	English,	1	
	French,	4	
Mathematics,	Algebra,	5	
Science,	Agriculture,	4	
	Botany, 2+1,	3	
Military,	Tactics,	1	
History,		2	
			20

Second Semester.

Language,	English,	4	
	French,	4	
Mathematics,	Geometry and trigonometry,	4	
Science,	Anatomy and physiology, half semester, / Chemistry, half semester,	4	
	Botany, 1+1,	2	
History,		2	
			20

Sophomore Year.

First Semester.

Language,	English,	3	
	German,	4	
Physics,		4	
Science,	Agriculture,	4	
	Chemistry,	3	
	Zoölogy, 1+1,	2	
			20

Second Semester.

Language,	English,	4	
	German,	3	
Physics,		4	
Surveying,		2	
Science,	Agriculture, 2+1,	3	
	Chemistry, 2+1,	3	
	Horticulture,	3	
			22

Junior Year.

First Semester.

Course in agriculture,	Agriculture, 3+1,	4	
	Botany, 2+1,	3	
	Chemistry,	3	
	Economics,	4	
	Horticulture,	3	
	English,	4	
			21
Course in horticulture,	Horticulture,	4	
	Horticulture, 1+3,	4	
	Botany, 2+1,	3	
	Chemistry,	3	
	Economics,	4	
	English,	4	
			22
Course in biology,	Zoölogy, 3+1,	4	
	Botany, 2+1,	3	
	Chemistry,	3	
	Economics,	4	
	Horticulture,	3	
	English,	4	
			21
Course in chemistry,	Chemistry,	4	
	Agriculture, 3+1,	4	
	Mathematics,	4	
	Economics,	4	
	English,	4	
	Special subject,	2	
			22

Course in mathematics,	Analytical geometry,	4	
	Engineering, 1+3,	4	
	Free-hand drawing,	2	
	Landscape gardening,	4	
	Economics,	4	
	English,	4	
		—	22
Course in landscape gardening,	Landscape gardening,	4	
	Agriculture, 2+1,	3	
	Botany, 2+1,	3	
	Free-hand drawing,	2	
	Horticulture,	3	
	Economics,	4	
	English,	4	
		—	23

Second Semester.

Course in agriculture,	Agriculture, 2+1,	3	
	Botany, 2+1,	3	
	Chemistry,	4	
	Horticulture,	2	
	Entomology,	4	
	Geology,	3	
		—	19
Course in horticulture,	Horticulture,	4	
	Botany, 2+1,	3	
	Chemistry,	4	
	Landscape gardening,	2	
	Entomology,	4	
	Geology,	3	
		—	20
Course in biology,	Entomology,	4	
	Zoölogy,	4	
	Botany, 2+1,	3	
	Chemistry,	4	
	Horticulture,	2	
	Geology,	3	
		—	20
Course in chemistry,	Chemistry,	5	
	Agriculture, 2+1,	3	
	Mathematics,	4	
	Geology,	3	
	Special subject,	5	
		—	20
Course in mathematics,	Engineering,	4	
	Mathematics,	4	
	Mechanical drawing,	2	
	Landscape gardening,	4	
	Geology,	3	
		—	17

Course in landscape gardening,	Landscape gardening,	4	
	Botany, 2+1,	3	
	Mechanical drawing,	2	
	Engineering,	5	
	Entomology,	4	
	Geology,	3	
		—	21

Senior Year.

First Semester.

The following subjects are required in all courses: —

Bacteriology, half semester, 4, Constitution of the United States, half semester, 4,	4	
Military science,	1	
	—	5

Second Semester.

Constitution of the United States,	4	
Military science,	1	
	—	5

From the following the student must elect three courses, closely correlated with his junior year course; only one course in language may be elected: —

Agriculture,	4	Physics,	4
Horticulture, 3+1,	4	Engineering,	4
Veterinary,	4	English,	4
Botany, 3+1,	4	French,	4
Landscape gardening, 3+1,	4	German,	4
Entomology, 3+1,	4	Spanish,	4
Chemistry, 3+1,	4	Latin,	4
Floriculture, 3+1,	4		

SHORT COURSES.

These courses are open to persons of both sexes. Applicants must be at least sixteen years of age, and must furnish papers certifying good moral character. No entrance examination is required. Tuition is free to citizens of the United States. The same privileges in regard to room and board obtain as with other students. Attendance upon chapel is required. The usual fees are charged for apparatus and material used in laboratories. Attendance upon military drill is not expected.

I. Dairy Farming.

	Hours per Week.
Soils, tillage and methods of soil improvement; manures and fertilizers and their use; crops and rotations,	4
Breeds and breeding of dairy stock; judging to scale of points,	2
Fodders and feeding farm live stock,	1
Stable construction and sanitation,	1
Common diseases of stock; prevention and treatment,	1
Dairy products: their general characteristics; testing,	2
Chemical composition of milk and of special milk products,	1
Botany,	2
Horticulture,	3
Entomology,	3
Dairy practice, including testing, use of separators, butter making, preparation of certified and modified milk, and pasteurization,	4
Practice in horticulture,	1

Begins first Wednesday in January, and continues ten weeks.

II. Horticulture.

	Hours per Week.
Soils, tillage, manures, etc.,	4
Plant propagation and pruning,	3
General fruit growing,	3
Market gardening,	3
Botany,	4
Entomology,	3
Practice work in seed testing, seeding, grafting, budding, transplanting, judging fruit, etc.	

Begins first Wednesday in January, and continues ten weeks. This course will not be given unless at least eight men register for it.

III. Bee Culture.

	Total Hours.
The structure of bees, with special reference to their work (Prof. H. T. Fernald),	3
Flowers and fruits in their relations to bees (Professor Stone),	10
Honey crops, and how to grow them (Professor Brooks),	5
Bees and bee keepers' supplies (Professor Paige),	10
Work in the apiary, under direction of an expert,	20
Instruction by specialists,	4

This course begins the fourth Wednesday in May, and continues two weeks, but will not be given unless applied for by at least six students.

EQUIPMENT OF THE SEVERAL DEPARTMENTS.

Agriculture.

The part of the college estate assigned to the department of agriculture contains one hundred and sixty acres of improved land, forty acres of pasture and sixteen acres of woodland. The latest inventions in improved agricultural tools and machinery are in practical use. The large and commodious barn and stables destroyed by fire in November, 1905, were stocked with the best breeds of horses, cattle, sheep and swine, and will be replaced by new buildings at as early a date as possible. The laboratory is provided with the latest forms of apparatus for mechanical analysis of soils and determination of their physical characteristics. Provision has been made in the laboratory for the study of seeds and crops and for germination trials. Power has been introduced into the laboratory, so that farm machinery may be operated for purposes of demonstration. The department has also a line of instruments for use in drainage and irrigation practicums. The museum contains a collection of implements, seeds, plants and models of animals, all of which are designed to illustrate the evolution and the theory and practice of agriculture. The department has assigned to its use one lecture room with museum attached, and five rooms for laboratory and dairy purposes.

Horticulture.

For illustration of the science and the practice of horticulture the department possesses about one hundred acres devoted to orchards planted with all the leading old and all new varieties of apples, pears, peaches, plums, Japanese and American cherries, quinces, chestnuts, hickory nuts and walnuts; vineyards containing nearly two hundred named varieties of grapes, for sale, beside several hundred seedlings, and about an acre devoted to a commercial crop of a few market varieties; nurseries containing all kinds of fruit and ornamental trees, shrubs and plants, in all stages of growth, from the seed and cuttings to those ready for planting in the orchard or field; small fruit plantations containing valuable varieties, and showing the modern methods of training, pruning and cultivation; extensive greenhouses that contain not only valuable collections of specimen plants, representing types of the flora of the world, but also the most valuable economic plants, such as the orange, banana, lemon, guava, pomegranate, sago palm, arrowroot, tapioca, ginger, pepper, tea, coffee, camphor, India rubber, Manila hemp, banyan tree, etc. All the common greenhouse and outdoor decorative plants are found, and small quantities of roses, carnations, chrysanthemums and other commercial flowering plants are grown, to illustrate the business of horticulture. All vegetable crops, now so largely grown under glass, are grown in limited quantities for purposes of instruction and for market.

For illustration in the work of landscape gardening, the grounds about the greenhouses, as well as that part of the grounds known as the Clark Park, are planted with a very large and complete collection of ornamental trees, shrubs and plants.

For forestry there are two large groves of trees of varying ages, from those of almost primeval growth to the youngest seedlings, besides several plantations of younger growth either natural or planted; and in the botanical museum there is a very complete collection of woods of Massachusetts.

The work in horticulture, floriculture and landscape gardening is now much better provided for than in the past, through the completion of the new Wilder Hall. This contains three class rooms, three student laboratories, a large drafting room and a library, besides offices, a museum and private laboratories. It is a substantial structure, three stories high, containing all the most modern appliances, and exemplifying the best ideas in college laboratory building. It is practically fireproof, being constructed of red brick, terra cotta and tile. The floors and the roof are of tile.

All kinds of pumps and other appliances for distributing insecticides and fungicides, as well as various modern tools and implements, are in constant use.

A small cold-storage room makes possible the keeping of the products beyond their natural season, and illustrates one of the most important adjuncts to the business of modern horticulture.

Chemistry.

This department has fourteen rooms, well adapted to their special uses. They are supplied with a large assortment of apparatus and chemical materials. The lecture room on the second floor has a seating capacity for seventy students. Immediately adjoining it are four smaller rooms, used for storing apparatus and preparing materials for the lecture table. The laboratory for beginners is a large room on the first floor, furnished with forty working tables. Each table is provided with reagents and apparatus for independent work. A well-filled laboratory for advanced work is also provided on the first floor. A weighing room has six balances, and improved apparatus for determining densities of solids, liquids and gases. The apparatus includes, besides balances, a microscope, a spectroscope, a polariscope, a photometer, a barometer, and numerous models and sets of apparatus. The various rooms are furnished with an extensive collection of industrial charts. A valuable and growing collection of specimens and samples, fitted to illustrate different subjects taught, is also provided. This includes rocks, minerals, soils, raw and manufactured fertilizers, foods, including milking products, fibres and other vegetable and animal products, and artificial preparations of mineral and organic compounds. Series of preparations are used for illustrating the various stages of different manufactures from raw materials to finished product.

Geology.

As a part of general culture, geology has a well-recognized importance; but more particularly as a part of the training of agriculturists it forms an important part of the curriculum of our agricultural colleges.

The equipment is ample. It consists of a complete educational series of rock-forming minerals and rocks, a large collection of the rocks of the State, student collections, charts, models and maps.

Zoölogy.

Zoölogical Laboratory. — A large, well-lighted room, situated in the old chapel building, is amply supplied with the best apparatus obtainable. The equipment includes compound and simple microscopes, dissecting instruments and trays, an incubator, paraffin bath, microtomes, etc., also a reference library, containing the current zoölogical journals and a good series of mounted slides for the microscope.

Zoölogical Lecture Room. — The lecture room is in south college, adjacent to the museum; its equipment includes, besides the museum specimens, the Leuckart series of charts, and many specially made charts as well; the Auzoux models, illustrative of human and comparative anatomy; and an electric stereopticon.

Museum of Zoölogy. — The museum is mainly for the purpose of exhibiting those forms treated of in the lecture and laboratory courses, but, in addition to this, the aim has been to show as fully as possible the fauna of the Commonwealth, and those types which show the evolution and the relationship of the members of the animal kingdom. The total number of specimens contained in the museum now exceeds eleven thousand. The museum is open to the public from 3.30 to 5.30 P.M. each week day.

Entomology.

Entomological Laboratory. — The equipment for work in entomology during the senior year and for graduate students is unusually good. The laboratory building contains a large room for laboratory work, provided with tables, dissecting and compound microscopes, microtomes, reagents and glassware. One portion of the building is fitted up as a lecture room. Another room is devoted to library purposes, and contains a card catalogue of over fifty thousand cards, devoted to the literature of insects. In addition to a well-selected list of entomological works in this room, the college library has an unusual number of rare and valuable books on this subject. This is supplemented by the private entomological library of the professor in charge, which contains over twenty-five hundred volumes, many of which cannot be found elsewhere in the United States. In another room is a large and growing collection of insects, both adult and in the early stages, which is of much assistance to the students. As the laboratory is directly connected with the insectary of the Hatch Experiment Station, the facilities of the latter are directly available. The apparatus room of the insectary, with its samples of spray pumps, nozzles and other articles for the practical treatment of insects; the chemical room fitted up for the analysis of insecticides and other chemico-entomological work; and a greenhouse, where plants infested by injurious insects are under continual observation and experimental treatment, — all these are available to the student. In addition, several private laboratory rooms and a photographing room with an unusually good equipment of cameras are provided. The large greenhouses, grounds, gardens and orchards of the college are also to be mentioned under this head, providing, as they do, a wide range of subjects for study of the attacks of injurious insects under natural conditions.

Veterinary Science.

The department has for its sole use a commodious and modern laboratory and hospital stable, erected in 1899. Both buildings are constructed in accordance with the latest ideas regarding sanitation. Every precaution has been taken in the arrangement of details to prevent the spread of disease, and to provide for effective heating, lighting, ventilation and disinfection.

The laboratory building contains a large working laboratory for student use, and several small private laboratories for special work. In addition, there is a lecture hall, museum, demonstration room, photographing room and workshop. The hospital stable contains a pharmacy, operating hall, post-mortem and disinfecting room, besides a section for poultry, one for cats and dogs, and six sections, separated from each other, for the accommodation of horses, cattle, sheep, swine and other domestic animals.

The laboratory equipment consists of a dissecting Auzoux model of the horse, Auzoux models of the foot and the legs, showing the anatomy of the diseases of every part. There are skeletons of the horse, cow, sheep, dog and pig, and, in addition, a growing collection of anatomical and pathological specimens. The lecture room is provided with numerous maps, charts and diagrams, which are made use of in connection with lectures and demonstrations.

The laboratories are supplied with the most modern high-power microscopes, microtomes, incubators and sterilizers, for the use of students taking the work in bacteriology and parasitology.

Botany.

The botanical department possesses a general laboratory, furnished with tables and benches for microscopical and physiological work, and with a dark closet for photographic purposes. There are forty compound microscopes, twenty-three dissecting microscopes, a micro-photographic and landscape camera and various accessories; also microtomes, paraffin baths, etc., for histological work; a large and useful collection of physiological apparatus for the study of photo-synthesis, respiration, metabolism, transpiration, heliotropism, geotropism, hydrotropism, galvanotropism, chemotropism, and other irritable phenomena connected with plants; a set of apparatus for the study of the mechanical constituents of the soil; a large and unique outfit of electrical appliances for the study of all phenomena related to electricity and plant growing; various devices for the study of mechanics of plant structure; numerous contrivances to determine the power exerted by living plant organisms; several types of self-registering auxanometers, used to measure the rate of growth of plants; self-registering thermometers, and hygrometers for recording constant changes in conditions.

A small special laboratory for graduate students is equipped with microscopes and other apparatus and reagents for advanced work.

Botanical Lecture Room. — The botanical lecture room adjoining the laboratory is adapted for general work in morphology and flower analysis, with opportunity to use dissecting microscopes. It contains a movable chart system, arranged to display over three thousand figures relating to the structure and function of plants.

Mathematics, Physics and Engineering.

Surveying. — The department possesses a considerable number of the usual surveying instruments, with the use of which the students are required to become familiar by performing a required amount of field work. Among the larger instruments are two plain compasses, railroad compass with telescope, surveyor's transit, two engineer's transits with vertical arc and level, solar compass, omnimeter with verniers reading to ten seconds, adapted to geodetic work, Queen plane table, two wye levels, dumpy level, builder's level, sextant, hand level, and a large assortment of levelling rods, flag poles, chains, tapes, etc. For drafting, a vernier protractor, pantograph, parallel rule, etc., are available. A cement-testing outfit has recently been added, for use in the course in strength of materials.

Physics. — Among the apparatus in use for general instruction in general physical processes may be found a set of United States standard weights and measures, precision balances, spherometer, vernier calipers, etc.; in mechanics, apparatus to illustrate the laws of falling bodies, systems of pulleys and levers, motion on an incline plane, and the phenomena connected with the mechanics of liquids and gases. The usual apparatus for lecture illustration in heat, light and sound are also in the possession of the department. In electricity, the equipment consists of apparatus for both lecture illustration and laboratory work, among which may be enumerated a full set of Weston ammeters and volt meters, a Carhart-Clark standard cell, Mascart quadrant electrometer, Siemens electro-dynamometer, as well as reflecting galvanometers and Wheatstone bridges for ordinary determinations of currents and resistance.

Military Science.

In addition to a large campus, suitable for battalion drill, the military department possesses a special building in which there is a drill room 60 by 135 feet, an armory, a recitation room, an office for the commandant, and a field gun and gallery practice room. The building also has a large bathroom immediately adjoining the armory.

In a plot of ground west of the college buildings there is a rifle range, marked for practice at distances of 100 and 200 yards. The range is furnished with a revolving target suitably protected by earthworks. The national government supplies, for the use of the department, arms and equipments; the new Krag Jorgensen rifle, with complete accoutrements and ammunition.

The State supplies instruments for the college band.

Students are held responsible for all articles of public property while in their possession.

The Chapel-Library Building.

One of the most attractive and commodious buildings belonging to the college is the chapel-library. It has a commanding position, approximately in the centre of the group of buildings adjoining the campus. The chapel occupies the entire second story. A large room, capable of seating about four hundred, is used for daily prayers, Sunday services, the various commencement exercises, and not infrequently for lectures or social gatherings. The room has an excellent pipe organ. Two adjoining rooms are used for small religious gatherings, and meetings of the class teachers and of the faculty. The rooms can be thrown open so as to become a part of the main audience hall.

The entire lower story is given over to the library. This library is available for reference or investigation, and is open daily, except on Sundays, from 8 A.M. to 5 P.M. and from 6.30 to 8.30 P.M. It is open on Sundays from 10 A.M. to 1 P.M. The volumes at present number 27,690. The library contains carefully selected books in the departments of agriculture, horticulture, botany, entomology and other natural sciences. Sociology, economics, history, literature, the fine arts and the useful arts are well represented. Constant additions will be made to secure the latest and best works in the several departments of learning.

Dining Hall.

A colonial dining hall, built of brick and equipped with all modern conveniences, was completed and opened February, 1903, for the accommodation of students. A committee composed of two members of the faculty, two members of the student body, and the steward, manages the affairs of the dining hall.

The hall contains a number of suites of rooms which may be secured for occupancy by young women attending any of the departments of the college.

The Heating, Lighting and Power Plant.

This plant is located in the ravine, near the chemical laboratory. It is equipped with two large boilers, an engine and an electric generator. Here steam is generated which heats the college buildings on the west side of the public highway, extending from the dining hall to the veterinary laboratory, and the horticultural building and botanic museum on the east side. Here also is produced the electricity which lights all the buildings and the grounds of the college. Electric power is also generated which is used to drive the machinery in the dairy and in the barn. Connected with the plant is a machine shop in which much work is done for the college. The plant affords opportunity for students in mechanical and electrical engineering to observe the modern utilization of steam and electricity.

EXPENSES.

Tuition. — Tuition is free to citizens of the United States. Citizens of Massachusetts, however, in accordance with an act of the Legislature, must make application to the Senator of the district in which they live for a free scholarship that covers the charge for tuition. Blank forms for such application may be obtained from the president of the college.

Rooms. — It is expected that students will occupy rooms in the college dormitories, unless excused to room elsewhere. For the information of those desiring to carpet their rooms, the following measurements are given: in the south dormitory the study rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. In the north dormitory the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen and one-half by fourteen and one-half feet, and the bedrooms eight by eight feet. All rooms are unfurnished. Mr. Thomas Canavan has the general superintendence of the dormitories, and all correspondence relative to the engaging of rooms should be with him.

Board. — Board at the new dining hall has been $3.25 per week; in private families, $4 to $5. The college does not guarantee to keep the price of board at any particular figure.

Incidental Expenses. — The military suit must be obtained immediately upon entering college, and used in the drill exercises prescribed. The following fees, to be paid in advance, are applied towards the maintenance of the several laboratories: chemical, $15 per semester used; zoölogical, $2 per semester used sophomore year, other classes $4 per semester; entomological, $3 per semester used. The fee for use of the botanical laboratory for one period of two hours during each week is $1 per semester; other periods will be charged for proportionally. Some expense is also incurred for text-books. In exceptional cases incidental expenses necessitate additional charges.

Room rent, in advance,	$15 00	$45 00
Board, $3.25 to $4 per week,	117 00	144 00
Fuel,	12 00	12 00
Washing, 30 to 60 cents a week,	11 00	22 00
Military suit,	12 50	20 00
Lights,	12 00	12 00
Miscellaneous,	41 00	45 00
	$220 50	$300 00

In addition to the above expenses, $120 tuition is charged to foreigners.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

Congressional Scholarships.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Application for such scholarships should be made to the representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course.

State Scholarships.

The Legislature of 1883 passed the following resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide for the students of said institution the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually for the term of four years eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district. But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following resolve, making perpetual the scholarships established: —

Resolved, That annually the scholarships established by chapter forty-six of the resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, any one desiring admission to the college can apply to the senator from his district for a scholarship. Blank forms of application will be furnished by the president.

THE STATE LABOR FUND.

The object of this fund, five thousand dollars appropriated annually by the State, is to assist those Massachusetts students who are dependent either wholly or in part on their own exertions, by furnishing them work in the several departments of the college. The greatest opportunity for such work is found in the agricultural and horticultural departments. Application should be made to Profs. William P. Brooks and Frank A. Waugh, respectively in charge of said departments. Students desiring to avail themselves of its benefits must bring a certificate signed by one of the selectmen of the town in which they are resident, certifying to the fact that they require aid.

ENDOWED LABOR FUND.

There is available also the income of five thousand dollars, the gift of a generous friend of the college, which will be used in payment for labor of deserving students needing assistance.

PRIZES.

Burnham Rhetorical Prizes.

These prizes are awarded for excellence in declamation, and are open to competition, under certain restrictions, to members of the sophomore and freshman classes.

Flint Prizes.

Mr. Charles L. Flint of the class of 1881 established two prizes, one of thirty dollars and another of twenty dollars, to be awarded, at an appointed time during commencement week, to the two members of the junior class who may produce the best orations. Excellence in both composition and delivery is considered in making the award.

Notwithstanding the death of Mr. Flint, these prizes will be continued under the name of the Flint prizes.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first and second prize, to be called the Grinnell agricultural prizes, in honor of George B. Grinnell, Esq., of New York. These two prizes are to be paid in cash to those two members of the graduating class who may pass the best written and oral examination in theoretical and practical agriculture.

Hills Botanical Prizes.

The Hills prizes of thirty-five dollars, given by the late Henry F. Hills of Amherst, will this year be awarded to members of the senior class as follows: fifteen dollars for the best general herbarium; ten dollars for the best collection of Massachusetts trees and shrubs; and ten dollars for the best collection of Massachusetts woods.

J. D. W. French Prize.

Offered by the Bay State Agricultural Society to the members of the senior class for the best essay on forestry. Twenty-five dollars, to be called the J. D. W. French prize, in honor of the late J. D. W. French, formerly a trustee of the college, and one of the very earliest movers in favor of improved forestry management in New England.

Western Alumni Prize.

Twenty-five dollars, to be awarded at the end of sophomore year to that member of the sophomore class who during his two years in college has shown the greatest improvement in scholarship, character and example. Offered by the Western Alumni Association.

Forestry Prize.

Two prizes, fifteen and ten dollars, offered to those members of the senior and junior classes who prepare the best essays on the management of the farm woodlot. Given by an anonymous friend.

Winter Course Prizes.

The dairy prizes, given by the Massachusetts Society for Promoting Agriculture, to members of the short winter course. Two sets of prizes are offered: the first set consists of three prizes of fifty, thirty and twenty dollars, respectively, given for general excellence in all branches of the course as offered; the second set consists of three prizes of twenty-five, fifteen and ten dollars, respectively, for excellence in the making of butter.

Award of Prizes, 1906.

Grinnell Agricultural Prizes (*Senior*). — First prize, Edwin Hobart Scott; second prize, Edwin Francis Gaskill.

Hills Botanical Prizes (*Senior*). — Best collection of Massachusetts trees and shrubs, Daniel Henry Carey; best collection of Massachusetts woods, James Edward Martin.

Flint Oratorical Prizes (*Junior*). — First prize, Wayland Fairbanks Chace; second prize, Charles Morton Parker.

Burnham Essay Prizes (*Sophomore*). — First prize, Danforth Parker Miller; second prize, Herbert Linwood White; third prize, Orton Loring Clark; honorable mention, Roland Hale Verbeck.

Burnham Declamation Prizes (*Freshman*). — First prize, Oscar Christopher Bartlett; second prize, Paul Edgar Alger.

Western Alumni Improvement Prize (*Sophomore*). — John Daniel.

Military Honors (*Senior*). — The following cadets were reported to the Adjutant-General, U. S. A., and to the Adjutant-General of Massachusetts, as having shown special aptitude for military service: Herman Augustus Suhlke, George Talbot French, Stanley Sawyer Rogers, Benjamin Strain.

Dairy Prizes (*Winter Course Students*). — Massachusetts Society for Promoting Agriculture: for general excellence, first prize, Helen Holmes; second prize, Nelson Lansing Martin, Jr.; third prize, John Anson Newhall.

Massachusetts Society for Promoting Agriculture: for highest scoring butter, first prize, Francis Curry; second prize, Nelson Lansing Martin, Jr.; third prize divided between Leslie Rogers Corbin and John Anson Newhall.

Massachusetts Society for Promoting Agriculture: for excellence in stock judging, first prize, Lester Gifford Heath; second prize, Frank David McKenzie; third prize, John Wood Leonard, Jr.; fourth prize, Henry Weston Trask.

Special prize, offered by W. H. Bowker of Boston, for best knowledge of the use of fertilizers on the farm, one-half ton Stockbridge fertilizer, Helen Holmes.

Special prize, given by B. von Herff of New York, for best knowledge of the use of fertilizers on grass lands, Helen Holmes.

RELIGIOUS SERVICES.

Chapel services are held every week day at 8 A.M. Further opportunities for moral and religious culture are afforded by Bible classes, and by a religious meeting Thursday evening, both under the auspices of the College Young Men's Christian Association.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston & Albany Railroad, and at Millers Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven & Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of four hundred acres, with its varied surface and native forests, gives the student the freedom and quiet of a country home.

REPORTS.

TREASURER'S REPORT.

RECEIPTS AND DISBURSEMENTS, DEC. 21, 1905, TO NOV. 30, 1906.

	Received.	Paid.
State Treasurer, Morrill fund,	$16,666 66[1]	
Endowment fund: —		
United States grant,	3,650 00	
State grant,	3,313 32	
Annual Appropriation.		
Maintenance,	5,000 00	
Instruction,	13,000 00	
Scholarship,	15,000 00	
Labor,	5,000 00	$4,492 59
Heating and lighting maintenance,	500 00	500 00
Dining hall maintenance,	500 00	500 00
Veterinary laboratory maintenance,	1,000 00	794 08
Library income: —		
Amherst Savings Bank,	115 86	1,819 57
Bonds,	400 00	
Burnham emergency fund income: —		
Northampton Institution for Savings,	75 00	130 00
Massachusetts Agricultural College, interest,	75 00	
Agricultural laboratory fees,	21 40	215 33
Botanical laboratory fees,	364 19	398 51
Chemical laboratory fees,	687 62	721 07
Entomological laboratory fees,	49 50	145 03
Landscape gardening fees,	107 90	54 30
Zoölogical laboratory fees,	139 71	133 79
Agricultural department (including dairy school),	908 51	2,612 87
Farm department (produce, live stock, labor, etc.),	7,085 93	12,792 89
Horticultural department (market gardening, nursery, etc.),	6,995 70	9,005 41
Expense (rents, interest, etc.),	1,855 30	6,616 45
Amounts carried forward,	$82,511 60	$40,931 89

[1] Annual appropriation from the United States, received from State Treasurer.

	Received.	Paid.
Amounts brought forward, ...	$82,511 60	$40,931 89
Term bill (tuition, students' rents, text-books), ...	4,691 94	2,112 95
Heating and lighting department, . .	2,309 50	10,055 00
Salaries, ...		32,768 52
Extra instruction, ...		160 00
Band, ...		73 38
Advertising, ...		616 05
Furniture, ...		593 62
Tools, lumber account, ...		1 32
Fire apparatus, ...		18 00
Insurance, ...	317 25	5,615 16
Dining hall, ...	12,973 93	15,749 66
Excess of disbursements over receipts, .	5,892 33	
	$108,696 55	$108,696 55

Cash Account.

Dr.

Cash on hand Dec. 20, 1905, ...	$22,413 62	
Excess of disbursements over receipts, Nov. 30, 1906, ...	5,892 33	
		$16,521 29

Cr.

Cash on hand Nov. 30, 1906, ...	$16,521 29

Inventory — Real Estate.

Land (Estimated Value).

College farm, ...	$37,000 00	
Pelham quarry, ...	500 00	
Bangs place, ...	2,350 00	
Clark place, ...	4,500 00	
		$44,350 00

Buildings (Estimated Value).

Drill hall, ...	$5,000 00	
Powder house, ...	75 00	
Gun shed, ...	1,500 00	
Stone chapel, ...	30,000 00	
South dormitory, ...	35,000 00	
North dormitory, ...	25,000 00	
Chemical laboratory, ...	8,000 00	
Entomological laboratory and insectary, .	6,000 00	
Veterinary laboratory and stable, . .	22,500 00	
Amounts carried forward, ...	$133,075 00	$44,350 00

Amounts brought forward,	$133,075 00	$44,350 00
Farmhouse,	2,000 00	
Horse barn,	5,000 00	
Farm barn, dairy school and wagon house (unfinished),	34,000 00	
Graves house and barn,	1,500 00	
Dining hall,	35,000 00	
Botanic museum,	5,500 00	
Botanic barn,	2,500 00	
Wilder Hall,	37,000 00	
Clark Hall (unfinished),	45,000 00	
Tool house,	2,000 00	
Durfee plant house and fixtures,	13,000 00	
Small plant house, with vegetable cellar and cold grapery,	4,700 00	
President's house,	6,500 00	
Dwelling houses purchased with farm,	5,000 00	
		331,775 00
		$376,125 00

EQUIPMENT.

Botanical department,	$4,200 00	
Botanical laboratory,	3,500 00	
Horticultural department,	18,091 49	
Farm,	19,683 79	
Chemical laboratory,	1,332 00	
Entomological laboratory,	15,450 00	
Zoölogical museum,	6,150 00	
Zoölogical laboratory,	3,300 00	
Veterinary laboratory,	6,000 00	
Physics and mathematics,	4,000 00	
Agricultural department,	2,500 00	
Agricultural laboratory,	1,700 00	
Library,	28,000 00	
Fire apparatus,	300 00	
Band,	500 00	
Furniture,	2,000 00	
Text-books,	450 00	
Tools, lumber and supplies,	834 25	
Heating and lighting,	61,263 80	
Dining hall,	5,000 00	
		$184,255 33

BALANCE SHEET, NOV. 30, 1906, NOT INCLUDING REAL ESTATE AND EQUIPMENT.

Assets.

Due farm from sundry persons,	$266 10	
Due horticultural department, sundry persons,	707 51	
Due from students for text-books,	553 53	
Due from students for room rent,	347 34	
Due from students for heat and light,	872 83	
Due from students for laboratory fees,	759 32	
Due from students for board,	793 10	
Due from State of Massachusetts (Wright & Potter Printing Company's bill),	320 35	
Notes,	200 00	
Cash on hand,	16,521 29	
		$21,341 37

Liabilities.

Due labor fund,	$1,308 45	
Due veterinary laboratory,	359 42	
Due insurance,	11,897 20	
Due Burnham emergency fund, note,	3,000 00	
Due excess of assets over liabilities,	4,776 30	
		$21,341 37

FUNDS.

Endowment Fund.

	Amount.	Income.
United States grant,	$219,000 00	$3,650 00
Commonwealth grant,	142,000 00	3,313 00
		$6,963 32

This fund is in the hands of the State Treasurer, and the Massachusetts Agricultural College receives two-thirds of the income from the same.

Burnham Emergency Fund.

	Amount.	Income.
Northampton Institution for Savings,	$2,000 00	$75 00
Massachusetts Agricultural College note,	3,000 00	75 00
	$5,000 00	$150 00

Library Fund.

	Amount.	Income.	Market Value.
Five bonds Lake Shore & Michigan Southern 4s,	$5,000 00	$200 00	par.
Five bonds New York Central & Hudson River Railroad,	5,000 00	200 00	par.
Amherst Savings Bank,	367 77	7 34	
Interest from Amherst Savings Bank, received Jan. 1, 1906,		108 52	
	$10,367 77	$515 86	

Special Funds.

Endowed Labor Fund (the Gift of a Friend of the College).

	Amount.	Income.	Market Value.
Two bonds American Telephone and Telegraph 4s,	$2,000 00	$80 00	93
One bond New York Central debenture 4s,	1,000 00	40 00	par.
Two bonds Lake Shore & Michigan Southern 4s,	2,000 00	80 00	par.
	$5,000 00	$200 00	
Unexpended balance Jan. 1, 1906,		220 21	
		$420 21	
Paid for labor,		206 43	
Cash on hand,		$213 78	

Hills Fund.

	Amount.	Income.	Market Value.
Northampton Institution for Savings,	$2,180 00	$81 75	
One bond American Telephone and Telegraph Company 4s,	1,000 00	40 00	93
Three American Telephone notes, 5 per cent.,	3,000 00	150 00	par.
One bond New York Central debenture 4s,	1,000 00	40 00	par.
One bond New York Central & Lake Shore $3\frac{1}{2}$s,	1,000 00	35 00	89
Boston & Albany Railroad stock,	362 00	31 68	240
	$8,542 00		
Unexpended balance Jan. 1, 1906,		686 11	
		$1,064 54	
Paid botanical and horticultural departments,		124 60	
Cash on hand,		$939 94	

Mary Robinson Scholarship Fund.

	Amount.	Income.	Market Value.
Northampton Institution for Savings,	$820 00	$30 75	
Boston & Albany Railroad stock,	38 00	3 32	240
	$858 00	$34 07	
Paid deficit Jan. 1, 1906,		4 74	
Cash on hand,		$29 33	

Whiting Street Scholarship Fund.

	Amount.	Income.	Market Value.
One bond New York Central debenture 4s, .	$1,000 00	$40 00	par.
Amherst Savings Bank, ...	271 64	5 20	
Unexpended balance Jan. 1, 1906, . .		17 16	
	$1,271 64	$62 36	
Paid cash, scholarship, ...		20 00	
Cash on hand, ...		$42 36	

Gassett Scholarship Fund.

	Amount.	Income.	Market Value.
One bond New York Central debenture 4s, .	$1,000 00	$40 00	par.
Amherst Savings Bank, ...	11 64		
Unexpended balance Jan. 1, 1906, . .		20 00	
	$1,011 64	$60 00	
Paid cash, scholarship, ...		20 00	
Cash on hand, ...		$40 00	

Grinnell Prize Fund.

	Amount.	Income.	Market Value.
Ten shares New York Central & Hudson River Railroad stock, ...	$1,000 00	$50 00	132½
Cash received for sale of rights, . . .		62 50	
Unexpended balance Jan. 1, 1906, . .		66 24	
	$1,000 00	$178 74	
Paid cash for prizes, ...		50 00	
Cash on hand, ...		$128 74	

Massachusetts Agricultural College.

	Amount.	Income.	Market Value
One share New York Central & Hudson River Railroad stock, ...	$100 00	$5 00	132½
Cash received from sale of rights, . .		11 75	
Unexpended balance Jan. 1, 1906, . .		5 00	
	$100 00		
Cash on hand, ...		$21 75	

Summary of Cash on Hand to the Credit of Special Funds.

Endowed labor fund,	$213 78	
Hills fund,	939 94	
Mary Robinson fund,	29 33	
Whiting Street fund,	42 36	
Gassett scholarship fund,	40 00	
Grinnell prize fund,	128 74	
Investment,	21 75	
		$1,415 90

I hereby certify that I have this day examined the Massachusetts Agricultural College accounts, as reported by the treasurer, George F. Mills, for the eleven months, Dec. 21, 1905, to Nov. 30, 1906. All bonds and investments are as represented in the treasurer's report. All disbursements are properly vouched for, and all cash balances are found to be correct.

CHARLES A. GLEASON,
Auditor.

AMHERST, Dec. 14, 1906.

GIFTS.

Books donated Better Farming Special Library.

By American Sheep Breeders' Press: The Domestic Sheep, — Henry Stewart.

P. Blakiston's Son & Co.: Agricultural Bacteriology, — H. W. Conn. Bacteria in Milk and its Products, — H. W. Conn.

J. E. Bryant Company: Weeds, — Thomas Shaw.

John A. Craig: Judging Live Stock, — John A. Craig.

John W. Decker: Elements of Dairying, — John W. Decker. Cheese Making, — John W. Decker.

Farm Poultry Publishing Company: Poultry Craft, — J. H. Robinson. Broilers and Roasters, — J. H. Robinson. Winter Eggs, — J. H. Robinson. First Lessons in Poultry Keeping, — J. H. Robinson. Profitable Poultry Farming, — Michael K. Boyer. A Living from Poultry, — Michael K. Boyer.

C. Griffin & Co.: Dairy Chemistry, — H. D. Richmond.

Peter Henderson & Co.: Henderson's Handbook of Plants and General Horticulture, — Peter Henderson.

W. A. Henry: Feeds and Feeding, — W. A. Henry.

I. S. Johnson & Co.: The Farm Poultry Doctor, — Nathan W. Sanborn.

F. H. King: Physics of Agriculture, — F. H. King.

King-Richardson Co.: Agriculture (two-volume set), — W. P. Brooks. Agriculture (three-volume set), — W. P. Brooks.

J. B. Lippincott Company: Economic Entomology, — J. B. Smith. Insects Injurious to Fruit, — William Saunders.

Lodeman: The Spraying of Plants, — Lodeman.

Mendota Book Company: Testing Milk and its Products, — Farrington & Woll.

By The Macmillan Company: Farm Poultry,—Watson. The Horse, — Roberts. The Feeding of Animals, — Jordan. Milk and its Products, — Wing. The Care of Animals, — Mayo. Fertilizers, — Voorhees. The Farmer's Business Handbook, — Roberts. The Fertility of the Land, — Roberts. The Soil, — King. The Farmstead, — Roberts. The Principles of Fruit Growing, — Bailey. The Principles of Vegetable Growing, — Bailey. Bush Fruits, — Card.

John Michels: Creamery Butter Making, — John Michels.

National Dairy Union: The Creamery Patron's Handbook.

Orange Judd Company: Draining for Profit and Health, — Waring. Soiling Crops and the Silo, — Shaw. Swine Husbandry, — Coburn. Animal Breeding, — Shaw. The Dairyman's Manual, — Stewart. Spraying Crops, — C. M. Weed. Fumigation Methods, — W. S. Johnson. Landscape Gardening, — Waugh. Plums and Plum Culture, — Waugh. The Potato, — Fraser. The Chemistry of the Farm, — Warington. Gardening for Profit, — Peter Henderson. Insects and Insecticides, — C. M. Weed. The Book of Corn, — Herbert Myrick. The Cereals in America, — Thomas F. Hunt. Alfalfa, — F. D. Coburn. Farm Grasses of the United States, — W. J. Spillman. Successful Fruit Culture, — Maynard.

W. P. Page: The Philosophy of judging Fowls, — I. K. Felch & H. S. Babcock.

Rand, McNally & Co.: The Book on Silage, — F. W. Woll. Practical Farming and Gardening.

A. I. Root Company: The A B C of Bee Culture, — A. I. Root. Tile Drainage, — W. I. Chamberlin.

The Rural New Yorker: The Farmer's Garden (three copies), — H. W. Collingwood. The Business Hen (three copies), — H. W. Collingwood.

H. L. Russell: Outlines of Dairy Bacteriology, — H. L. Russell.

J. H. Sanders Publishing Company: American Dairying, — H. B. Gurler. Horse Breeding, — J. H. Sanders.

Webb Publishing Company: Farm Blacksmithing, — J. M. Drew. Feeding and Management of Live Stock, — Thomas Shaw. Grasses and how to grow Them, — Shaw. Vegetable Gardening, — Green.

By Wiley & Sons: Handbook for Farmers and Dairymen, — Woll. Landscape Gardening applied to Home Decoration, — Maynard. Principles of Animal Nutrition, — Armsby. The Sanitation of a Country House, — Henry B. Bashore. Principles and Practice of Butter Making, — McKay and Larsen.

W. M. Wood Company: The American Fruit Culturist, — Thomas.

Charles Scribner's Sons: Agriculture in Some of its Relations to Chemistry, — F. H. Storer.

Doubleday, Page & Co.: How to make School Gardens, — Hemenway.

S. T. Maynard: Landscape Gardening applied to Home Decoration, — Maynard.

From B. Von Herff, German Kali Works, New York: one ton kainit, or money value, as prize in dairy school.

Society for the Promotion of Agriculture: prizes offered in dairy school as follows: For butter: first, $25; second, $15; third, $10. For best work during the entire course: first, $50; second, $30; third, $20. For excellence in stock judging: first, $10; second, $7.50; third, $5; fourth, $2.50.

W. H. Bowker & Co.: one-half ton Stockbridge fertilizer, as prize in dairy school.

William S. Myers, New York: two thousand pounds nitrate of soda.

B. Von Herff, New York: one ton each high-grade sulfate of potash, low-grade sulfate of potash, muriate of potash.

Rockland Rockport Lime Company, Boston: one one-hundred-pound bag agricultural lime (shipped to Falmouth for experiment with cranberries); one bag R-R agricultural lime; one barrel pine cone hydrated lime.

H. J. Baker & Co., New York: tartar pomace, nitrogenous chalk, beet refuse compound and kalksalpeter, for experimental purposes.

The Dow Chemical Company, Midland, Mich.: one pound sodium benzoate, for experimental purposes.

Peter Henderson & Co., New York: four pounds Queen potatoes; four pounds Improved Green Mountain potatoes; four pounds Bliss' Red Triumph potatoes.

From Michigan Seed Company, Bay City, Mich.: Improved Early Rose, Michigan, New Wonderful, and Rural New Yorker potatoes.

W. Atlee Burpee, Philadelphia: Uncle Gideon's Quick Lunch potatoes.

George G. Schroeder, 1310 G Street, N. W., Washington, D. C.: publication, Egg Production and Preserving.

General Machinery and Supply Company, Chicago, Ill.: hand-power shearing machine.

Loans.

Empire Cream Separator Company, Bloomfield, N. J.: one Empire Separator No. 2.

The Sharples Separator Company, West Chester, Pa.: one Tubular Hand Separator No. 3; one Tubular Hand Separator No. 4; one Tubular Hand Separator No. 10.

De Laval Separator Company, 74 Cortlandt Street, New York, N. Y.: one Acme Turbine Separator; one Baby No. 2 Separator; one Alpha Daisy Separator.

D. H. Burrell & Co., Little Falls, N. Y.: one Simplex Hand Separator No. 2; one Simplex Turbine Separator No. 2½; one 10-bottle "Facile" Hand Tester; one 4-bottle "Facile, Jr.," Tester; one 24-bottle "Facile" Turbine Tester.

Vermont Farm Machine Company, Bellows Falls, Vt.: one Separator No. 7; one Separator No. 5; one No. 2½ Steam Turbine Separator; one Agos steam Babcock Tester; one 10-bottle Hand Tester.

Dairymen's Supply Company, Philadelphia, Pa.: Steam Turbine Bottle Washer.

Stoddard Manufacturing Company, Rutland, Vt.: one 24-bottle Wizard Turbine Tester.

FARM REPORT.

The work of the past year has been interrupted greatly by the loss of the farm barn, which was burned Nov. 16, 1905; and the housing of the live stock has in most cases caused a hardship, animals having to be kept in different buildings somewhat removed from each other, and where feed had to be drawn daily. Even to put these buildings in shape to keep the stock required an outlay for lumber and labor, thus materially increasing the expense.

During the fall of 1905 preparations were made for increasing our acreage in crops for 1906; accordingly, a considerable amount of land was turned over. This had to be handled, consequently it was decided that about 34 acres of corn should be planted, and a large part of the land seeded to grass. About 22 acres of the field was seeded in July, which resulted in a fine stand of grass. We wish to emphasize the importance of the selection of the seed; only the very best seed is used on the college farm. One of Professor Brooks's requirements in purchasing the seed is that it shall have been tested, thus selecting only that of high germinating power. This means a little extra cost per pound, but experience seems to warrant a fourfold result.

Corn.

Three varieties of corn were obtained from Minnesota for the main corn crop, namely; Rustlers White Dent, Pride of the North, and University of Minnesota No. 13. These were especially bred, and are being grown in latitudes farther north than is the State of Massachusetts. The prime object in going so far north for seed corn was to get something that would never fail to mature. The result this year seems to indicate that one of these varieties chosen, the Rustlers White Dent, is going to make good. The yield this year was an average of 150 bushels of mature ears per acre; the ears are of good length and size, well filled to the tip with mature corn.

The two varieties Pride of the North and University of Minnesota No. 13 did not do as well, giving a much lighter yield of shorter ears, and not as well filled. The stover from each variety was of good quality.

Ten acres were planted to Leaming corn for silage, but, owing to unavoidable circumstances, the new silos were not built in time to ensile all the crop. A part of the crop, however, was harvested into a temporary silo, and is of excellent quality. The balance, about 5 acres, was allowed to mature the grain. From this about 840 bushels of ears were picked. While all this corn was not as hard as one would wish for, there was a fair amount of well-matured corn.

Potatoes.

Seven acres of field and 3½ acres of newly reclaimed stump land were planted to this crop.

On those grown on the field quite an extensive experiment with different kinds of insecticides and fungicides was arranged and carried out. Through the generosity of the Bowker Fertilizer Company the following materials were donated for this experiment, namely, dust Bordeaux, copper phosphate and 1–2–3. Dust Bordeaux is a fungicide to take the place of wet Bordeaux, copper phosphate an insecticide and fungicide, and 1–2–3 an insecticide and fungicide. The field was systematically laid out, so that comparisons between this and wet Bordeaux could be made. Two check rows between each kind were left. The materials all did very well, and there was not enough difference between them to warrant a full report at this time.

The results obtained on the reclaimed land in the Durfee pasture were beyond expectations: 1,057 bushels of marketable potatoes and 50 bushels of small potatoes were harvested from 3½ acres. One and one-half acres of this land was cleared of stumps in the fall of 1905, and plowed; the remaining 2 acres, in the spring of 1906. From our experience we have found that a liberal use of dynamite lessens the expense materially. On the 5½ acres cleared the past two years, the cost of labor for getting out and piling the stumps has been $11 per acre. To this add $8.15 per acre for dynamite, and we have the cost per acre of preparing land ready for the plow, $19.15.

Experiments with Nitrate of Soda, High-grade Sulfate of Potash and Phosphatic Slag on Grasses.

On one of the fields of the campus plots of one-half acre were laid out, and fertilizers were applied as shown in the following table, together with the yields of the hay and rowen for the seasons of 1905 and 1906. The methods of applying the fertilizer are to spread broadcast with a Stevens' fertilizer spreader in the spring at about the time that the grass is well started.

A very interesting thing about the experiment is the behavior of the plots during the season of 1905, when we had an abundance of rainfall during the first part of the season for the first crop, and very little rainfall for the rowen. These conditions were nearly reversed for the season of 1906.

It should be said that the sod in these plots is almost entirely made up of grasses, herd's grass prevailing.

Experiments with Fertilizers on Permanent Mowings (Pounds per Acre.)

Plot.	Phosphatic Slag.	Nitrate of Soda.	High-grade Sulfate of Potash.	1905.		1906.	
				Hay	Rowen.	Hay.	Rowen.
0,	–	–	–	3,580	168	2,900	760
1,	500	150	150	5,943	358	6,004	2,100
2,	500	200	150	9,696	510	6,116	2,280
3,	500	250	150	12,300	300	6,680	2,570

College Farm Crops, 1906.

CROPS.	Acres.	Total Product.		Cost.		Value.	Profit.
		Bushels.	Tons.	Manures and Fertilizers.[1]	Labor and Seed.		
Mangels,	$\frac{1}{3}$	–	$3\frac{3}{4}$	$2 00	$15 20	$22 50	$5 30
Carrots,	$\frac{1}{3}$	250	–	2 00	40 50	62 50	20 00
Pop corn,	$3\frac{1}{3}$	227[2]	5[3]	3 00	60 40	239 50	176 10
Squashes,	2	–	20	14 00	55 00	300 00	231 00
Ensilage and field corn,	$34\frac{1}{3}$	3,793[2]	94[3]	265 46	871 10	2,022 00	1,191 00
	–	–	74[4]	–	–	–	–
Winter rye,	$\frac{1}{3}$	–	$1\frac{1}{4}$	3 00	10 00	20 00	7 00
Hay and rowen,	71	–	300[5]	98 09	1,125 00	3,000 00	1,776 91
Potatoes: —							
Large,	–	2,303	–	–	–	–	–
Small,	$10\frac{1}{2}$	200	–	117 90	727 80	1,313 60	467 96
Onions,	3	817.5	–	113 58	197 78	347 59	26 23

[1] Three-fourths value of fertilizer, one-half value of manure.
[2] Corn on the ear.
[3] Stover.
[4] Silage.
[5] In part estimated.

Manures and Fertilizers for the Several Crops per Acre.

	Squash Field.	Squash Pasture.	Pop Corn Pasture.	Pop Corn Field.	Corn, Rustler's White Dent.	Corn, Yellow.	Corn, Leaming.	Corn, University of Minnesota No. 13.	Corn, Pride of the North.	Calico Corn.	Mangels.	Carrots.	Potatoes.	Corn, Leaming.	Onions.
Manure (cords),	3	-	-	4	-	-	4	-	-	3	3	3	-	5	-
Nitrate of soda (pounds),	-	-	-	-	100	-	-	100	100	-	-	200	250	-	233
High-grade sulfate of potash (pounds),	-	-	-	-	100	-	-	100	100	-	-	-	250	-	350
Phosphatic slag (pounds),	-	-	-	-	300	-	-	300	200	-	-	600	400	-	800
Lime (pounds),	-	-	-	-	2,000	-	-	2,000	2,000	-	-	-	-	-	1,000
Muriate of potash (pounds),	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dried blood (pounds),	-	-	-	-	-	-	-	-	-	-	-	-	-	-	330
Tankage (pounds),	-	-	-	-	-	-	-	-	-	-	-	-	80	-	400
Acid phosphate (pounds),	-	-	-	-	-	-	-	-	-	-	-	-	200	-	600
Ashes and waste from barn ruins (cords),	-	5	-	-	-	5	-	-	-	-	-	-	-	-	-

Live Stock.

The kinds and numbers of the several classes of live stock are shown below: —

Horses. — French Coach, 3 stallions, 4 mares, 2 filleys; Percheron, 1 stallion; Percheron, three-fourths blood, 1 stallion, 2 mares, 2 filleys; German Coach, 1 mare; French Coach, half blood, 2 mares, 4 work horses.

Neat Cattle. — Jersey, 2 calves, 1 yearling heifer, 2 cows; Ayrshire, 2 bulls, 3 calves, 2 yearlings, 7 cows; Holstein-Friesian, 7 cows, 2 calves.

Swine. — Berkshire, 7 boars, 2 sows, 1 pig; Yorkshire, 1 boar, 4 sows, 34 shoats.

The stock is in a healthy condition generally. We have lost one of a pair of team horses the past year, due to colic causing ruptured stomach.

Swine.

We have made a practice of keeping an accurate account of foods consumed by our growing pigs, and a brief report of the results of feeding a mixed lot of Berkshire, Yorkshire and Chester White pigs, 42 in all, will be of interest. This lot of pigs would not average better than those of most farmers who make a business of raising good hogs, and it cannot be said that they were selected for the purpose of making a show, for there were mixed in some three or four very small ones.

They were weaned and turned into the hog lot May 18, and allowed the run of a shed for shelter from cold and storms. The following table gives the amount of food, etc., consumed from May 18 to September 9, when they were shipped to Brighton market: —

Date.	Food.	Amount.	Rate per 100.	Total Value.
May 18 to Sept. 9.	Corn meal,	9,050 lbs.	$1 20	$108 60
	Middlings,	212 lbs.	1 20	2 54
	Skim milk,	30,994 lbs.	20	61 98
	Molasses,	68.8 gal.	12½ per gal	8 60
	Low-grade flour,	5,068 lbs.		65 88
Total cost of feed,				$247 60
To this add the value of 42 pigs, at $2.50,				105 00
Total cost of pigs,				$352 60

September 9, by cash from 42 pigs, $500, leaving a profit of $147.40, or $3.50 each.

No account was made of labor and manure, for it was estimated that the value of one offset the value of the other.

The flour ration was fed mostly during the first half of the period, corn meal being substituted in the latter half, or fattening period.

As has been said, this feeding was not planned for an experiment. We simply kept account of what was fed, the chief aim being to grow the pigs as fast as possible, and not waste feed.

The Farm Finances.

The cash receipts for the year are $7,013.46, and there is due on account of sales made during the year over and above bills payable the sum of $266.10; this, added to the cash receipts, makes a total of $7,279.56.

The inventory at the present time is $19,953.79, — an increase of $7,022.61 over last year's inventory; this increase of $7,022.61, added to cash receipts, makes a total of $14,302.16; from this deduct the total expenses for the year, or $12,594.08, and we have a balance of $1,708.08 to credit to the farm. There is also another credit due the farm, of work reclaiming 5½ acres of the Durfee pasture, at $50 per acre, making the total credit to the farm $1,983.08. In addition to the above total of expenses, there has been an expenditure of $2,910.93 from insurance funds, for the purchase of new equipment. The final net result of the farm operation is a loss, represented by the difference between the above apparent credit of $1,953.08 and this expenditure of $2,910.93, or $957.85.

The cash received during the year has been derived from the following sources: for milk and cream, $1,722.10; cattle, $214.66; horses, $308; swine, $205.95; sheep, $232.35; hay, $232.68; potatoes, $1,266.51; labor, $1,189.09; credit on bills charged to insurance, $599.40; sundries, $1,030.63.

E. H. FORRISTALL,
Superintendent.

MILITARY DEPARTMENT.

President Kenyon L. Butterfield, *Massachusetts Agricultural College.*

Sir: — I have the honor to submit the following report of the military department of this college for the year ending Dec. 20, 1906.

I have been in charge of the department of military science and tactics since September, 1905, under Special Order, No. 195, War Department, dated Washington, D. C., Aug. 23, 1905. The instruction has been both theoretical and practical, and conducted in compliance with college regulations and War Department orders.

Under the provisions of General Orders, No. 101, War Department, 1905, this instruction is graded, in respect to the military course, as of the second class, "B," requiring the following minimum of exercises, viz.: —

At every institution of Class B, at which a professor of military science and tactics is detailed, it shall be provided in its regular schedule of studies that at least three hours per week for two years, or the equivalent thereof, shall be assigned for instruction in the military department, not less than two-thirds of the total time to be devoted to practical drill, including guard mounting and other military ceremonies, and the remainder to theoretical instruction.

The character of instruction will vary according to the nature of the institutions and the facilities afforded; but instruction of classes A, B, and C shall include practical instruction in the following subjects: —

Infantry drill regulations.
Field service regulations.
Manual of guard duty.
Firing regulations for small arms.

Theoretical instruction shall include the portions of the above subjects covered by the practical instruction, and may be supplemented by lectures.

The above requirements of the War Department have been strictly complied with, and additional drills have been given in "Butts' Manual of Physical Drills" and in artillery drill. Only seniors and freshmen have been required to take theoretical instruction, each class once per week.

As arranged at present, military exercises are conducted in accordance with the following schedule, viz.: —

Monday, recitation of seniors, 5 P.M.; drill, 3.45 P.M.

Tuesdays, the same practical instruction as for Mondays.

Thursdays, drill at 3.45 P.M.; recitation of freshmen, 2.30 P.M.

Saturdays, inspection of dormitories, including students' rooms, 8.30 A.M.; instruction in guard duty and duties of sentinels, 8.15 to 10.15 A.M. The latter exercise is required only of those students who have incurred demerits in the military department, such as unauthorized absence from drill or inspection, or room not in proper order.

Drills are both in close and extended order; battalion drills are usually preceded by parade and review.

The order of drill commences with small squads in the school of the soldier, and proceeds step by step, with and without arms, until the freshmen become proficient, when they are assigned to the companies, after which the exercises include all movements in company and battalion drill.

The drills are varied as much as consistent with official regulations, to embrace gallery practice (firing indoors at an iron target with a reduced charge of powder, two grains) and "Butts' Manual of Physical Drill," the latter in the drill hall during the winter months, and when the weather is too inclement to drill out of doors.

During the visit of the inspector sent here last May by the War Department a thorough inspection was made of the target range, and it was decided by him to be unsafe, in which opinion I thoroughly concurred. As a result, the range was immediately condemned; and, as a consequence, only 70 students received instruction in target practice on the field range last year. The rifles used were the old Springfield cadet rifles, and, as they were practically worn out and obsolete, the progress made was poor. This is a subject of the greatest importance, and much more time could be well devoted to it. To become a good marksman requires a careful study of the mechanism of the rifle; frequent practice upon the rifle range under various conditions of weather, and daily practice for a few minutes each day in the sighting;

pointing and aiming drills for at least a month before going to the range; also gallery practice.

If target practice is to be continued, I strongly recommend that a new range be built, with at least three targets; and, if it is possible, that some provision be made by the State whereby tentage and camp equipage be provided which would enable the whole student body to go into camp for one week in each college year, the time to be given to instruction in guard and outpost duty, target practice, construction of shelter trenches, etc.

Recently all of the old Springfield rifles have been returned to the War Department, and new Krag Jorgensen rifles have been sent to replace them. This rifle is modern and up to date, and with it the very best of target practice can be accomplished.

The War department recently decided to call in all artillery material that was not obsolete from all Class B institutions; and, in compliance with a request to that effect, this department caused to be shipped in the month of November the two 3.2-inch B. L. steel rifles, together with all pertaining material.

The band, under the leadership of a civilian, who has thus far had it for only six lessons, has made wonderful improvement, and well deserves all the encouragement that has been given it in the way of appropriations. A number of new instruments have been purchased, and old ones repaired. During the winter months it will play for the drills in "Butts' Manual."

All the buildings under my supervision are in good condition. The plumbing in all the buildings, as far as I can ascertain, is in good sanitary condition. I would recommend that snow guards be put on the two buildings used as dormitories; also, that additional bath rooms and water-closet facilities be added to the north dormitory.

Last year I reported that the college flagstaff had been blown down, and recommended that a new one of steel be erected, similar to the one in the town of Amherst. I again renew that recommendation. In an institution of this kind our national flag should always be displayed.

Under the provisions of General Orders, No. 101, War Department, 1905, the following-named students of the class of 1906 were reported to the Military Secretary of the Army and to the Adjutant-General of the Commonwealth, as having shown special aptitude in military exercises, viz.: Herman Augustus Suhlke, George Talbot French, Stanley Sawyer Rogers, Benjamin Strain.

Under the provisions of General Orders, No. 101, War Department, dated June 29, 1905, I quote the following: —

The reports of the regular inspection of the colleges and schools to which officers of the army are detailed as professors of military science and tactics will hereafter be submitted annually to the general staff for its critical examinations; and the chief of staff shall report to the Secretary of War from the institutions which have maintained a high standard the six whose students have exhibited the greatest application and proficiency in military training and knowledge.

The President of the United States authorizes the announcement that an appointment as second lieutenant in the regular army will be awarded annually to an honor graduate of each of the six institutions thus designated, provided that sufficient vacancies exist after the appointment of graduates of the Military Academy at West Point and the successful competitors in the annual examination of enlisted men. By the term honor graduate is understood a graduate whose attainments in scholarship have been so marked as to receive the approbation of the president of the school or college, and whose proficiency in military training and knowledge and intelligent attention to duty have merited the approbation of the professor of military science and tactics.

This has been the rule for the past three years, but up to date no agricultural college, Class B, has received such an appointment. I believe this to be due entirely to the limited amount of time that can be given to the military department at institutions of Class B. Thus far all appointments provided for in above order have gone to institutions of Class A and Class C, schools that are essentially military schools, and where a great amount of time is devoted to the military department. I do not believe Class B institutions can compete with those of Class A and Class C in the military department.

Inasmuch as there are 45 Class B institutions and only 40 of Class A and Class C that are affected by above order, it would seem to me a better arrangement if at least two of the above appointments could go to Class B institutions, and thus create competition among them in military work. This, in my opinion, is a prize of great value, well worth striving for, and should inspire the ambition of every student. I make the above suggestion, hoping it may bear fruit by way of recommendation to the War Department, which will lead to giving Class B institutions the above-suggested two appointments.

The following is a list of ordnance and ordnance stores, property of the United States, in possession of the college: —

2 8-inch mortars, with implements (obsolete).
2 mortar beds (obsolete).
200 Krag-Jorgensen rifles, model 1898.
200 sets infantry accoutrements.
6 non-commissioned officers' swords, steel scabbards.
14 non-commissioned officers' waist belts and plates.
14 sliding frogs for waist belts.
100 paper targets, "A" and "B."
1 set of marking rods, disks and brushes for gallery practice.

All of this property is in good condition and well cared for. Two hundred and thirty-six students have received practical instruction in the military department during the year, some for only a short period, on account of not remaining in college. These figures include the class of 1906.

The organization at present is as follows: one battalion of three infantry companies, and band.

Commandant.

Capt. George Chipman Martin, Eighteenth U. S. Infantry.

Cadet Major, ... Walter Ebenezer Dickinson.

Staff.

Cadet Captain and Adjutant, . John Nicholas Summers.
Cadet First Lieutenant and Quartermaster, ... James Hervey Walker.
Cadet Sergeant Major, . . . Raymond Dean Whitmarsh.
Cadet Quartermaster Sergeant, . Carlton Craig Gowdy.
Cadet Color Sergeant, . . . Edwin Daniels Philbrick.
Cadet Color Sergeant, . . . Fred Alexander Watkins.

Company A.

Cadet Captain, ... Frederick Charles Peters.
Cadet First Lieutenant, . . Herbert Poland Wood.
Cadet Second Lieutenant, . . Harold Edward Alley.
Cadet First Sergeant, . . . Chester Socrates Gillett.
Cadet Quartermaster-Sergeant, . Roland Hale Verbeck.
Cadet Sergeant, ... Clifton Leroy Flint.
Cadet Sergeant, ... Charles Francis Allen.
Cadet Sergeant, ... Joseph Worcester Wellington.
Cadet Sergeant, ... John Daniel.
Cadet Corporal, ... Horace Wells French.

Cadet Corporal, ... Rockwood Chester Lindblad.
Cadet Corporal, ... Charles Sumner Putnam.
Cadet Corporal, ... Lamert Seymour Corbett.
Cadet Corporal, ... Thomas Webster Bean.
Cadet Corporal, ... James Valentine Monahan.

Privates, 41; aggregate, 56.

Company B.

Cadet Captain, ... Wayland Fairbanks Chace.
Cadet First Lieutenant, . . Joseph Otis Chapman.
Cadet Second Lieutenant, . . Clinton King.
Cadet First Sergeant, . . . Thomas Addis Barry.
Cadet Quartermaster-Sergeant, . John Robert Parker.
Cadet Sergeant, ... John Albert Anderson.
Cadet Sergeant, ... Parke Warren Farrar.
Cadet Sergeant, ... Lai-Kwei Liang.
Cadet Sergeant, ... William Franklin Turner.
Cadet Corporal, ... Myron Wood Thompson.
Cadet Corporal, ... Leroy Henry Turner.
Cadet Corporal, ... Samuel Sutton Crossman.
Cadet Corporal, ... Elmer Francis Hathaway.
Cadet Corporal, ... John F. O'Donnell.
Cadet Corporal, ... Charles Russell Webb.

Privates, 41; aggregate, 56.

Company C.

Cadet Captain, ... Clifford Briggs Thompson.
Cadet First Lieutenant, . . Ralph Jerome Watts.
Cadet Second Lieutenant, . . John Thomas Caruthers.
Cadet First Sergeant, . . . Harry Milliken Jennison.
Cadet Quartermaster-Sergeant, . Hermon Temple Wheeler.
Cadet Sergeant, ... Carleton Bates.
Cadet Sergeant, ... Arthur James Farley.
Cadet Sergeant, ... Samuel Judd Wright.
Cadet Sergeant, ... William John Coleman.
Cadet Corporal, ... Roger Sherman Eddy.
Cadet Corporal, ... Harry Orrison Knight.
Cadet Corporal, ... Richard Potter.
Cadet Corporal, ... Harold Gordon Neale.
Cadet Corporal, ... Paul Edgar Alger.
Cadet Corporal, ... Leon Clark Cox.

Privates, 41; aggregate, 56.

Band.

Cadet Captain, ... George Henry Chapman.
Cadet First Lieutenant, . . Earle Goodman Bartlett.
Cadet Drum Major, . . . Frederick Augustus Cutter.

Cadet Sergeant, ...	Edward Houghton Shaw.
Cadet Sergeant, ...	Milford Henry Clark, Jr.
Cadet Sergeant, ...	Jaspar Fay Eastman.
Cadet Corporal (leader), . .	Kennith French Gillett.
Cadet Corporal, ...	Lloyd Warren Chapman.
Cadet Corporal, ...	Roy Edward Cutting.
Cadet Corporal, ...	Allan Dana Farrar.
Cadet Corporal, ...	James Augustus Hyslop.
Cadet Corporal, ...	Raymond Hobart Jackson.

Privates, 10; aggregate, 22.

Total in military department: 1 major, 5 captains, 5 first lieutenants, 3 second lieutenants, 1 sergeant major, 1 battalion quartermaster-sergeant, 2 color sergeants, 3 first sergeants, 1 drum major, 3 company quartermaster-sergeants, 15 sergeants, 24 corporals, 133 privates, aggregate 197.

Respectfully submitted,

GEORGE CHIPMAN MARTIN,
Captain, Eighteenth United States Infantry, Commandant.

Report of the President of the Massachusetts Agricultural College to the Secretary of Agriculture and the Secretary of the Interior, as required by Act of Congress of Aug. 30, 1890, in Aid of Colleges of Agriculture and the Mechanic Arts.

I. Value of Additions to Equipment during the Year ended June 30, 1906.

1. Library,	$1,000 00
2. Apparatus,	200 00
3. Buildings,	37,000 00
4. Live stock,	2,001 00
Total,	$40,201 00

II. Receipts for and during the Year ended June 30, 1906.

1. State aid: —	
(*a*) Income from endowment,	$3,313 32
(*b*) Appropriations for current expenses,	40,250 00
(*c*) Appropriations for buildings or for other special purposes,	51,650 00
2. Federal aid: —	
(*a*) Income from land grant, act of July 2, 1862,	7,300 00
(*b*) Additional endowment, act of Aug. 30, 1890,	16,666 66
3. Fees and all other sources,	7,648 36
Total,	$126,828 34
4. Federal appropriation for experiment stations, act of March 2, 1887,	$15,000 00

III. Property, Year ended June 30, 1906.

Value of buildings,	$252,775 00
Value of other equipment,	$169,372 61
Total number of acres,	404
Acres under cultivation,	275

Acres used for experiments,	60
Value of farm and grounds,	$44,350 00
Number of acres of land alotted to State under act of July 2, 1862,	360,000
Amount of land grant fund of July 2, 1862,	$219,000 00
Amount of other permanent funds,	$142,000 00
Number of bound volumes in library June 30, 1906,	26,944

IV. Faculty during the Year ended June 30, 1906.

College of Agriculture and Mechanic Arts, collegiate and special classes,	32
Number of staff of experiment station,	26

V. Students during the Year ended June 30, 1906.

College of Agriculture and Mechanic Arts, collegiate and special classes,	262
Graduate courses,	8
Total, counting none twice,	270

THE NEW BOTANICAL LABORATORY.

Clark Hall, the new botanical laboratory now nearly completed at this college, for which the last Legislature appropriated $45,000, will be one of the most substantial and artistic buildings on the college grounds. The plans for the structure are from the office of Cooper & Bailey, the well-known Boston architects. It is of a mixed style of architecture, coming nearest to the colonial, adapted from the English. The dimensions are 95 by 55 feet, with an eight-foot projection on the east side. The base is of granite and the rest of red brick, the whole having ornamentation of pressed brick and marble. The roof and gutters are of copper, canvas and slate.

Clark Hall is to be devoted to teaching and experimental purposes, and the work previously carried on in the department of vegetable physiology and pathology, at the East experiment station, and in the botanical museum, will now be conducted in Clark Hall. The new building contains a large recitation room capable of seating about 140 students, built in the amphitheatre style. This room is intended to be supplied with automatic working curtains, for use with the stereopticon. There is also a museum room on the first floor, which will be used for a lecture room, with a capacity of about 65 or 70 students. The museum proper consists mainly of cases on the wall, leaving the interior of the room free for class room work. The east side of the building is devoted to experiment station purposes, and includes rooms for special laboratories, and office, library and herbarium.

On the second floor there is a large laboratory for freshmen and junior work, capable of accommodating about 75 men. There is also a laboratory for seniors, with ample accommodations, together with rooms for graduate and special students. The Knowlton herbarium will be preserved in a room in the upper story, which will be used as a small lecture and seminar room.

On the third floor, or attic, there are two sleeping rooms and a study room for the caretakers of the building, which will be provided with bath and toilet rooms. From the attic there are stairs leading to a platform on the roof which commands an excellent view of the college grounds.

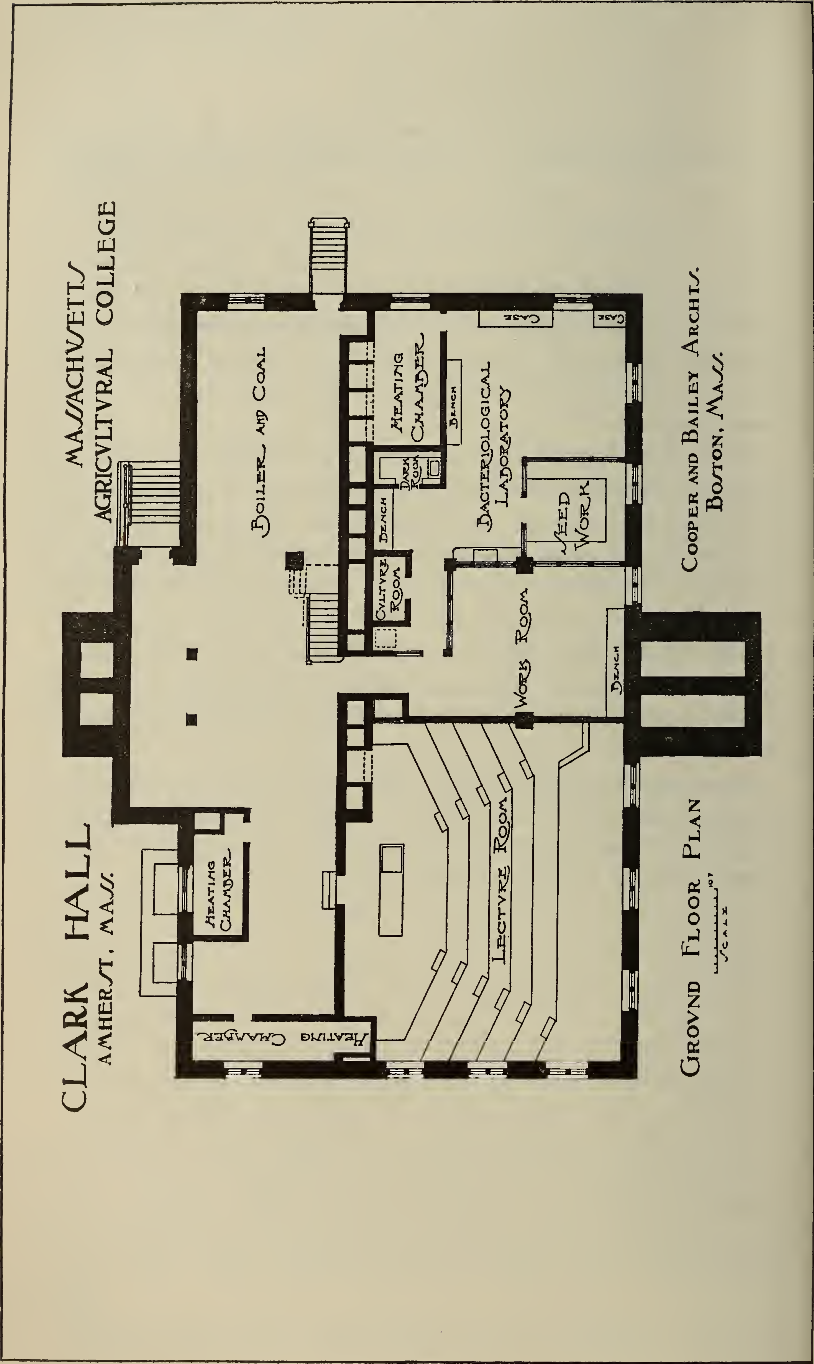
A portion of the basement is well lighted, and will be used for various lines of work connected with seed testing, separation, soil work, etc. Provision is also made for a tool room and a large bacteriological laboratory, which will be equipped for the study of problems connected with the bacteriology of soils, etc.

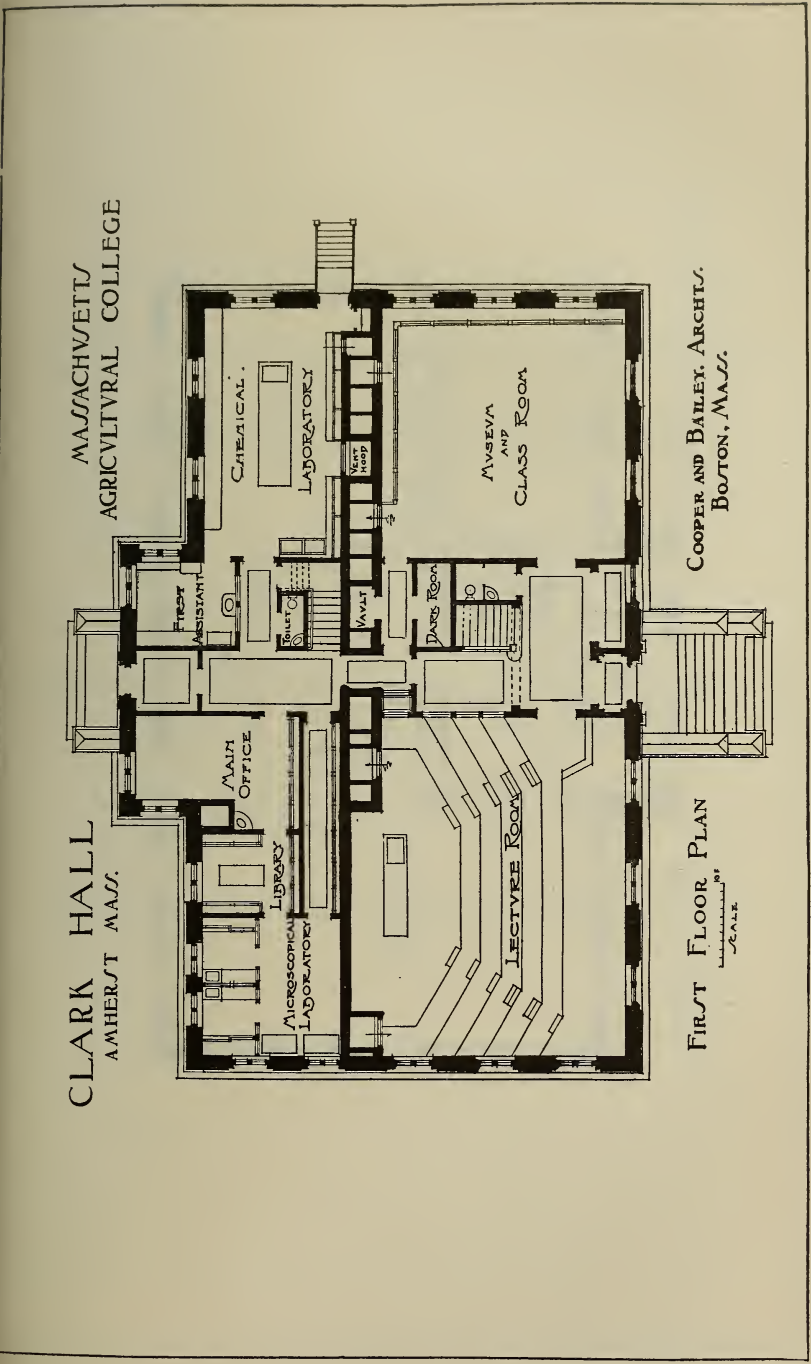
A small greenhouse for special experimental work, in the place of that previously used at the east experiment station, will be constructed on the south side of the building. This will be devoted to the study of the diseases of the most important greenhouse crops.

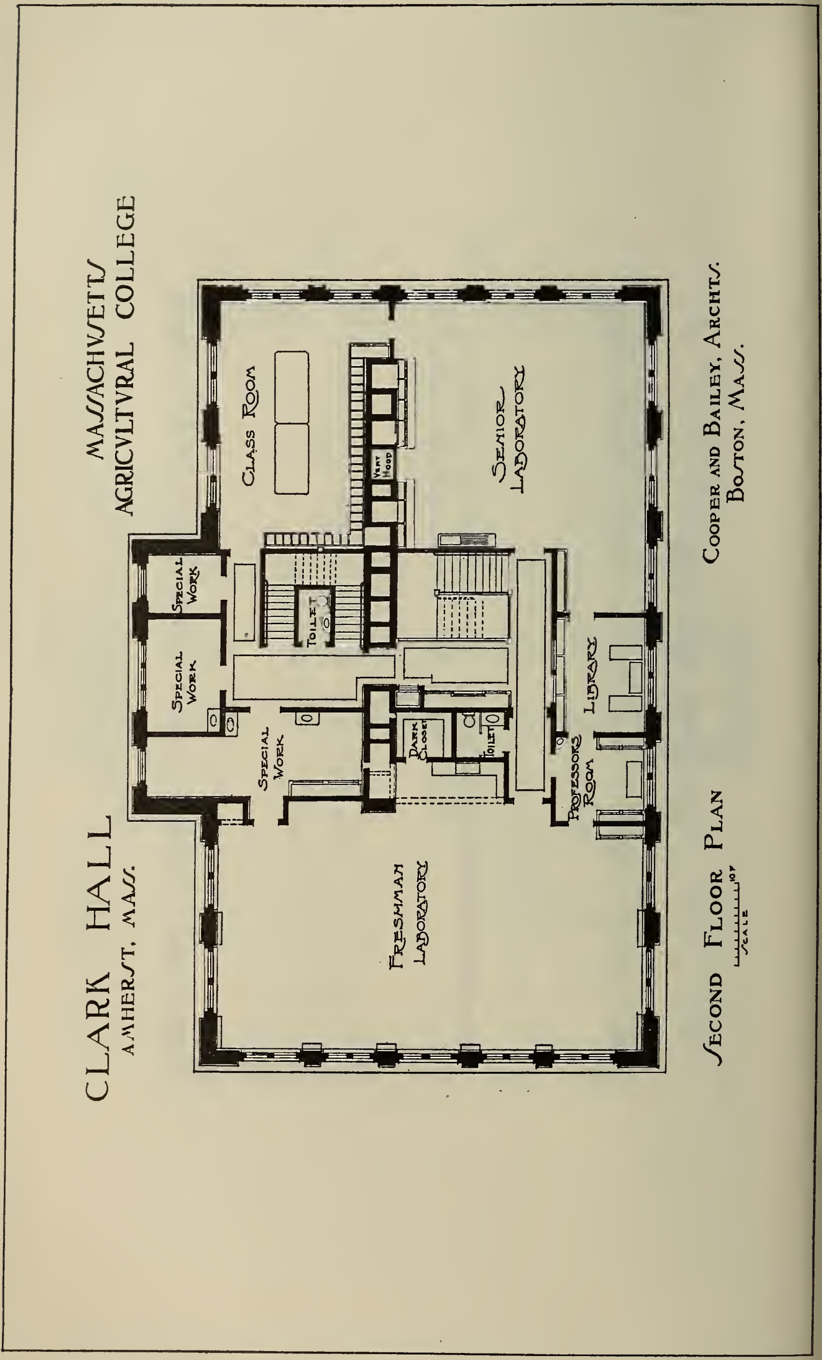
The construction of Clark Hall will not be quite fireproof, but would be classified for insurance purposes as "slow-burning." It is unexposed by any fire hazard, and will be equipped with hose connected with standpipes and chemical extinguishers; therefore there is only the remotest possibility of the building ever being seriously damaged by fire.

The object of the trustees and architects has been to combine, in a marked degree, beauty and utility in this structure, and to provide a convenient, permanent home for this department of the college.

It is very fitting that the building should be named after Col. W. S. Clark, one of the first presidents of the college, whose ability, enthusiasm and great versatility are recognized at the present time as well as in former years.


CLARK HALL
AMHERST, MASS.
MASSACHUSETTS
AGRICULTURAL COLLEGE
BOILER AND COAL
HEATING CHAMBER
BENCH
DARK ROOM
BACTERIOLOGICAL LABORATORY
CASE
CASE
SEED WORK
BENCH
CULTURE ROOM
WORK ROOM
BENCH
LECTURE ROOM
HEATING CHAMBER
HEATING CHAMBER
GROUND FLOOR PLAN
SCALE
COOPER AND BAILEY ARCHTS.
BOSTON, MASS.


CLARK HALL
AMHERST MASS.
MASSACHUSETTS
AGRICULTURAL COLLEGE
CHEMICAL.
LABORATORY
VENT HOOD
VAULT
FIRST ASSISTANT
TOILET
DARK ROOM
MUSEUM
AND
CLASS ROOM
MAIN OFFICE
LIBRARY
MICROSCOPICAL
LABORATORY
LECTURE ROOM
COOPER AND BAILEY, ARCHTS.
BOSTON, MASS.
FIRST FLOOR PLAN
SCALE


CLARK HALL
AMHERST, MASS.
MASSACHUSETTS
AGRICULTURAL COLLEGE
Class Room
Vent Hood
Senior Laboratory
Special Work
Special Work
Toilet
Special Work
Dark Closet
Toilet
Library
Professors Room
Freshman Laboratory
Second Floor Plan
Scale
10 ft
Cooper and Bailey, Archts.
Boston, Mass.

NINETEENTH ANNUAL REPORT

OF THE

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

JANUARY, 1907.

MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE,

AMHERST, MASS.

ORGANIZATION.

Committee on Experiment Department.

Station Staff.

CHARLES A. GOESSMANN, Ph.D., LL.D.,	*Honorary Director and Chemist* (fertilizers).
WILLIAM P. BROOKS, Ph.D.,	*Director and Agriculturist.*
GEORGE E. STONE, Ph.D.,	*Botanist.*
JOSEPH B. LINDSEY, Ph.D.,	*Chemist* (foods and feeding).
CHARLES H. FERNALD, Ph.D.,	*Entomologist.*
FRANK A. WAUGH, M.S.,	*Horticulturist.*
J. E. OSTRANDER, C.E.,	*Meteorologist.*
HENRY T. FERNALD, Ph.D.,	*Associate Entomologist.*
JAMES B. PAIGE, D.V.S.,	*Veterinarian.*
ERWIN S. FULTON, B.Sc.,	*Assistant Agriculturist.*
NEIL F. MONAHAN, B.Sc.,	*Assistant Botanist.*
HENRI D. HASKINS, B.Sc.,	*First Assistant Chemist* (fertilizers).
EDWARD G. PROULX, B.Sc.,	*Second Assistant Chemist* (fertilizers).
E. THORNDIKE LADD, B.Sc.,	*Third Assistant Chemist* (fertilizers).
EDWARD B. HOLLAND, M.S.,	*First Chemist* (foods and feeding).
PHILIP H. SMITH, B.Sc.,	*Assistant Chemist* (foods and feeding).
LEWELL S. WALKER, B.Sc.,	*Assistant Chemist* (foods and feeding).
WILLIAM K. HEPBURN,	*Inspector* (foods and feeding).
HOWARD A. PARSONS,	*Dairy Tester* (foods and feeding).
ROY F. GASKILL,	*Assistant in Foods and Feeding.*
CHARLES P. HALLIGAN, B.Sc.,	*Assistant Horticulturist.*
EDWIN F. GASKILL, B.Sc.,	*Assistant Agriculturist.*
T. A. BARRY,	*Observer.*

REPORT OF THE DIRECTOR.

During the past year the work of the station has for the most part followed the usual lines, but an important change in policy, as affecting college and station, should be noted. Early last year it was voted by the Board of Trustees to separate the administrative duties of the presidency of the college and the directorship of the station, and a director was elected. The station, it will be remembered, is a department of the college, and the director, therefore, is responsible to the president. He is made *ex officio* a member of the committee of the Board of Trustees on the experiment department, without vote. Although this change, as stated, was voted early last year, it did not become practically operative until early in July, for up to that time the director-elect served as acting president of the college as well as director, so that his time and energies were divided.

The Adams Act.

The past year has been rendered notable in station history by the passage of the Adams act, granting additional appropriations to all the agricultural experiment stations of the country. This act takes its name from the late Hon. H. C. Adams of Wisconsin, who labored long and earnestly to secure its passage, and who perhaps in a very real sense gave his life for the passage of the bill which bears his name.

The Adams bill provided an appropriation by the national government of $5,000 to each experiment station for the year ended June 30, 1906. It provides for an increase of $2,000 in the amount appropriated for each station annually until the total amount per year for each State reaches $15,000, at which figure it is then to remain. This act will then, in brief, within a few years double the amount of the national appropriations to each of the experiment stations of the country. This act was approved on March 16, 1906. There was for a time doubt as to whether the first installment of $5,000 would become available during the fiscal year ended June 30 last. A final decision was not made until very late in June. The passage of the act had, however, been anticipated, and, in preparation for an increase in the scope of station work, the principal part of the first installment was used in the purchase of scientific apparatus. The Adams bill stipulates that the funds which it makes available are "to be applied only to all the necessary expenses of conducting original researches or experiments bearing directly on the agricultural industry of the United States." It should by the terms of the bill be devoted to research of the highest scientific character. No part of the funds made available by the Adams bill can be used for ordinary administrative expenses or for publication.

The bill was so drawn that acceptance of its provisions by the Legislatures of the several States was a necessary prerequisite to the reception of the funds which it provided. Such acceptance on the part of the Legislature of Massachusetts was promptly obtained.

Change in the Name of the Station.

At the time when work was organized under the Hatch act, establishing experiment stations as departments of agricultural colleges, there was already in existence in Amherst a station organized under State law, known as the Massachusetts Experiment Station. It will be remembered that for some years the two stations continued in operation side by side and without disadvantage, for there was agreement as to the lines of investigation to be undertaken by each, and there was no duplication of work. The fact that the name Massachusetts Experiment Station was already in use made it necessary to adopt another name; and, as a mark of respect to Senator Hatch, to whose activity and influence the establishment of the stations under the general government had been due, this experiment department in Massachusetts was called the Hatch Experiment Station. In the course of a few years it became apparent that superior economy in the administrative work of the Massachusetts stations might be secured should both come under one organization. An act of the Legislature was secured, uniting the State station with the Hatch station, and under the latter name. The use of this name has been attended with numerous minor disadvantages. The reason for its adoption is not generally understood. It is contrary to the custom in other States to give the stations a special name; in all other States the station is known by the name of the State. It has therefore seemed best to conform to this general practice, and the name of this station by act of the Legislature recently secured has been changed to the Massachusetts Agricultural Experiment Station.

Changes in Staff.

No very important changes in the general policy of the station have been made during the year, and yet it has been a year of progress. The station has been fortunate in retaining the services of all the heads of its various divisions, and in June last the scope of its work was extended through the establishment of a division of veterinary science, of which Dr. James B. Paige was made the head.

A considerable number of minor changes in the station staff have been made necessary, owing to the fact that assistants in various departments have left us to take positions of greater responsibility and emolument. These changes have been as follows: —

E. S. Fulton, B.S., in place of F. R. Church, B.S.

E. F. Gaskill, B.S., appointed assistant agriculturist, in place of S. B. Haskell, B.S.

Howard S. Parsons, dairy tester, in place of Sumner R. Parker, B.S.

Charles P. Halligan, B.S., assistant horticulturist, in place of Walter B. Hatch, B.S.

Lewell S. Walker, B.S., assistant chemist, in place of Arthur C. Whittier, B.S.

W. K. Hepburn, inspector, in place of Frank G. Helyar, B.S.

T. A. Barry, observer, in place of C. H. Chadwick.

The correspondence, as pointed out by the heads of a number of divisions, has largely increased. This increase has affected not simply the heads of divisions, but the director's office as well, and has made necessary the employment of an increased number of private secretaries. The clerical work of the station now affords full employment for from five to six such assistants.

New Lines of Work.

During the past year two new lines of work have been undertaken, in both instances at the solicitation and with the hearty co-operation of persons engaged in the special industries affected.

Asparagus growing is an important industry in a number of sections. Of late years it has been found difficult to produce satisfactory crops, on account of the prevalence of rust. It is hoped that it may be possible to obtain or to produce more rust-resistant varieties of this crop; and, for the purpose of working with that end in view, an arrangement has been made with the division of plant industry of the department of agriculture for co-operative work. Much of this work will be carried on in Concord, which is the center of what is without doubt the most important asparagus-producing section in the State. In connection with the asparagus-breeding experiments in Concord, an extended series of fertilizer experiments is also to be undertaken. Considerable preliminary work in both directions has been done during the past year.

The cranberry industry, which is so important chiefly in the seaboard towns of southeastern Massachusetts, has long suffered from a variety of insect pests. An important beginning has been made in the study of these pests during the past season. In this work the station has employed an assistant, who spent the entire summer in Wareham, which is one of the principal towns of the cranberry district of Plymouth County. The results of his work and important suggestions as to methods of fighting the injury due to some of the more serious insect pests will be presented in a bulletin, which will be ready for publication at an early date.

An extended series of experiments in the use of fertilizers for cranberries has also been begun during the past year. The bogs where these experiments are in progress under direct station management are located in Falmouth. An almost equally extensive series of experiments with fertilizers has been begun on the bogs of one of the largest private growers.

Revision of Mailing Lists.

The mailing lists of the station have been kept by the card catalogue system, and have not been revised for a number of years. These lists include a total of some 25,000 cards. It is believed that they may include duplicates, and a considerable number of names of parties who no longer care for our publications, — possibly of persons deceased or removed. An important beginning has been made in the revising of these lists. The revision now in progress will be made of the most thorough possible character, and as soon as it can be completed, improved systems of addressing and mailing will be installed.

Work under the Adams Act.

Careful plans have been laid for investigations under the Adams act. These investigations, as will be evident from the statement made concerning the nature of the work which can be undertaken under it, will usually extend over a considerable number of years. A portion of the work with asparagus and cranberries, which has been referred to, will be provided for out of the funds furnished by this act.

Among other lines of work which have been begun are investigations to determine the effect of feed on the composition of milk and butter fat and on the consistency or body of butter; the effect of Porto Rico molasses on the digestibility of hay, and of hay and a nitrogenous concentrate; the preparation of descriptions and life histories of important groups of insects; and a study of the relations of climate to the development of plants and crops both in health and disease.

Bulletins issued.

Meteorological bulletins have been issued monthly, as usual, and in addition the station has published and distributed four other bulletins, — two on fertilizers, one on the inspection of concentrates and one on market milk.

The fertilizer bulletins, Nos. 109 and 111, have presented the analyses of the fertilizers officially examined under the fertilizer law, as well as the analyses of a considerable number of soils and the more abundant miscellaneous materials possessing fertilizer value, which are sent in by the general public. They have also included brief discussions of the results.

The bulletin on the inspection of concentrates, No. 108, besides presenting the results of the analyses of food stuffs collected under the feed law, included much valuable information on the general subject of food stuffs and their use.

The bulletin on market milk, No. 110, included: first, general discussion of the composition and value of milk as food; second, it presented the results of an examination into the conditions under which the milk marketed in parts of Northampton and Amherst is produced, as well as the results of a critical examination of samples of this milk. The milk was subjected to physical, chemical and bacteriological tests, for the purpose of determining its quality, value and suitability as human food. The results are carefully and fully discussed, and some of the more important conclusions presented were as follows: Very little milk showed evidence of adulteration, and most of it was sweet. The larger part of it was above the average in chemical composition. Bacteria were especially numerous in the product of cows kept under uncleanly conditions, and such samples were far too numerous. Many samples showed barny or disagreeable smell, apparently due to the fact that the milk was allowed to stand too long in the stable after milking. The general conclusion was, that a great deal of the milk offered for general consumption was not produced under satisfactory sanitary conditions. The bulletin concludes with brief, important and pointed practical suggestions both to producers and to consumers.

Besides the bulletins which have been mentioned, three others have been prepared, and are now in press: No. 112, "The Examination of Cattle and Poultry Feeds;" No. 113, "Fertilizer Bulletin;" and No. 114, "The Oriental Moth: a Recent Importation."

Bulletins and Reports available for Free Distribution.

The supply of many of the reports and bulletins which have been issued by the station, available for general distribution, has been exhausted, but those in the following list will still be furnished on application: —

No. 3. Tuberculosis.
No. 33. Glossary of fodder terms.
No. 34. Fertilizer analyses.
No. 41. On the use of tuberculin (translated from Dr. Bang).
No. 64. Analyses of concentrated feed stuffs.
No. 68. Fertilizer analyses.
No. 76. The imported elm-leaf beetle.
No. 81. Fertilizer analyses; treatment of barnyard manure with absorbents; trade values of fertilizing ingredients.
No. 83. Fertilizer analyses.
No. 84. Fertilizer analyses.
No. 89. Fertilizer analyses; ash analyses of plants; instructions regarding sampling of materials to be forwarded for analysis.
No. 90. Fertilizer analyses.
No. 92. Fertilizer analyses.
No. 96. Fungicides; insecticides; spraying calendar.
No. 97. A farm wood lot.
No. 99. Dried molasses beet pulp; the nutrition of horses.
No. 100. Fertilizer analyses; market values of fertilizing ingredients.
No. 102. Analyses of manurial substances and fertilizers; market values of fertilizing ingredients.
No. 103. Analyses of manurial substances; instructions regarding sampling of materials to be forwarded for analysis; instructions to manufacturers, importers, agents and sellers of commercial fertilizers; discussion of trade values of fertilizing ingredients.
No. 105. Tomatoes under glass; methods of pruning tomatoes.

No. 107. Analyses of manurial substances forwarded for examination; market values of fertilizing ingredients; analyses of licensed fertilizers collected in the general markets.
No. 109. Analyses of manurial substances forwarded for examination; analyses of Paris green and other insecticides found in the general markets; instructions regarding the sampling of materials to be forwarded for analysis; instructions to manufacturers, importers, agents and sellers of commercial fertilizers; discussion of trade values of fertilizing ingredients for 1906.
No. 110. Market milk.
No. 112. The examination of cattle and poultry feeds.
No. 113. Fertilizer analyses.
No. 114. The oriental moth: a recent importation.

Of most of the other bulletins of the station a few copies still remain; these will be supplied only to complete sets for libraries.

The co-operation and assistance of farmers, fruit growers and horticulturists, and all interested directly or indirectly in agriculture, is earnestly requested. Communications may be addressed to the "Massachusetts Agricultural Experiment Station, Amherst, Mass."

Reports of Divisions.

The reports of the different heads of divisions are transmitted herewith.

The report of the meteorologist calls attention to two or three important improvements in equipment.

The report of the agriculturist is elsewhere briefly summarized.

The report of the fertilizer section of the division of chemistry calls attention to a moderate increase in the number of fertilizers licensed in the State and in the number analyzed. Three hundred and fifty-four brands of fertilizers and chemicals have been licensed in Massachusetts during the year. As was pointed out in the last annual report, there can be no possible necessity for such a large number of different kinds of fertilizers. The report of the chemist this year emphasizes this point. It should be more generally understood that the fertilizers purchased by the farmer cost more as a consequence of this needless multiplication of brands. It would seem to be the part of common sense for the manufacturers to reduce their number, for whatever enables them to lower the price to the consumer must eventually help manufacturer and dealer as well as consumer. The fertilizers analyzed during the past year have shown an improvement in quality, as compared with stated composition. No particular improvement can be noted in the direction of better adaptation to crops. The different brands of special crop fertilizers show the same extreme variations as heretofore. It is evident that not all of the fertilizers advertised as suitable for any particular crop can possibly meet the promises of the manufacturers. The analyses completed by the station show some decline in the general quality of wood ashes, and the report emphasizes the desirability that consumers of ashes should purchase only on a guarantee as to quality.

The report of the section of foods and feeding is largely devoted to the presentation of the results of experiments to determine the digestibility of some of the newer food stuffs. The publication of such results seems to be essential as a basis for proper use of such materials. The report calls attention to the general results of the analyses of samples of drinking water, which indicate, as in previous years, the necessity of caution in cases where contamination seems possible or is suspected. The report includes also brief statements of the results of the execution of the feed and dairy laws. Dealers in food stuffs seem in general disposed to comply with the law, although in a few cases it is believed that retailers are in the habit of removing or failing to attach labels required by the law. Attention is called to the fact that the tests of Babcock glassware for accuracy show a comparatively large proportion to be inaccurately graduated. There is much need of greater care on the part of manufacturers.

The results of a feeding trial in which Porto Rico molasses was tested are presented. They show such molasses to have apparently about 80 per cent. of the value of corn meal. Attention, however, is called to the fact that molasses depresses the digestibility of other foods. Should it be found that such depression inevitably follows the use of molasses, this consideration will materially decrease its value as a food stuff.

Feeding experiments with alfalfa meal indicate that it is not equal to wheat bran in food value, as is claimed by some of its manufacturers.

Experiments with sorghum as a fodder show that the large quantities of seed sometimes recommended are unnecessary, and that the fodder fills a useful place in a soiling system.

The report of the botanist and vegetable pathologist covers a considerable variety of topics. Attention is called to the tonic influence of Bordeaux mixture on plant assimilation. As a result of this influence, it seems apparent that the benefit following the application of Bordeaux mixture is not due solely to the prevention of disease, but in considerable measure as well to increased vigor of growth.

Attention is called to the importance of further study for the discovery of a remedy for tomato rot, which so seriously injures the greenhouse crop in this State.

The report shows a considerable increase in the amount of work done by the station in testing seeds for farmers and gardeners. It presents a review of the year as regards the prevalence of plant diseases. It seems that during the past year the potato has been comparatively free from disease, while celery, pears and apples have been affected to an unusual degree. The report calls attention to defoliation of fruit trees not infrequently following improper spraying, and makes important suggestions in connection therewith.

Attention is called to a bacterial disease of cucumbers under glass. It has been found that relatively late planting insures absolute or comparative freedom from this disease. A bacterial disease of lettuce is common in the south, and growers are cautioned to be on the outlook for similar disease in their houses. The promptest measures should be taken to eradicate it, should it appear.

Attention is called to a serious trouble which tobacco growers have experienced within the last year or two, which appears to be due to improper use of fertilizers.

It is pointed out that the lime and sulfur treatment now so often adopted as a means of destroying the San José scale exercises a repressive influence upon a number of fungous diseases. It has been noted that fruit trees have been remarkably free from such diseases, and the fruit unusually perfect and free from imperfections where the lime and sulfur treatment has been practiced, and the opinion is expressed that the San José scale may prove "a blessing in disguise."

A brief report is presented of the trial of a number of different fungicides for potatoes. The wet Bordeaux mixture was found to be superior to any of the dry applications, but the results of the season are comparatively inconclusive.

The report includes an important paper upon banding substances which are used for the protection of trees and shrubs from insects. Relatively few of the substances upon the market satisfy all the requirements in such a material. A number of them prove highly injurious if applied direct to the bark.

The report of the botanist includes a paper on the injury to trees caused by illuminating gas. It appears that a large amount of careless work has been done in the putting in of gas mains. The injury to trees consequent upon the escape of illuminating gas into the soil surrounding their roots has in a number of instances proved very serious.

The report concludes with a discussion as to the varying texture of soil required for some of our more important special crops.

The report of the entomologists calls attention to the large amount of injury to various greenhouse crops consequent upon the attacks of the white fly. Fumigation with hydrocyanic acid gas has been found the most successful method of destroying this insect, but the results of such fumigation have in numerous instances resulted in great injury to the plants fumigated. The capacity of different plants to endure such fumigation is for the most part unknown. This subject has been carefully investigated for greenhouse tomatoes, and a bulletin soon to be published will present the results and give definite directions. The report calls attention to the rapid spread of the San José scale, which seems to be at present distributed in nearly every town east of the Connecticut River. The scale is found in old as well as in recently set trees. The report calls attention to the fact that earlier experiments here showed the lime and sulfur treatment to be the most effective. Later investigation confirms these early results. The report deals briefly with a number of the proprietary mixtures recommended for the destruction of the San José scale, but states that none of them has been found equal to the lime and sulfur mixture. The report makes mention of the work on cranberry insects and the investigation as to the newly imported oriental moth, both of which have been previously referred to. It concludes with brief reference to some of the more destructive insects of the year.

The report of the veterinarian briefly discusses the nature of the work which his department has been called upon to do. It will be remembered that this division has been organized only since July.

The report of the horticulturist makes brief mention of the different lines of experimental work in progress, and reports in detail the results of experiments in mushroom growing. These indicate pure-culture spawn to be much superior to the ordinary commercial spawn, and that there is a wide difference in the characteristics of different varieties as regards productiveness and quality. The results indicate that the possibilities of profit in mushroom culture are by no means as great as is often represented.

WILLIAM P. BROOKS,
Director.

ANNUAL REPORT

Of George F. Mills, *Treasurer* of the Massachusetts Agricultural Experiment Station of the Massachusetts Agricultural College,

For the Year ending June 30, 1906.

Cash received from United States Treasurer,		$14,617 70
Unexpended balance, 1904–05,		382 30
		$15,000 00
Cash paid for salaries,	$6,539 52	
for labor,	3,003 07	
for publications,	719 01	
for postage and stationery,	438 09	
for freight and express,	168 01	
for heat, light, water and power,	245 42	
for chemical supplies,	406 54	
for seeds, plants and sundry supplies,	525 57	
for fertilizers,	569 43	
for feeding stuffs,	699 10	
for library,	21 10	
for tools, implements and machinery,	246 05	
for furniture and fixtures,	51 52	
for scientific apparatus,	292 62	
for live stock,	195 25	
for travelling expenses,	229 66	
for contingent expenses,	25 00	
for building and repairs,	625 04	
		$15,000 00
Cash received from State Treasurer,	$13,500 00	
from fertilizer fees,	4,745 00	
from farm products,	2,836 02	
from miscellaneous sources,	4,993 76	
		$26,074 78

Cash paid for salaries,	$13,411 67	
for labor,	2,220 35	
for publications,	809 52	
for postage and stationery,	394 61	
for freight and express,	186 63	
for heat, light, water and power,	1,118 36	
for chemical supplies,	237 79	
for seeds, plants and sundry supplies,	680 65	
for fertilizers,	67 55	
for feeding stuffs,	902 65	
for library,	142 60	
for tools, implements and machinery,	58 10	
for furniture and fixtures,	212 13	
for scientific apparatus,	1,210 72	
for live stock,	10 00	
for travelling expenses,	1,587 59	
for contingent expenses,	88 10	
for buildings and repairs,	170 47	
Balance,	2,495 29	
		$26,074 78

REPORT OF THE METEOROLOGIST.

J. E. OSTRANDER.

The work of the meteorological division during the past year has been continued along the same lines as in previous years. While changes in the instruments at times are necessary, and a modification in the form of the records must occasionally be made, these are avoided unless the necessity is very apparent. The value of a set of records at any station is dependent on the uniformity with which they have been made, as well as on the length of time covered. Notwithstanding the objections to a change, it was considered advisable at the beginning of the year to discontinue the publication of the wind movement as given by the Draper anemometer, and to use instead that given by the electric register which was installed last year. This was done so that our records would be better comparable with those of the United States Weather Bureau meteorological stations, which use electric recorders. A comparison of the two records at this station shows a difference of from 5 to 10 per cent. in the total movement during a month, that of the electric register usually being the larger. The Draper records are still taken, and will be continued during the coming year for the purpose of further comparison.

The records of the electric sunshine recorder have been substituted for those of the Draper instrument, and, while they are made more precise, it is not thought that the monthly results are materially affected by the change.

With the close of the year the records for eighteen years will be complete. A summary of the records for the first ten years was published in the report for 1900. This summary has been carried along to date for the purpose of deducing mean values which are taken for the normals of the station. It should again be published when the records for twenty years are completed.

The usual monthly bulletins have been issued, and the one for December will contain a summary of the records for the year. The station has also furnished the Boston office of the United States Weather Bureau with the monthly voluntary observers' reports, and has arranged to send weekly snow reports during the winter season.

The local forecasts are received by telegraph daily, Sundays excepted, from the Boston office, and the proper flags are displayed.

During the year a new Draper self-recording thermometer was purchased, to replace the one in use. A new maximum thermometer of standard pattern was purchased, to replace the one in use which was broken in resetting. A Felt and Tarrent comptometer has been added to the equipment, and is used in making many of the computations. All computations are checked, to reduce the probability of errors to a minimum.

In February Mr. C. H. Chadwick, the observer, retired to accept a position in civil engineering in the south; and the assistant observer, Mr. T. A. Barry, was advanced to the place.

REPORT OF THE AGRICULTURIST.

WM. P. BROOKS; ASSISTANTS, E. S. FULTON, E. F. GASKILL.

The work carried on in the agricultural division of the experiment station during the past season has involved the care of 308 field plots in the various fertilizer and variety tests; 150 closed plots, largely used in fertilizer experiments; and 286 pots in vegetation experiments, mainly designed to throw light upon problems connected with the use of fertilizers. It will be remembered that a large number of the experiments in this division are continued from year to year. Such repetitions are desirable, for reasons which are fully set forth in the last annual report. A detailed account of results obtained will at this time be presented only for a relatively small number of the experiments in progress. The experiments discussed, and the more important results, briefly stated, are as follows: —

I. — Experiment to determine the relative value as sources of nitrogen of barnyard manure, nitrate of soda, sulfate of ammonia and dried blood. This experiment has been in progress since 1890. The crop of this year was corn, and on the basis of yield the nitrogen materials under comparison rank in the following order: barnyard manure, nitrate of soda, sulfate of ammonia, dried blood. On the basis of increase in crop, as compared with the product of the no-nitrogen plots, taking into account all the crops grown since the experiment began (1890), the materials on a percentage basis rank as follows: nitrate of soda, 100; barnyard manure, 85.31; dried blood, 70.06; sulfate of ammonia, 63.54.

II. — Experiment to determine the relative value of muriate and high-grade sulfate of potash. The crops on the basis of which comparisons are possible this year were soy beans, asparagus, rhubarb, raspberries, blackberries, mixed hay and potatoes. The sulfate of potash gives the larger crops in the case of soy beans, rhubarb, raspberries, blackberries, potatoes, and (as the average of two experiments) for mixed hay. The muriate gives the larger crop of asparagus.

III. — Experiment to determine the relative value of different potash salts for field crops. The salts under comparison were kainit, high-grade sulfate, low-grade sulfate, muriate, nitrate, carbonate and silicate. The crop was potatoes. The salts on the average of five trials for each rank as follows: muriate, low-grade sulfate, high-grade sulfate, nitrate, carbonate, kainit and silicate. Where potash is not used as a fertilizer, the vines appear to be far more susceptible to early blight than on the other plots.

IV. — Experiment to show the relative value in corn and hay production of special corn fertilizers, as compared with a fertilizer mixture richer in potash. The crop of the past season was mixed grass and clover. The special corn fertilizer gave the larger yield at the first cutting, the fertilizer richer in potash the larger yield of rowen. This experiment has continued since 1891. Ten corn crops and six crops each of hay and rowen have been produced. As the average of the entire number of experiments, the special corn fertilizer has given a slightly larger yield of grain and less stover than the mixture of materials richer in potash. As the average of six years' results, the mixture richer in potash has given the larger crops both of hay and rowen.

V. — Experiment to determine the relative value for production of corn and mixed hay of manure alone, as compared with a smaller application of manure and a moderate amount of sulfate of potash. The crop of the past year was mixed hay. The larger application of manure alone gave slightly larger yields both at the first and second cuttings than the combination of the smaller amount of manure and potash. This experiment has continued sixteen years. Ten corn crops and six crops each of hay and rowen have been harvested. The average yields both of corn and hay have been greater on the larger amount of manure alone, but not sufficiently greater, estimating the manure to cost $5 per cord, to cover the larger cost of the manure applied to those plots where it is used alone.

VI. — Experiment to determine the relative value, as measured by crop production, of a considerable number of phosphates used in quantities to furnish equal phosphoric acid to each plot. The phosphates under comparison are fine ground, — apatite, South Carolina rock and Tennessee rock phosphates; Florida soft phosphate, basic slag meal, dissolved bone black, raw bone meal, dissolved bone meal, steamed bone meal and acid phosphate. The crop of the past season was mixed hay. The yields on the different phosphates varied relatively little, indicating that the hay crop is dependent in far less degree upon the quantity of available phosphoric acid applied than are the crops belonging to the Cruciferæ, such as cabbages and turnips, as shown by previous trials.

VII. — Soil tests. The past season was the eighteenth during which the soil test reported in detail has continued. The results show the great importance of a supply of nitrogen in highly available form for the production of a satisfactory hay crop.

VIII. — Experiment in applying manurial substances in rotation for the production of grass. The materials applied in the rotation are: first, barnyard manure; second, wood ashes; and third, a combination of fine-ground bone and potash. The average yield of hay during the past season was at the rate of 4,002 pounds per acre. The average for the fourteen years during which the experiment has continued has been 6,389 pounds.

IX. — An experiment comparing winter with spring application of manure on a slope. The crop of the past year was corn, and the results indicate a small loss in fertilizer value, resulting from winter application, but the gain in crop where the manure was applied in spring was not sufficient to repay the extra cost in handling the manure in that manner.

X. — Experiment in the application of nitrate of soda for rowen. The increase in crop during the past season was considerably more than sufficient to cover the cost of the application; but the results in the different years that the experiment has continued show a wide variation with the amount of rainfall during the season of growth of the crop.

XI. — A variety test of potatoes, including twenty-five varieties. The most productive varieties, mentioned in order, were: Climax, Chenango White, Hammond's Wonderful and Simmon's Model, all of which gave a yield in excess of 200 bushels merchantable potatoes per acre.

XII. — Comparisons of food combinations furnishing the essential nutrients in varying proportions for laying hens. The results indicate corn to have superior merit among the different grains for the production of eggs whenever the total fiber content of the ration is low, and the fat content relatively high. Rice, which contains less fiber than any other grain, gives a satisfactory egg product, but costs too much to render its use advisable.

I. — Manures and Fertilizers furnishing Nitrogen compared. (Field A.)

The materials furnishing nitrogen which are under comparison in this experiment are barnyard manure, nitrate of soda, sulfate of ammonia and dried blood. With few and unimportant exceptions, each plot has been manured in the same way since 1890. The field includes eleven plots, of one-tenth acre each. All the plots annually receive equal and liberal amounts of phosphoric acid and potash. The phosphoric acid is supplied to all plots in the form of dissolved bone black. The potash is applied to six plots (1, 3, 6, 7, 8 and 9) in the form of muriate; it is applied to four plots (2, 4, 5, and 10) in the form of low-grade sulfate. There are three plots in the field which have had no nitrogen applied to them in any form since 1884. The nitrogen materials under comparison are applied in such quantities as to furnish nitrogen at the rate of 45 pounds per acre to each. Barnyard manure is used on one plot, nitrate of soda on two, sulfate of ammonia on three and dried blood on two.

The plots to which nitrogen has been applied in the form of sulfate of ammonia have shown a tendency to comparative unproductiveness, due without doubt to unfavorable chemical or biological conditions. These unfavorable conditions have apparently tended to prevent or to retard the nitrification of the ammonia nitrogen. As a means of correcting the faulty conditions, 50 pounds of unslaked lime were applied to plot

6 in 1896. Twice since that date, in 1898 and in 1905, the entire field has been limed, as observation of the growth of the crops, especially of clover, indicated that liming would be beneficial. In 1898, lime was applied at the rate of 2,000 pounds per acre of air-slaked lime. In 1905, 2,395 pounds of slaked lime were applied to the entire field, this being at the rate of a little more than a ton to the acre.

The crops grown in this experiment previous to this year in the order of their succession have been: oats, rye, soy beans, oats, soy beans, oats, soy beans, oats, oats, clover, potatoes, soy beans, potatoes, soy beans, potatoes, oats and peas.

The crop of the past season was Rustler White Dent corn, the seed having been obtained in Minnesota. It may be here remarked that this variety seems to be well adapted to our local soil and climatic conditions. It gave a thoroughly matured crop and a heavy yield.

After the harvest of the crop of the season 1905 (oats and peas), the land was replowed and sown to clover late in August. This clover made a poor start, and was badly injured by the winter. The condition in the spring was best on plot 0 (manure). It was poorest on plots 5 and 6 (sulfate of ammonia). On these there were but few living plants remaining. The condition of the clover being so poor, the field was plowed on May 18. The manure and the fertilizers were applied in accordance with the regular system on May 21. The field was harrowed thoroughly on May 22 and 23; it was planted on the 23d. The crop was thoroughly cared for, and no exceptional conditions likely to interfere with the experiment were noted. The rates of yield on the several plots and the sources of nitrogen on each are shown in the following table: —

Yield of Corn and Stover per Acre.

Plots.	Nitrogen Fertilizers used.	Corn (Bushels).		Stover (Pounds).
		First Quality.	Second Quality.	
0, . .	Barnyard manure, ...	86.71	16.14	6,500
1, . .	Nitrate of soda (muriate of potash), . .	62.14	13.57	6,300
2, . .	Nitrate of soda (sulfate of potash), . . .	70.00	14.00	6,100
3, . .	Dried blood (muriate of potash), . . .	62.43	10.43	6,000
4, . .	No nitrogen (sulfate of potash), . . .	34.29	13.86	6,200
5, . .	Sulfate of ammonia (sulfate of potash), . .	62.57	10.00	5,400
6, . .	Sulfate of ammonia (muriate of potash), .	62.86	9.86	5,350
7, . .	No nitrogen (muriate of potash), . . .	35.00	10.00	5,350
8, . .	Sulfate of ammonia (muriate of potash), .	61.71	12.86	5,930
9, . .	No nitrogen (muriate of potash), . . .	29.29	15.71	5,600
10, . .	Dried blood (sulfate of potash), . . .	57.71	12.57	5,800

The yield on the three no-nitrogen plots (4, 7 and 9) is much inferior to that on any of the others, although it is still almost equal to the average rate of yield of corn per acre in this State. The yield on all the plots receiving nitrogen was good, but wide differences will be noticed. The plot to which manure was applied gave a yield much superior to that obtained on any of the other plots. The relative rank of the manure plot with most of the crops grown has been much lower. In corn, as is well understood, we have a crop capable, in unusual degree, of utilizing the nitrogen of our coarser manures, since its principal growth occurs at a season sufficiently late so that the nitrogen of the comparatively inert organic compounds of the manure can previously have been rendered available by the natural processes of decay and nitrification, for which the warm weather of the early and mid-summer months is so favorable.

The average yields of this year on the several fertilizers are shown in the following table: —

Fertilizers used.	Corn (Bushels).		Stover (Pounds).
	First Quality.	Second Quality.	
Average of no-nitrogen plots (4, 7, 9),	32.86	13.19	5,717
Average of the nitrate of soda plots (1, 2),	66.07	13.79	6,200
Average of the dried blood plots (3, 10),	60.07	11.50	5,900
Average of the sulfate of ammonia plots (5, 6, 8),	62.38	10.90	5,560

As a result of all the experiments previous to this year, it has been found that the materials furnishing nitrogen have produced crops in the following relative amounts: —

	Per Cent.
Nitrate of soda,	100.00
Barnyard manure,	94.47
Dried blood,	91.09
Sulfate of ammonia,	88.83
No nitrogen,	71.52

Similar averages for this year are as follows: —

	Per Cent.	
	Corn.	Stover.
Nitrate of soda,	100.00	100.00
Barnyard manure,	131.24	104.83
Sulfate of ammonia,	94.41	89.68
Dried blood,	90.92	95.16
No nitrogen,	49.73	92.20

If we combine the results showing relative standing in 1906 with the similar figures for all the years previous to 1906, the relative standing is as follows: —

	Per Cent.
Nitrate of soda,	100.00
Barnyard manure,	96.63
Dried blood,	91.08
Sulfate of ammonia,	89.14
No nitrogen,	70.24

All the figures showing relative standing included in the above tables are based upon the total yields. Presented in this way, they are not without interest. Of even greater interest, however, will be a comparison on the basis of the increases as compared with the no-nitrogen plots, due to the different nitrogen-containing materials which have been used. On this basis, increase in crop, rather than on the basis of total product, the manure and fertilizers used as a source of nitrogen rank to date for the entire period of the experiment, 1890 to 1906, inclusive, as follows: —

Relative Increases in Yields (Averages for the Seventeen Years).

	Per Cent.
Nitrate of soda,	100.00
Barnyard manure,	85.32
Dried blood,	70.03
Sulfate of ammonia,	63.51

It will be noticed that, whatever the basis of comparison, the nitrate of soda has on the average given results considerably superior to those obtained either with manure or with either of the other nitrogen fertilizers. It will also be noticed that the sulfate of ammonia, on the other hand, has given results much inferior to those obtained with either of the other materials supplying nitrogen. If nitrogen, then, can be purchased in the form of nitrate at a price per unit not exceeding that which it will cost in other forms, there can be little doubt that it should be depended upon as a source of this element for most of the crops of the farm. The results of the past season, however, indicate that, as would naturally be anticipated, the nitrate does not show the same degree of superiority for corn as has usually been shown with the crops raised in this field, almost all of which complete their growth at a much earlier date in the season than corn.

II. — The Relative Value of Muriate and High-grade Sulfate of Potash. (Field B.)

In this experiment, muriate of potash is compared with the high-grade sulfate on the basis of such applications as will furnish equal actual potash per acre. These potash salts are used in connection with bone meal at the rate of 600 pounds per acre. The experiment was begun in 1892. During the first eight or nine years, potash salts were applied in varying quantities, but for the most part at the rate of about 350 to 400 pounds per acre. Since 1900, each has been applied annually at the rate of 250 pounds per acre. There are ten plots in the field, each containing about one-seventh of an acre. Five of these plots receive muriate of potash, and these plots alternate with the same number of plots which are yearly manured with sulfate of potash.

A large variety of crops has been grown in the different years during which this experiment has continued. The crops of the past year were asparagus, rhubarb, raspberries, blackberries, mixed hay, potatoes and soy beans. On each of plots 13 and 14 four different perennial crops are grown, namely, asparagus, rhubarb, raspberries and blackberries, each crop occupying substantially one-quarter of the area. The hay crop occupied four plots, the potatoes and soy beans two each.

No accidental conditions were observed which unfavorably influenced any of the crops. It is believed that the differences shown by the table giving the yields are due to the difference in potash salt employed. The rates of yield per acre of the various crops on the different fertilizers are presented in the following table: —

Crops.	Fertilizer used.	Plots.	Yield per Acre.	
			Beans.	Straw.
Soy beans,	Muriate of potash,	11	23.83 bush.	2,419 lbs.
	Sulfate of potash,	12	28.44 bush.	2,887 lbs.
Asparagus,	Muriate of potash,	13	2,649.7 lbs.	
	Sulfate of potash,	14	1,730.3 lbs.	
			Stalks.	Leaves.
Rhubarb,	Muriate of potash,	13	23,999 lbs.	20,733 lbs.
	Sulfate of potash,	14	40,992 lbs.	33,148 lbs.
Raspberries,	Muriate of potash,	13	57.26 lbs.	
	Sulfate of potash,	14	151.82 lbs.	
Blackberries,	Muriate of potash,	13	266.00 lbs.	
	Sulfate of potash,	14	857.90 lbs.	
			Hay.	Rowen.
Hay,	Muriate of potash,	15	2,438 lbs.	2,000 lbs.
	Sulfate of potash,	16	2,261 lbs.	1,911 lbs.
Hay,	Muriate of potash,	17	2,045 lbs.	1,981 lbs.
	Sulfate of potash,	18	2,709 lbs.	2,046 lbs.
			Large.	Small.
Potatoes,	Muriate of potash,	19	158.1 bush.	25.2 bush.
	Sulfate of potash,	20	180.8 bush.	28.5 bush.

Soy Beans. — The yield of soy beans, as will be noticed, was considerably larger upon the sulfate of potash. We have now carried through a similar experiment with soy beans fifteen times. In seven of these trials the result has been favorable to the sulfate of potash, and in one it was the same on the two salts. The average of all trials is favorable to the sulfate, and it would seem that there can be little doubt that where the two potash salts are continuously used the sulfate rather than the muriate should be selected. The superiority in yield on the former is usually much more than sufficient to cover the small additional cost of that salt, as compared with the muriate.

Asparagus. — It will be noticed that the yield of asparagus on the muriate of potash is more than 50 per cent. greater than on the sulfate. This result in so far as it goes appears to furnish evidence that the customary practice of depending largely upon the muriate as a source of potash for the asparagus crop is sound.

Rhubarb. — The yield of rhubarb this year is much larger than in any preceding year during which this crop has been grown in this experiment. In the earlier years the yield on the sulfate of potash has been moderately greater than on the muriate; this year it is very much greater, exceeding the yield on the muriate by about 80 per cent. Should further experiment support the evidence afforded thus far by this, it would appear that rhubarb growers in general will be wise to depend upon the sulfate rather than the muriate as a source of potash for that crop.

Raspberries and Blackberries. — The yield of both these crops is small on both fertilizers, that of raspberries especially so. During the three or four years the experiment on these plots has continued, the sulfate has invariably given better results than the muriate. Particularly noticeable has been the difference in the degree of winter-killing. The canes upon the plot to which muriate of potash is applied seem to be much less hardy than those on the plot where sulfate is used; and, with little doubt, the greater yield on the latter potash salt is mainly a consequence of the fact that the injury due to winter-killing is so much less.

Should further experiment confirm what now appears to be probable in regard to the varying effect of these two potash salts upon the ability of the canes of these fruits to resist the winter's cold, the point demonstrated will be one of much importance, for winter-killing is one of the most serious obstacles to the successful production of some of the most desirable varieties of these fruits.

The Hay Crops. — The hay crop of the past year occupied four plots. Clover seed alone was sown, but the clover did not make a good stand, and the vacancies were filled in part by timothy, in part by weeds. Where the clover was best, a considerable superiority in favor of the sulfate of potash was manifest. Aside from this observation, the results of the year with the hay crop did not appear to have much significance.

Potatoes. — It will be noted that the yield of merchantable potatoes upon the sulfate of potash was materially larger than on the muriate. This result is in accordance with the results which have usually been obtained in experiments upon our grounds; and, in spite of the fact that the season during which the potatoes made their chief growth was this year characterized by a considerable deficiency of rainfall, the soil where the sulfate has been continuously used shows its superiority over that where the muriate has been similarly used.

III. — Comparison of Different Potash Salts for Field Crops. (Field G.)

This experiment is designed to show the ultimate effect upon the soil, as well as the current effect upon the crops, of continuous use of different potash salts. We have under comparison kainit, high-grade sulfate, low-grade sulfate, muriate, nitrate, carbonate and silicate. The field includes forty plots, in five series of eight plots each. Each series includes a no-potash plot, as well as the seven potash salts which have been named. The experiment is therefore carried out each year in quintuplicate. The area of each plot is one-fortieth of an acre. The potash salts under comparison are used in quantities which will supply annually actual potash at the rate of 165 pounds per acre to each of the plots. All plots are equally manured, and liberally, with materials furnishing nitrogen and phosphoric acid.

The crops which have been grown in this field in the order of their succession beginning in 1898 have been as follows: —

1898. Medium Green soy beans.
1899. Potatoes.
1900. Plots 1–8, cabbage; 9–24, Medium Green soy beans; 25–40, cowpeas.
1901. 1–8, wheat; 9–40, corn.
1902. Clover.
1903. Clover.
1904. 1–16, cabbage; 17–40, corn.
1905. Soy beans.
1906. Potatoes.

The results last year with the soy bean seemed rather inconclusive, on account of the number of variations due to exceptional conditions not necessarily connected with the varying use of potash salts. In brief, it may be stated that the plots to which kainit was applied gave the smallest average crops in the field, the yield being less even than on the no-potash plots. Carbonate of potash gave the highest average yield, followed closely by high-grade sulfate and silicate, while the yields on nitrate, muriate and low-grade sulfate were not much inferior.

The crop of the past season was potatoes. The variety grown was the Green Mountain, the seed having been purchased in Maine. One accidental variation must here be recorded, viz., that the quantity of Green Mountain seed proved to be slightly less than was needed, so that it was necessary to use another variety, Carmen No. 3, also from Maine, on one of the plots (40). The seed potatoes were treated with formalin at the rate of 1 pint to 15 gallons of water in the usual way on May 7. The field was plowed on May 8. On May 10, 2,427 pounds of freshly slaked lime were applied. This was harrowed in on May 11. On May 12, fertilizers were applied and harrowed in on the same day. On the same date, also, one-half the plots, four series, 1-20, were planted. On May 14, the balance of the field was planted. The crop was carefully cared for throughout the entire season. The vines were repeatedly sprayed with Bordeaux mixture, and carefully protected from bugs by the customary measures. Early in the season the vines on the no-potash plots showed a marked inferiority in growth. They were characterized by a dark, bluish-green color. The vines on the plots receiving chlorides in any form showed a distinctly lighter shade of green (pea green) than those manured with other potash salts. The vines on the silicate of potash plots were very dark in color, and somewhat resembled in general appearance, though much larger in growth, the vines on the no-potash plots.

The yields per plot and the rates of yield per acre are shown in the following table: —

Plots.	Potash Salt.	Pounds per Plot.		Bushels per Acre.	
		Large.	Small.	Large.	Small.
1, . .	No potash, ...	305.25	106.50	203.50	71.00
2, . .	Kainit, ...	424.75	83.75	283.16	55.83
3, . .	High-grade sulfate, ...	428.50	74.50	285.66	49.66
4, . .	Low-grade sulfate, ...	407.00	65.00	271.33	43.33
5, . .	Muriate, ...	439.75	74.00	293.16	49.33
6, . .	Nitrate, ...	412.75	71.50	275.16	47.66
7, . .	Carbonate, ...	374.25	94.50	249.50	63.00
8, . .	Silicate, ...	362.25	63.75	241.50	42.50
9, . .	No potash, ...	280.25	45.00	186.83	30.00
10, . .	Kainit, ...	340.00	47.00	226.66	31.33
11, . .	High-grade sulfate, ...	351.00	49.00	234.00	32.66
12, . .	Low-grade sulfate, ...	360.25	47.25	240.66	31.50
13, . .	Muriate, ...	332.50	53.00	221.66	35.33
14, . .	Nitrate,.	350.75	37.00	235.50	24.66
15, . .	Carbonate, ...	313.50	76.00	209.00	50.66
16, . .	Silicate, ...	337.75	58.50	225.16	39.00
17, . .	No potash, ...	172.50	44.50	115.00	29.66
18, . .	Kainit, ...	231.25	33.25	154.16	22.66
19, . .	High-grade sulfate, ...	267.00	38.00	178.00	25.33
20, . .	Low-grade sulfate, ...	247.50	36.75	166.66	24.50
21, . .	Muriate, ...	269.50	40.00	179.66	26.66
22, . .	Nitrate,.	241.50	55.50	161.00	37.00

Plots.	Potash Salt.	Pounds per Plot.		Bushels per Acre.	
		Large.	Small.	Large.	Small.
23, . .	Carbonate, ...	252.25	81.25	168.66	54.16
24, . .	Silicate, ...	235.25	61.25	156.83	40.33
25, . .	No potash, ...	135.50	50.50	90.33	33.66
26, . .	Kainit, ...	264.75	29.00	176.50	19.33
27, . .	High-grade sulfate, ...	278.75	35.50	185.83	23.66
28, . .	Low-grade sulfate, ...	330.25	36.25	220.16	24.16
29, . .	Muriate, ...	320.25	47.50	213.50	31.66
30, . .	Nitrate, ...	285.75	58.75	190.50	39.16
31, . .	Carbonate, ...	335.00	76.50	223.33	51.00
32, . .	Silicate, ...	254.25	74.25	167.83	49.50
33, . .	No potash, ...	167.00	46.00	111.33	30.66
34, . .	Kainit, ...	292.00	39.00	194.66	26.00
35, . .	High-grade sulfate, ...	307.25	41.00	204.83	27.33
36, . .	Low-grade sulfate, ...	310.00	44.00	206.66	29.33
37, . .	Muriate, ...	315.75	73.00	210.50	48.66
38, . .	Nitrate, ...	321.75	49.00	214.50	32.66
39, . .	Carbonate, ...	298.25	70.00	198.83	46.66
40, . .	Silicate, ...	312.00	59.00	208.00	39.33

The average yields under the varying fertilizer treatments are as follows: —

Potatoes. — Average Yields per Acre (Bushels).

Potash Salt.	Large.	Small.
No potash (plots 1, 9, 17, 25, 33), ...	141.40	39.00
Kainit (plots 2, 10, 18, 26, 34), ...	207.03	31.03
High-grade sulfate (plots 3, 11, 19, 27, 35), ...	217.66	31.73
Low-grade sulfate (plots 4, 12, 20, 28, 36), ...	221.09	30.56
Muriate (plots 5, 13, 21, 29, 37), ...	223.70	38.33
Nitrate (plots 6, 14, 22, 30, 38), ...	215.33	36.23
Carbonate (plots 7, 15, 23, 31, 39), ...	209.86	53.10
Silicate (plots 8, 16, 24, 32, 40), ...	199.86	42.13

It will be noticed that the no-potash plots on the average give a yield much inferior to that produced on the plots receiving potash. The best average yield is produced by the muriate, but the differences between the yield on this potash salt and the average yield produced by the low-grade and high-grade sulfate and the nitrate are small. Carbonate ranks next, followed by kainit and silicate. The past season (June 1 to August 15) was characterized by rainfall considerably below the average. Previous experiments have shown that in such seasons muriate of potash can usually be depended upon to give crops equal to those produced where the sulfates are used. Lime, moreover, is known to offset in a measure the unfavorable results consequent upon continued use of muriate; and the entire field, as stated, was limed this season.

We are unable at this time to make a report in relation to the quality of the tubers produced on the different fertilizers, but the different lots have been carefully sampled, and such a report will be made later.

The Effect of the Liming. — Attention is called to the fact that in using lime immediately preceding the potato crop we departed from the usually accepted rule. Such use of lime is not regarded as desirable on account of the chances that the immediately following crop of potatoes will be scabby. This result was noted upon a portion of the plots in this field, principally 1 to 8. The amount of scab, however, was not on the whole serious.

The Relation of the Potash to Potato Blight. — As has been stated in the description of the general care given the crop, the potatoes in this field were repeatedly and carefully sprayed with Bordeaux mixture. The dates of the successive applications were as follows: June 27, July 7, August 2–3, August 10. Early in August it was noticed that the leaves of all the no-potash potato plants were beginning to blight, while the foliage on all the plots to which potash has been annually applied still appeared to be practically unaffected. The blight made rapid progress on each of the five no-potash plots, while the foliage of the vines upon all the other plots for the most part ripened normally. Practically all the leaves on the no-potash plots were dead by the end of August, at which date there was still considerable living foliage on the other plots. There was no decay of the tubers, however, on any of the plots; but the marked inferiority in yield on the no-potash plots was no doubt in considerable measure due to the relatively early death of the foliage.

No explanation can be offered at this time for the observed phenomena. Earlier observers, among them Dr. Goessmann and Professor Maynard, have held that a liberal supply of potash has in some cases exercised a marked influence in enabling the foliage of fruits to resist fungous diseases. Some European investigators have attributed a similar effect to potash in connection with potato diseases. This matter should evidently receive further and most careful study, for, if potato blight can be in a measure controlled through more liberal use of potash salts, this will afford a comparatively easy method of reducing the amount of injury due to the fungi attacking the foliage of this important crop.

IV. — North Corn Acre. — Special Fertilizer *v.* Fertilizer richer in Potash.

This experiment was begun in 1891. It occupies an acre of ground, divided into four equal plots. Plots 3 and 4 were sown to millet during the first two years of the experiment, but with this exception their treatment has been the same as that of plots 1 and 2, 3 being a duplicate of 1, and 4 a duplicate of 2, both as regards fertilizer application and crops produced. During the period under consideration the entire area with the exception noted for plots 3 and 4, has been in corn, with the exception of three two-year periods, 1897 and 1898, 1899 and 1900, and the past two years, during which periods the land has been in mixed grass and clover. The method of seeding in every instance has been by sowing in the corn of the year preceding the first of each of the three two-year periods during which hay has been the crop.

The object in this experiment is to test the question whether the special corn fertilizers offered in our markets are of such composition as seems to be best suited for the production of corn and mixed hay in rotation. Plots 1 and 3 have yearly received an application of fertilizers (a home mixture) furnishing per acre the same amount of nitrogen, phosphoric acid and potash as would be furnished by 1,800 pounds of fertilizer having the composition of the average of the special corn fertilizers analyzed at this station. This average changes but little from year to year, and in 1899, since which date we have made no change in the kinds and amounts of fertilizers used, it was as follows: —

	Per Cent.
Nitrogen,	2.37
Phosphoric acid,	10.00
Potash,	4.30

The averages for the past year have been: nitrogen, 2.61 per cent.; phosphoric acid, 11.55 per cent.; and potash, 4 per cent.

The fertilizers which have been used on plots 2 and 4 are substantially the same in amount and kind as were recommended for corn in Bulletin No. 58 (Hatch). The essential difference in the fertilizer mixtures under comparison is that the mixture used on plots 2 and 4 is richer in potash and much poorer in phosphoric acid than the mixture representing the average market corn fertilizers. The difference in the application of the fertilizer elements is shown in the following table: —

Fertilizer Elements applied annually.

Plots.	Rates per Acre (Pounds).		
	N	P_2O_5	K_2O
Plots 1 and 3,	42.6	180	77.4
Plots 2 and 4,	47.0	50	125.0

The fertilizer materials applied to the several plots annually are shown below: —

Fertilizers used.	Plots 1 and 3 (Pounds Each).	Plots 2 and 4 (Pounds Each).
Nitrate of soda,	30.0	50.0
Dried blood,	30.0	-
Dry ground fish,	37.5	50.0
Acid phosphate,	273.0	50.0
Muriate of potash,	37.5	62.5

This field was limed in 1900 at the rate of 1 ton to the acre.

The crop of the past season was mixed grass and clover, the present being the second year for this seeding. The rates of yield per acre on the several plots and the averages for the two systems of manuring are shown by the following tables: —

Yields per Acre (Pounds).

Plots.	Hay.	Rowen.
Plot 1 (lesser potash),	2,600	1,680
Plot 2 (richer in potash),	2,320	1,480
Plot 3 (lesser potash),	2,980	1,300
Plot 4 (richer in potash),	2,400	2,020

Average Yields per Acre (Pounds).

Plots.	Hay.	Rowen.
Plots 1 and 3 (lesser potash),	2,790	1,490
Plots 2 and 4 (richer in potash),	2,360	1,750

It will be noticed that the combination of fertilizers representing the special corn fertilizer gives an average yield of hay at the rate of 430 pounds per acre heavier than that produced where the combination of fertilizer materials richer in potash was used. On the other hand the latter combination of fertilizer materials gives a yield of rowen averaging 260 pounds per acre greater than the special corn fertilizer. The total crops, then, produced under the two systems of fertilizing, are not far from equal for the past year.

Since this experiment was begun, this land has produced on plots 1 and 2, ten corn crops; on plots 3 and 4, eight corn crops. The average yields per plot and the averages for the two systems of fertilizing are shown in the following tables: —

Average Yields of Corn per Acre.

Plots.	Corn (Bushels).	Stover (Pounds).
Ten Years.		
Plot 1 (lesser potash), ...	56.77	4,596
Plot 2 (richer in potash), ...	51.98	4,640
Eight Years.		
Plot 3 (lesser potash), ...	55.18	4,371
Plot 4 (richer in potash), ...	52.99	4,590

Average Yields per Acre on the Two Systems of Fertilizing.

Plots.	Corn (Bushels).	Stover (Pounds).
Plots 1 and 3 (lesser potash), ...	55.98	4,484
Plots 2 and 4 (richer in potash), ...	52.48	4,615

During the period of this experiment the entire field has produced six crops each of hay and rowen. The averages for each plot and the averages for the two systems of fertilizing are shown in the following tables: —

Average Yields per Acre of Hay and Rowen, Six Years (Pounds).

Plots.	Hay.	Rowen.
Plot 1 (lesser potash), ...	3,655	1,100
Plot 2 (richer in potash), ...	3,785	1,176
Plot 3 (lesser potash), ...	3,459	885
Plot 4 (richer in potash), ...	3,607	1,203

Average Yields per Acre on the Two Systems of Fertilizing, Six Years (Pounds).

Plots.	Hay.	Rowen.
Plots 1 and 3 (lesser potash), ...	3,557	993
Plots 2 and 4 (richer in potash), ...	3,696	1,152

It will be noticed that the average crop of corn has been somewhat heavier, while the average crop of hay is slightly less, on the combination of materials representing the special corn fertilizer. The crops of corn stover and of rowen have been greater on the combination of materials furnishing more potash. This is in accordance with what is to be expected, as the potash is found almost invariably to favor a large proportion of clover in mixed mowings, and as it has been shown in the results of many experiments in this State that stover is increased in larger proportion through application of potash than is the grain.[1]

At the prices which have prevailed during the period of the experiment, the cost per acre of the fertilizers used on plots 2 and 4 has averaged about $5 less than the cost of the materials used on plots 1 and 3. Taking the crops as a whole, they have been substantially equal under the two systems of fertilizing; and the advantage, therefore, is clearly with the fertilizer combination richer in potash, unless it can be shown that the condition of the soil upon plots 2 and 4 is now inferior to that of the soil on plots 1 and 3. Such inferiority is not indicated by the present relative yields. Neither does a study of the income and outgo from the soil of fertilizer elements upon the several plots point in that direction. Calculations made at the close of 1905 to determine the fertilizer ingredients supplied and removed from the several plots gave the following results: —

Plots.	Fertilizer Ingredients.					
	Supplied.			Removed.		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Plot 1 (lesser potash),	135.10	537.94	216.00	331.08	117.74	228.46
Plot 2 (richer in potash),	117.55	217.63	470.00	322.44	114.32	229.79
Plot 3 (lesser potash),	135.10	537.94	216.00	259.52	93.37	180.26
Plot 4 (richer in potash),	117.55	217.63	470.00	307.38	109.97	234.27

A study of the figures of the above table indicates that on every plot a much larger quantity of nitrogen has been removed from the soil than has been supplied in the fertilizers used. The large excess of nitrogen removed can be

[1] Bulletin No. 9 and Bulletin No. 14, Hatch Experiment Station.

accounted for only as a result of the frequent introduction of clover in the rotation.

It will be noticed that on plots 1 and 3 phosphoric acid has been applied in the fertilizers used in quantity on the average more than five times greater than the quantity removed. Even on plots 2 and 4 phosphoric acid has been supplied in quantity practically double that removed.

Potash on one of the plots (1 and 3) has been supplied in slightly larger quantity than removed, while on the other plot the quantity removed is slightly in excess of the quantity supplied.

On the average, the condition of the soil as regards this element on plots 1 and 3 cannot be materially different from what it was at the beginning of the experiment. On plots 2 and 4, on the other hand, potash has been supplied in quantity a little more than double that removed.

V. — South Corn Acre. — Manure Alone *v.* Manure and Potash.

The object in view in this experiment is to compare the crop-producing capacity of manure alone applied in fairly liberal amounts with a combination of a lesser amount of manure and a moderate quantity of a potash salt. An acre of land is used in the experiment. It is divided into four plots, of one-quarter acre each. Two of the plots (1 and 3) have received applications of manure only; the other two plots (2 and 4) have been fertilized by applications of lesser amounts of manure, together with a potash salt.

This experiment was begun in 1891. The crop for the first six years was corn. Corn was raised also in 1899 and 1900, and in 1903 and 1904. The field has been put into mixed grass and clover three times, being seeded in the summer preceding the first year of cutting in the corn crop. Each time that the land has been seeded it has been cut twice annually for two years. The sod has then been broken in the fall for the corn crop of the following year. The years when the field has been in mowing are 1898 and 1899, 1901 and 1902, and 1905 and 1906.

Manure has been applied to plots 1 and 3 every year, at the rate of 6 cords per acre, with the following exceptions. No manure was applied in 1897, 1902 and 1905, and in 1898 the amount applied was at the rate of 4 cords per acre. The reason for the omission of manure in the years mentioned and for the smaller amount in 1898 was that experience indicated that its application would cause the grass and clover to lodge badly.

Manure has been applied to plots 2 and 4 as follows: in 1891 and 1892, at the rate of 3 cords per acre; in 1898, at the rate of 2 cords per acre; while in 1897, 1902 and 1905 no manure was applied. In all other years the application has been at the rate of 4 cords per acre. Potash has been applied to plots 2 and 4 at the rate of 160 pounds per acre of high-grade sulfate annually, except in the years when no manure was applied. In these years the potash also was withheld.

The entire field was limed in 1900, at the rate of 1 ton per acre. The manure applied has been that made by well-fed milch cows, and carefully preserved. It has usually weighed about 3 tons per cord. Both manure and fertilizer have been applied broadcast after plowing, and harrowed in.

The crop of the past season was mixed grass and clover, this being the second year, as above indicated. The manure was applied with a spreader on May 2. The high-grade sulfate was applied broadcast by hand, and this year, by mistake, it was applied to plots 1 and 3 as well as to plots 2 and 4.

The following tables show the rates of yield on the several plots and the averages under the two systems of manuring: —

Yields Per Acre, 1906 (Pounds).

Plots.	Hay.	Rowen.
Plot 1 (manure alone),	3,880	2,640
Plot 2 (manure and potash),	3,200	2,384
Plot 3 (manure alone),	3,592	2,396
Plot 4 (manure and potash),	3,180	2,416

Average Yields per Acre (Pounds).

Plots.	Hay.	Rowen.
Plots 1 and 3 (manure alone),	3,736	2,518
Plots 2 and 4 (manure and potash),	3,190	2,400

It will be noticed that the hay crop on the combination of manure and potash is less than on the larger quantity of manure alone in both cases, the average difference being at the rate of 646 pounds per acre. The rowen crops are more nearly equal, the average difference amounting to only 118 pounds per acre in favor of the larger application of manure. The heavier application of manure means, of course, a larger application of nitrogen. It is not surprising, therefore, that the first crop, which includes a considerable proportion of timothy and redtop, is heavier where the manure is most largely used. The rowen crop is made up in much larger proportion of clover, and the proportion of clover is greater where the lesser quantity of manure and the potash salt are applied. Estimating the manure to cost on the land $5 per cord and the high-grade sulfate of potash at the market rates, the usual annual difference in cost of materials applied has amounted to about $6 to $6.50 per acre, the lesser amount of manure and potash costing about that amount less than the larger application of manure.

This experiment has now continued sixteen years. During this time ten corn crops have been raised. The average yields per plot and the averages for the two systems of manuring are shown in the following tables: —

Average Yields per Acre.

Plots.	Corn (Bushels).	Stover (Pounds).
Plot 1 (manure alone),	62.32	4,929
Plot 2 (manure and potash),	58.48	4,579
Plot 3 (manure alone),	61.29	4,292
Plot 4 (manure and potash),	57 54	4,104

Average Yields per Acre on the Two Systems of Manuring, Ten Crops.

Plots.	Corn (Bushels).	Stover (Pounds).
Plots 1 and 3 (manure alone), ...	61.81	4,611
Plots 2 and 4 (manure and potash), ...	58.01	4,342

It will be noticed that the average yield on plots 2 and 4 (lesser manure and potash) has been at the rate of about 3.8 bushels per acre less than on the larger quantity of manure alone.

During six years the experimental acre has been in mixed grass and clover. The following tables show the average results per plot and the averages for the two systems of manuring: —

Average Yields per Acre of Hay Crop, Six Years (Pounds).

Plots.	Hay.	Rowen.
Plot 1 (manure alone), ...	5,197	2,569
Plot 2 (manure and potash), ...	4,370	2,103
Plot 3 (manure alone), ...	4,970	2,546
Plot 4 (manure and potash), ...	4,923	2,415

Average Yields per Acre on the Two Systems of Manuring, Six Years (Pounds).

Plots.	Hay.	Rowen.
Plots 1 and 3 (manure alone), ...	5,084	2,558
Plots 2 and 4 (manure and potash), ...	4,647	2,259

It will be noticed that the average difference against the lesser quantity of manure and potash amounts to a little more than 400 pounds of hay and slightly less than 300 pounds of rowen per acre annually.

The differences indicated by the averages shown in the above tables, whether for corn or hay, are not sufficient to offset the greater cost of the heavier application of manure.

At the end of last year, calculations based in part upon analyses, and in part upon average figures for the composition of the crops raised, gave results presented in the following tables for the totals of plant food applied and removed in the several plots: —

Plots.	Fertilizer Ingredients.					
	Supplied.			Removed.		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Plot 1 (manure alone), ...	425.41	330.69	511.51	394.07	138.74	282.60
Plot 2 (manure and potash), . .	291.09	229.98	543.68	361.22	127.91	256.64
Plot 3 (manure alone), ...	449.96	330.94	500.76	373.34	132.10	262.21
Plot 4 (manure and potash), . .	281.10	233.37	549.56	355.02	126.26	250.82

It will be noticed that on plots 1 and 3 the amounts of nitrogen applied in the manure show a moderate excess above the amount removed in the crops. On the other hand, the application of nitrogen to plots 2 and 4 (lesser manure and potash) is materially less than the amount removed. This result may have been rendered possible in one of two ways: first, the soil on these plots may have been depleted in part of its original store of nitrogen; second, the excess may have been taken from the air by the clover in the mixed hay crops grown during six of the sixteen years. As these plots show no indication of declining fertility, but, on the contrary, appear on the whole to be improving from year to year, the latter is with little doubt the correct explanation.

It will be noticed that under both systems of manuring we have applied phosphoric acid and potash in large excess above the amounts removed. In the case of plots 1 and 3, phosphoric acid has been applied in approximately two and one-half times the quantity removed; potash, in rather less than twice the quantity removed. In the case of plots 2 and 4, phosphoric acid has been applied in considerably less than twice the quantities removed; potash, in rather more than twice the quantities removed. In view of the fact that neither phosphoric acid nor potash is supposed to be lost to the soil to any considerable extent by leaching, the condition of the soil on all the plots as regards the stock of phosphoric acid and potash in available form must now be considerably better than at the beginning of the experiment; and there can be little doubt that a lesser application of these fertilizer elements in the immediate future will prove sufficient to give satisfactory crops.

VI. — Comparison of Phosphates on the Basis of Equal Application of Phosphoric Acid.

The past season is the tenth of this experiment, the object of which is to determine, as measured by crop production, the relative availability of different materials which may be used as sources of phosphoric acid. All these materials have from the first been applied in such quantities as to furnish phosphoric acid at the rate of 96 pounds per acre in the case of each of the materials under comparison. The field comprises thirteen plots, each containing one-eighth of an acre. Three of the plots have received no phosphoric acid since the experiment began. One of these is located at either end of the field, the third in the middle. The phosphates under comparison are the following: apatite (fine ground), South Carolina rock phosphate (fine ground), Florida soft phosphate, basic slag meal, Tennessee rock phosphate (fine ground), dissolved bone black, raw bone meal, dissolved bone meal, steamed bone meal and acid phosphate. Materials supplying nitrogen and potash liberally are applied to each of the plots annually, and in such quantities as to furnish nitrogen at the rate of 52 pounds and potash at the rate of 152 pounds per acre. In the case of a few crops requiring especially high manuring (onions and cabbages), a supplementary application of quick-acting nitrogen fertilizers has been made to all plots alike. Owing to the impossibility of procuring the material, no apatite was applied to plot 2 during the past season. The crops which have been grown in the field during the progress of the experiment are as follows: corn, cabbages, corn, in 1900 two crops, — oats and Hungarian grass (both for hay), onions, onions, cabbages, and mixed grass and clover. The field was seeded in the spring of 1905 without a nurse crop. It was cut twice during the season, but the product, largely mixed with weeds, was not weighed.

During the past season the field has been cut twice and the product made into hay. The following table gives the yield per plot, the rates of yield per acre, and the gain or loss as compared with the no-phosphate plots, both for the hay and rowen: —

Plots.	Fertilizers used.	Yield per Plot (Pounds).		Yield per Acre (Pounds).		Gain or Loss (Pounds).	
		Hay.	Rowen.	Hay.	Rowen.	Hay.	Rowen.
Plot 1, .	No phosphate, . . .	825	225	6,600	1,800	-	-
Plot 2, .	Apatite, ...	940	215	7,520	1,720	800	—147
Plot 3, .	South Carolina rock phosphate.	930	202	7,440	1,616	720	—251
Plot 4, .	Florida soft phosphate, .	950	188	7,600	1,504	880	—363
Plot 5, .	Phosphatic slag, . .	950	200	7,600	1,600	880	—267
Plot 6, .	Tennessee phosphate, .	890	203	7,120	1,624	400	—243
Plot 7, .	No phosphate, . . .	875	275	7,000	2,200	-	-
Plot 8, .	Dissolved bone black, .	870	280	6,960	2,240	240	+373
Plot 9, .	Raw bone, ...	890	250	7,120	2,000	400	+133
Plot 10, .	Dissolved bone meal, .	940	319	7,520	2,552	800	+685
Plot 11, .	Steamed bone meal, . .	890	283	7,120	2,264	400	+397
Plot 12, .	Acid phosphate, . .	885	290	7,080	2,320	360	+453
Plot 13, .	No phosphate, . . .	820	200	6,560	1,600	-	-

It will be noticed that both the first and second crops of hay were heavy, the first especially so. This crop had lodged considerably before it could be cut, and there is little doubt that the possible increase due to the fertilizers was somewhat diminished through the check in growth consequent upon the badly lodged condition. We do not find the application of the phosphates to have apparently influenced the yield either of hay or rowen to a very large extent. The results are in harmony with previous observations upon our soils, which have indicated them to require relatively small applications of phosphates for all crops except those belonging to the Cruciferæ, such as cabbages and turnips. In 1903, when this entire field was planted to cabbages, the yields wherever phosphates were annually applied greatly exceeded the average yield on the no-phosphate plots. The range on the several phosphate plots was from about two to five times the average product of the no-phosphate plots. This year, with a mixed crop, grass and clover, representing Gramineæ and Leguminosæ, the largest increase on any phosphate is only about 17 per cent. In other words, when cabbages were the crop, the increase was in some instances as great as 500 per cent., or nearly thirty times as great as this year.

VII. — Soil Tests.

Two soil tests have been carried out during the past year, both in continuation of previous tests upon the same fields. In these tests fertilizers have been applied in accordance with the co-operative plan for soil tests. Each plot annually receives an application of the same kind or kinds of fertilizers, and usually in the same amounts for each of the plots from year to year. Particular attention is called to the fact that this system of fertilization is not expected to secure the production of heavy crops. It does throw important light upon the specific effects of the different leading elements of plant food by themselves and in combination on the crops which are grown in succeeding years. Every fertilizer used, whether applied by itself or in connection with one or both of the other fertilizer materials, is always applied in the same quantities; and both fertilizers and manure, when the latter is introduced for purposes of comparison, are always applied broadcast after plowing, and harrowed in when a hoed crop is to be grown. When mixed hay is the crop the materials are applied broadcast, and must of course be left on the surface. The kinds of fertilizers and the rates per acre are as follows: —

Nitrate of soda, 160 pounds, furnishing nitrogen.
Dissolved bone black, 320 pounds, furnishing phosphoric acid.
Muriate of potash, 160 pounds, furnishing potash.
Land plaster, 400 pounds.
Lime, 800 pounds.
Manure, 5 cords.

The germination of the soy beans on the north acre was very irregular. The stand of plants as a consequence was so uneven that the results do not indicate with any clearness the effect of the different fertilizers. The figures will not, therefore, be reported in detail. The results, however, clearly indicated the beneficial results which have followed the use of lime in connection with the other fertilizers.

Soil Test with Corn (South Acre). — This acre has been used in soil tests for eighteen years, beginning in 1889. The field has been limed twice during this period, each time at the rate of 1 ton to the acre. The lime was applied broadcast after plowing, and harrowed in. These applications of lime were made respectively in 1899 and in 1904.

The crops for successive years have been as follows: corn, corn, oats, grass and clover, grass and clover, corn (followed by mustard as a catch crop), rye, soy beans, white mustard, corn, corn, grass and clover, grass and clover, corn, corn, corn, grass and clover, grass and clover. Since 1899 this field has, therefore, borne eight corn crops. Three times it has been put into mixed grass and clover, each time for two years. The past season is the second of the third two-year period. The season has been a fairly favorable one for grass, although, as the soil of this field is inclined to be light, there can be no doubt that a somewhat heavier yield would have been obtained had the rainfall been larger. The following table shows the fertilizers used on the several plots, the rates of yield and the gain or loss per acre, compared with the nothing plots: —

Grass and Clover. — South Acre Soil Test, 1906.

Plots.	Fertilizers used.	Yield per Acre (Pounds).		Gain or Loss per Acre, compared with Nothing Plots.	
		Hay.	Rowen.	Hay.	Rowen.
Plot 1, .	Nitrate of soda, ...	1,400	520	+490.0	+220.00
Plot 2, .	Dissolved bone black, ...	760	295	−150.0	−5.00
Plot 3, .	Nothing, ...	910	300	-	-
Plot 4, .	Muriate of potash, ...	690	440	−136.7	+131.70
Plot 5, .	Lime, ...	890	260	+146.7	−56.70
Plot 6, .	Nothing, ...	660	325	-	-
Plot 7, .	Manure, ...	2,940	2,670	+2,226.7	+2,323.30
Plot 8, .	Nitrate of soda and dissolved bone black.	2,200	520	+1,433.3	+151.70
Plot 9, .	Nothing, ...	820	390	-	-
Plot 10, .	Nitrate of soda and muriate of potash.	2,400	470	+1,536.7	+73.33
Plot 11, .	Dissolved bone black and muriate of potash.	1,790	1,220	+883.3	+816.70
Plot 12, .	Nothing, ...	950	410	-	-
Plot 13, .	Plaster, ...	640	320	−310.0	−90.00
Plot 14, .	Nitrate of soda, dissolved bone black and muriate of potash.	3,000	1,100	+2,050.0	+1,690.00

It will be noticed that the yield on all the nothing plots is extremely small, — considerably less than one-half ton per acre. It will be noticed, further, that neither lime nor plaster used by itself produced an increase; indeed, the yield on both is lower than the average yield of the nothing plots. Nitrate of soda by itself produces a very small increase; in combination with either of the other fertilizer elements the increase is much larger, but it is best, as would naturally be expected, in combination with both the other fertilizer elements. It will be noted that the use in combination of dissolved bone black and muriate of potash gives a considerable increase in the crop. This increase shows itself almost as plainly in the rowen as in the first crop, as a consequence, of course, of the relatively large proportion of clover which follows continuous use of materials supplying phosphoric acid and potash without nitrogen. The average results obtained in the six years during which this field has been in hay will be of interest. They are shown in the following table: —

Average Increases in Six Hay and Rowen Crops.

	Averages of Nothings.	Nitrate.	Bone Black.	Muriate.	Lime.	Manure.
Hay, ...	853.8	722.5	—100.0	152.6	120.0	2,579.2
Rowen, ...	604.4	743.3	+52.5	632.0	108.8	2,357.2
Totals, . . .	1,458.1	1,465.8	—47.5	784.5	228.8	4,936.4

Average Increases in Six Hay and Rowen Crops — Concluded.

	Nitrate and Bone Black.	Nitrate and Muriate.	Bone Black and Muriate.	Plaster.	Nitrate, Bone Black and Muriate.
Hay, ...	1,183.3	1,474.2	1,113.3	—275.5	2,092.5
Rowen, ...	430.3	565.5	952.8	—221.8	878.3
Totals, . . .	1,513.6	2,039.7	2,066.2	—497.2	2,970.8

This table affords conclusive evidence that hay can be grown at a profit on fertilizers alone, although naturally the increases produced by the very moderate applications of fertilizers used in this experiment are not equal to those produced by the annual application of manure. The latter, however, at $5 per cord on the land costs annually at the rate of $25 per acre; the combination of dissolved bone black and muriate of potash costs annually at the rate of about $6 per acre; while the annual application of all three fertilizer elements costs at the rate of about $10 to $11 per acre.

VIII. — Experiment in Manuring Grass Land.

The plan of this experiment, which was begun in 1893, is fully outlined in the sixteenth annual report. From that report I quote: —

> In this experiment, which has continued since 1893, the purpose is to test a system of using manures in rotation for the production of grass. The area used in the experiment is about 9 acres. It is divided into three approximately equal plots. The plan is to apply to each plot one year barnyard manure, the next year wood ashes, and the third year, fine-ground bone and muriate of potash. As we have three plots, the system of manuring has been so arranged that every year we have a plot illustrating the results of each of the applications under trial. The rates at which the several manures are employed are as follows: barnyard manure, 8 tons; wood ashes, 1 ton; ground bone, 600 pounds; and muriate of potash, 200 pounds, per acre. The manure is always applied in the fall; ashes and the bone and potash in early spring.

The past season, which showed a considerable deficiency in rainfall during the months when a liberal supply of moisture is highly important for the hay crop, was unfavorable to large yields, and the product of the past season falls considerably below the average product for the period of the experiment. The yields of hay and rowen and the total yields for each system of manuring were at the following rates per acre: —

Fertilizers used.	Hay (Pounds).	Rowen (Pounds).	Total (Pounds).
Barnyard manure,	2,892	1,063	3,955
Bone and potash,	2,420	1,396	3,816
Wood ashes,	2,932	1,240	4,172

The average for the entire area this year was 4,002 pounds. The average yield of the entire area from 1893 to 1905, inclusive, was 6,572 pounds. Including the crop of the past season, the average for the entire period, 1893 to the present time, is 6,389 pounds. The average yields to date under the different systems of top-dressing have been as follows: —

	Pounds per Acre.
When top-dressed with manure, ...	6,658
When top-dressed with wood ashes, . . .	6,059
When top-dressed with bone and potash, . . .	6,331

IX. — Experiment in the Application of Manure.

This experiment was planned to be continued through a series of years, with a view to throwing light upon the question as to the best method of handling farm manures. The field in use has an area of a little less than three acres, and slopes moderately to the west. It had been divided into five plots a number of years previous to the beginning of this experiment, for the comparison of different fertilizers. Each of these five plots was subdivided into two sub-plots. To one of these sub-plots in each of the five pairs the manure is applied during the winter, being spread upon the surface as it is hauled to the field; to the other sub-plot in each of the five pairs the manure as it is hauled is put into a large, compact heap. The manure used is carefully preserved, from well-fed dairy cows on four of the pairs of plots (1, 2, 3 and 4), and purchased stable manure from horses on one pair of plots (5). The experiment is so managed that all the manure is hauled for a single pair of plots at one time, usually during a single day, or at most within two days. To insure even quality of the manure on the two sub-plots, loads are placed alternately on the north half, where it is spread as hauled; and on the south half, where, as has been stated, it is put into a large heap. The land has usually been plowed late in the fall. The manure has usually been applied to the two sub-plots 1 early in the winter; to the sub-plots 2, 3 and 4 respectively at intervals each about one month later than the preceding. The manure which is placed in the heaps remains there until it is time to prepare the soil for planting in the spring. It is then spread, and as soon as convenient the entire area, including both the winter and the spring applications, is plowed. It is estimated that the double handling of the manure required in the case of that portion which is applied in the spring costs at the rate of $4.80 per acre more than the single handling where the manure is spread when hauled during the winter.

The experiment was begun in 1899; the present season, therefore, is the eighth during which the experiment has been continued. The crop of the past season was corn. Fourteen different varieties of seed were used. The different plots, however, were so planted that each contained equal areas of each variety. The fact that a number of varieties was used is mentioned only because it is a partial explanation of the fact that the yield in this field is considerably lower than is usual in this vicinity on well-manured land. This inferiority in yield was due to the fact that many of the varieties which we had been asked to test by the United States Department of Agriculture proved comparatively worthless. The rates of yield per acre and the relative standing of the several plots are shown in the following tables: —

Corn and Stover. — Actual Yields (Rates per Acre).

Plots.	North Half, Winter Application.			South Half, Spring Application.		
	Stover (Pounds).	Hard Corn (Bushels).	Soft Corn (Bushels).	Stover (Pounds).	Hard Corn (Bushels).	Soft Corn (Bushels).
Plot 1, ...	3,741	36.43	5.86	3,961	38.61	5.65
Plot 2, ...	3,414	30.50	4.64	3,893	37.48	4.99
Plot 3, ...	3,563	35.72	5.34	3,847	38.73	5.05
Plot 4, ...	3,171	32.13	5.01	3,143	29.95	5.61
Plot 5, ...	3,401	31.22	4.32	3,457	31.91	4.13

Corn and Stover. — Relative Yields (Per Cent.).

Plots.	North Half, Winter Application.		South Half, Spring Application.	
	Stover.	Hard Corn.	Stover.	Hard Corn.
Plot 1, ...	100	100	105.7	104.7
Plot 2, ...	100	100	114.0	122.9
Plot 3, ...	100	100	107.8	108.4
Plot 4, ...	100	100	99.1	93.2
Plot 5, ...	100	100	101.6	102.2

It will be noticed that in every instance the spring application of manure has given a larger yield both of stover and of hard corn than the winter application, except on plot 4. This exception, in our judgment, is due to the fact that during the early part of the season it was comparatively rainy, and a part of the area on the south half of plot 4 was over wet, so that the seed germinated imperfectly. The results of this year, then, although naturally not showing precise numerical agreement, are in entire accord with those obtained in 1905. During the entire period that the experiment has continued the results as a rule have been similar.

It has been noticed that the degree of superiority of the crops on the sub-plots where the manure was spread in the spring has varied with the character of the preceding winter. There is evidently some loss in manurial value through the exposure of the manure throughout the winter, and this loss is probably for the most part due to wash over the frozen ground during the winter or early spring. It has been found that in a season following a cold winter, where snow has covered and protected the manure during practically all the time, and where there has been a minimum of water flowing over the surface, the winter-applied manure has given results closely approaching those upon the manure applied in the spring. It is manifestly impossible to foresee the character of the approaching winter months, and so there must always be a degree of uncertainty as to results. Taken as a whole, however, the differences obtained in our experiments in favor of spring application have been relatively small, and during a large proportion of the time insufficient in value to cover the extra cost of the double handling.

In estimating the significance of our results, it should be kept in mind that the field on which these experiments have been tried has a considerable slope. It is, therefore, of such a character as is favorable to considerable waste through surface wash, whenever the conditions are such as to make such wash possible. It is not believed that on land which is substantially level, and which can be fall plowed, the amount of waste due to the exposure incident to surface application in winter will be sufficiently great to make it good farm economy to give the manure the double handling involved in the spring application. If the storage for manure is sufficient, so that it can be safely held where made until spring, application at that season will undoubtedly be safest on most of our New England farms, where the surfaces of the fields are usually far from level. With level fields, on the other hand, application of manure during the winter would seem to be the better farm practice.

X. — Nitrate of Soda for Rowen.

The station has been experimenting for a number of years, with a view to noting whether nitrate of soda applied soon after the first crop is cut will give a profitable increase in the rowen crop. The field in which most of our experiments have been tried was seeded to pure timothy in the fall of 1897. The crop is now considerably mixed with clover (mostly white), which has been gradually coming in. For the first crop we apply fertilizers at the following rates per acre: nitrate of soda, 150 pounds; muriate of potash, 200 pounds; fine-ground bone, 400 pounds. The total area of the field is a little more than three acres. The rate of yield of the first crop this year was 3,153 pounds per acre, which is considerably less than the average product since the field was seeded. For the purpose of the experiment with nitrate of soda, eight equal plots have been laid off, each containing almost exactly one-third of an acre. During the past six years alternate plots in this series of eight have annually received a top-dressing of nitrate of soda. For the past three years, in order that this may be more uniformly spread, we have mixed the nitrate of soda for each plot with such a quantity of basic slag meal as to constitute an application of the latter at the rate of 400 pounds per acre. To equalize conditions on the alternate plots to which no nitrate is applied, the slag meal is applied to all of these at the same rate. The application of fertilizers to the several plots and the rates of yield per acre are shown in the following table: —

Nitrate of Soda for Rowen.

Plots.	Fertilizers used (Rates per Acre).	Yield (Pounds).	Increase per Acre (Pounds).
Plot 1,	Slag meal, 400 pounds,	1,535	-
Plot 2,	Slag meal, 400 pounds; nitrate of soda, 150 pounds,	2,590	1,074
Plot 3,	Slag meal, 400 pounds,	1,496	-
Plot 4,	Slag meal, 400 pounds; nitrate of soda, 150 pounds,	2,148	592
Plot 5,	Slag meal, 400 pounds,	1,615	-
Plot 6,	Slag meal, 400 pounds; nitrate of soda, 200 pounds,	2,648	1,027
Plot 7,	Slag meal, 400 pounds,	1,627	-
Plot 8,	Slag meal, 400 pounds; nitrate of soda, 250 pounds,	3,614	1,987

The nitrate of soda has in every instance given a considerable increase, — more than enough in every instance to cover the cost of the nitrate applied. As was pointed out last year, however, it is not believed that the large increase on plot 8 is altogether due to the nitrate used, for evidently the moisture conditions on this plot are rather better than on plot 7, with which it is compared. Of the six trials of nitrate of soda for rowen which have been completed, three have shown increases sufficiently large to make the application profitable, while in the other trials the application was made at a loss. As is natural, the result of an application of nitrate for rowen varies widely with the season. When such an application is followed by a sufficient and well-distributed rainfall, it gives a very profitable increase in the crop; but when the weather succeeding the application is dry, the nitrate is relatively non-effective. It is of course impossible to foresee the nature of the weather which will follow the use of nitrate. It would appear, however, that there is at least an equal chance that a moderate application will give a good margin of profit. Close observation of the field in which this experiment has been tried indicates that where, owing to succeeding relatively dry weather, the nitrate proves ineffective for the immediately succeeding crop of rowen, it will, nevertheless, on this fairly compact loam be retained by the soil in sufficient quantity to favorably influence the hay crop of the following season. We have as yet, however, no figures that can be presented which demonstrate this fact.

XI. — Variety Test, Potatoes.

During the past season we have carried out the second year's trial with twenty-five varieties of potatoes. The seed used in making these trials was all of our own production, and was kept under similar conditions throughout the winter. The soil in which the varieties were planted is a medium loam, which was used for corn in 1905. It received a liberal application of commercial fertilizers. The varieties under trial, the area planted to each, the actual yields for each and the rate per acre are shown in the following table: —

Variety.	Area planted (Acres).	Yield per Plot (Pounds).		Yield per Acre (Bushels).	
		Large.	Small.	Large.	Small.
Good as Gold,	.0104	52.00	16.00	83.33	25.64
Early Quebec,	.0104	98.00	5.50	157.05	8.81
Chenango White,	.0104	126.75	7.50	203.13	11.91
Reliance,	.0104	108.75	15.00	174.28	24.04
Early Canada,	.0104	112.50	8.50	180.16	13.62
Great Divide,	.0104	82.50	11.50	132.21	18.43
Beauty of Hebron,	.0104	100.00	16.25	160.26	26.04
Clark's Pride,	.0104	84.50	18.00	135.32	28.85
Extra Early White Rose,	.0104	105.50	7.25	169.07	11.62
Banner,	.0104	66.75	2.00	106.97	3.21
Early Rose,	.0104	106.00	14.50	169.87	23.24
Vermont Gold Coin,	.0104	99.25	11.25	159.06	18.03
Climax,	.0104	127.00	17.00	203.52	27.24
Short Seasons,	.0104	59.25	5.00	94.95	8.01
Gorthsap,	.0104	119.00	11.75	190.71	18.83
Dewey,	.0052	59.50	4.00	190.70	12.84
Hammond's Wonderful,	.0052	63.25	6.00	202.72	19.26
Salzer's Sunlight,	.0052	35.50	5.00	113.78	16.01
Keller,	.0052	36.50	1.50	116.99	4.81
Uncle Gideon's Quick Lunch,	.0052	20.75	10.50	66.51	33.65
Noroton Beauty,	.0052	30.75	5.00	98.56	16.01
Nebraska,	.0052	48.00	4.25	153.85	13.62
Simmon's Model,	.0052	63.50	5.50	201.92	17.62
Harris' Snowball,	.0026	18.00	2.00	115.38	12.82
Mills' New Rose Beauty,	.0026	17.25	3.25	110.58	20.83

It will be seen that most of the varieties gave a fairly satisfactory yield. Four only gave a yield of merchantable tubers in excess of 200 bushels; these, in the order of their rank, were: Climax, Chenango White, Hammond's Wonderful and Simmon's Model. Four varieties gave a yield at the rate of less than 100 bushels of merchantable tubers per acre; these, in the order of their inferiority, were: Uncle Gideon's Quick Lunch, Good as Gold, Short Seasons and Noroton Beauty.

The seed of all the varieties was treated with formalin, and the product was free from scab. They were twice sprayed with Bordeaux mixture. The varieties showing blight earliest were Good as Gold, Uncle Gideon's Quick Lunch and Noroton Beauty. All the vines of these varieties were dead on August 14, on which date Salzer's Sunlight, Climax and Clark's Pride were beginning to show blight. The six varieties named were the only ones apparently much affected. Among these varieties, all except Climax gave a small yield, those earliest blighted being among the very poorest.

XII. — Poultry Experiments.

The poultry work of the past year has been a repetition of the feeding experiments of the preceding year. These experiments had indicated: first, that, provided fat is abundant in the ration, high protein content is not essential; second, that, if the fat content of the ration is low, a large proportion of protein in the feeds used appears to be much more essential; and third, that a large proportion of fiber in the ration used is unfavorable to a good egg product. The fowls used in the experiment this year, as last, were pullets of our own raising; and in comparing different food combinations, carefully matched flocks have been kept, as in former years, each in a house by itself, all the houses being of precisely similar dimensions and construction.

1. The fowls in houses Nos. 1 and 2 have been fed on rations characterized by high content both of ash and fat and low fiber. As wheat is relatively deficient in fat, the ration in which it is largely used received an addition of

corn oil. This is mixed with the grains in the mash in such quantities that the total amount of fat in the two food combinations under comparison is substantially the same for each. This experiment, therefore, in a general way affords opportunity to test the relative value for egg production of a ration relatively high in protein (the one containing a large proportion of wheat) with one relatively low in protein (containing a large proportion of corn). The nutritive ratio of the ration used in house No. 1, which may be denominated "the wheat ration," is narrow, — 1 to 4.57. The ration used in house No. 2, which may be called "the corn ration," has a relatively wide nutritive ratio, — 1 to about 6.5. The animal food used in both these rations was beef scraps. The following results were obtained. For the first period, January 25 to April 28, inclusive, the wheat ration produced eggs at the average rate of .48 per hen day; the corn ration, at the rate of .54 per hen day. For the second period, April 28 to September 5, inclusive, the wheat ration produced eggs at the average rate of .37 per hen day; the corn ration, at the rate of .39. In other words, 100 hens, if laying at the same rates, would have produced during the winter period 48 eggs per day on the wheat ration and 54 eggs per day on the corn ration; during the summer period, 37 eggs per day on the wheat ration and 39 eggs per day on the corn ration. The average food cost per egg produced was: for the wheat ration .96 cents, and for the corn ration .73 cents, for the first period; while for the second period the food cost per egg on the wheat ration was 1.01 cents and on the corn ration .82 cents. The gross cost of the food on the wheat ration varied from about .37 cents to .42 cents per day for each fowl, while on the corn ration the cost varied from .31 cents to .36 cents per day. The number of eggs on the corn ration, as will have been noted, was considerably more than on the other. The cost per egg was smaller and the daily cost per fowl was smaller. The results of the past year are in exact accord with those obtained in similar experiments in earlier years. Our egg production with these pens of fowls must be regarded as fairly satisfactory, and it seems impossible to doubt that corn judiciously used in combination with other foods has superior merits for egg production as compared with wheat.

2. The rations fed to the fowls in houses Nos. 3 and 4 were relatively high in ash and low in fiber. Milk albumen was the animal food used. This was selected on account of the low percentage of fat it contains, and the rations fed to the fowls in both of these houses were characterized by much lower fat contents than the rations fed to the fowls in houses Nos. 1 and 2. As in the experiment previously described, the fat content of the two rations used in houses Nos. 3 and 4 was equalized by the addition of corn oil to the one naturally lower in fat. Wheat was the leading grain in the ration fed to the fowls in house No. 3; corn the leading whole grain fed in the other house, No. 4. The results with the fowls in these houses, like the results obtained in houses Nos. 1 and 2, afford a basis for estimating the relative value of wheat and corn, but with a relatively low percentage of fat in both. The nutritive ratios used in this experiment were, for the ration containing wheat, 1 to 4.54; for the ration containing corn, 1 to 6.28. The egg product in this experiment was as follows: for the first period, January 25 to April 28, inclusive, for the wheat ration .49 and for the corn ration .47 eggs per hen day; for the summer period, April 28 to September 5, inclusive, for the wheat ration .35 and for the corn ration .46 eggs per hen day. In other words, 100 fowls, laying at similar rates, would have produced on the wheat ration 49 eggs per day during the winter period and 35 eggs per day during the summer period. On the corn ration, the same number of fowls would have laid 47 eggs per day during the winter period and 46 eggs per day during the summer period. It will be noticed that the result in the winter experiment is favorable to the ration containing the wheat. In the summer, on the other hand, it is favorable to the ration containing the corn. In the experiments reported last year the numbers of eggs both in the winter and in the summer period were greater on the wheat ration, although the cost per egg was less on the corn than on the wheat. In the experiments of the past year the gross cost of food per egg produced on the wheat ration has been

.96 cents both for the winter and summer periods. The gross cost of food per egg on the corn ration for the winter period was .86 cents and for the summer period .74 cents. This year, as last, therefore, the food cost per egg has been less on the corn than on the wheat. It is not easy to understand why the results as measured by the number of eggs produced in one instance should have been favorable to the wheat and in the other to the corn, but it may be that the difference in the average temperature of the two seasons in part accounts for it. It will be remembered that both rations in this experiment are low in fat. One of the products of protein metabolism in the animal body is fat, and fat, as is well understood, is the most effective heat producer. The higher protein content of the ration containing the more wheat may have proved serviceable, therefore, in enabling the fowls the better to maintain normal body temperatures during the cool weather. True, it is generally asserted that corn may be used more freely as a food for laying fowls in winter than in summer. It will be remembered, however, that in this experiment the fat content of the wheat ration was made equal to that of the corn ration by the addition of corn oil. It would seem, therefore, that, while the results in the two periods this year are not in exact agreement, they nevertheless in a general way support the conclusion which has previously been tentatively suggested, viz.: that, unless the fat content of the ration is relatively high, the more starchy foods are not sufficient to produce a satisfactory egg yield, and the product falls below that obtained from feeding a ration higher in protein.

3. The fowls in houses Nos. 5 and 6 received rations in both cases characterized by low protein, high ash and high fat content. The deficiency in fat in the grains selected was made up by the use of corn oil mixed with the meals used in the mash, as in the other experiments. The fowls in house No. 5 were fed grains, including oats and oat feed, characterized by a high proportion of fiber. Those in house No. 6 were fed grains among which rice, which is characterized by a very low percentage of fiber, was prominent. The object in this experiment was to get light regarding the influence

of fiber in the ration on egg production. The nutritive ratio in the two houses was kept substantially the same, about 1 to 6.5. The animal food used in these houses was beef scraps. The results were as follows: For the winter period, January 25 to April 28, inclusive, the egg production was: for the oat ration (high fiber), .32 per hen day; for the rice ration (low fiber), .46. For the summer period, April 28 to September 5, inclusive, the egg production was: for the oat ration (high fiber), .32; and for the rice ration (low fiber), .37 per hen day. In other words, 100 fowls, laying at the same rates, would have produced daily during the winter period, on the oat ration, 32 eggs; on the rice ration, 46 eggs; during the summer period, on the oat ration, 32 eggs; on the rice ration, 37 eggs. The food cost of the eggs was greater on the rice ration than on the oat ration. As has been pointed out in earlier reports, rice, on account of its high price, cannot as a rule be economically used as a food for laying fowls. It is used in this experiment because of its exceptionally low fiber content. The results of the past year are in exact accord with all earlier experiments testing this point. A large proportion of fiber in a ration for laying fowls seems to be highly unfavorable to a satisfactory egg product.

REPORT OF THE CHEMIST.

DIVISION OF FERTILIZERS AND FERTILIZER MATERIALS.

CHARLES A. GOESSMANN.
Assistants: HENRI D. HASKINS, EDWARD G. PROULX, E. T. LADD.

PART I. — REPORT ON OFFICIAL INSPECTION OF COMMERCIAL FERTILIZERS AND AGRICULTURAL CHEMICALS DURING THE SEASON OF 1906.

CHARLES A. GOESSMANN.

The total number of manufacturers, importers and dealers in commercial fertilizers and agricultural chemicals who have secured licenses during the past season is 64; of these, 40 have offices for the general distribution of their goods in Massachusetts, 11 in New York, 8 in Connecticut, 3 in Vermont, 2 in Ohio, 1 in Rhode Island, 1 in Maryland, 1 in Tennessee, 1 in Arkansas, 1 in Missouri, 1 in Canada, 1 in New Jersey and 1 in Pennsylvania.

Three hundred and fifty-four brands of fertilizers and chemicals have been licensed in Massachusetts during the year. Five hundred and thirty-three samples of fertilizers have been collected up to December 10 in our general markets by an experienced assistant in this department.

Four hundred and ninety-seven samples of officially collected fertilizers have been analyzed at the present date (December 10), representing 323 distinct brands of fertilizers. Some of these analyses were published in our July bulletin No. 111; the others will be published in our January bulletin. The analyses of other officially collected samples of fertilizers, not included in these two publications, will be published in our March bulletin for 1907. Twenty-eight more brands of fertilizers were licensed in Massachusetts during the year than in 1905, and 10 more have been analyzed than during the past year.

The following table shows the general character of the fertilizers analyzed during 1906, as compared with the previous year: —

	1905.	1906.
(*a*) Where three essential elements of plant food were guaranteed (complete fertilizers): —		
Number with three elements equal to or above the highest guarantee,	11	9
Number with two elements above the highest guarantee,	15	22
Number with one element above the highest guarantee,	59	71
Number with three elements between the highest and lowest guarantee,	100	106
Number with two elements between the highest and lowest guarantee,	74	71
Number with one element between the highest and lowest guarantee,	24	41
Number with three elements below the lowest guarantee,	1	0
Number with two elements below the lowest guarantee,	14	14
Number with one element below the lowest guarantee,	48	45
(*b*) Where two essential elements of plant food were guaranteed (bones, tankage, fish and ashes): —		
Number with two elements above the highest guarantee,	5	3
Number with one element above the highest guarantee,	22	20
Number with two elements between the lowest and highest guarantee,	12	7
Number with one element between the lowest and highest guarantee,	14	18
Number with two elements below the lowest guarantee,	2	4
Number with one element below the lowest guarantee,	13	8
(*c*) Where one essential element of plant food was guaranteed (chemicals): —		
Number above the highest guarantee,	11	13
Number between the lowest and highest guarantee,	13	18
Number below the lowest guarantee,	10	13

The quality of the officially collected fertilizers for 1906, as shown by the above table, shows a gain over the previous year.

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals, 1905 and 1906 (Cents per Pound).

	1905.	1906.
Nitrogen in ammonia salts,	17.50	17.50
Nitrogen in nitrates,	17.00	16.50
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	18.50	18.50
Organic nitrogen in fine bone and tankage,	18.00	18.00
Organic nitrogen in coarse bone and tankage,	13.00	13.00
Phosphoric acid soluble in water,	4.50	4.50
Phosphoric acid soluble in ammonium citrate,	4.00	4.00
Phosphoric acid in fine-ground fish, bone and tankage,	4.00	4.00
Phosphoric acid in cotton-seed meal, castor pomace and wood ashes,	4.00	4.00
Phosphoric acid in coarse fish, bone and tankage,	3.00	3.00
Phosphoric acid insoluble (in water and neutral citrate of ammonia) in mixed fertilizers,	2.00	2.00
Potash as sulphate (free from chlorides),	5.00	5.00
Potash as muriate (chloride),	4.25	4.25
Potash as carbonate,	8.00	8.00

A comparison of the market cost of the various forms in which the three essential elements of plant food are found shows the nitrogen in the form of nitrates to be a half-cent lower in cost than for the previous year; the cost of the other forms of nitrogen, as well as the various sources of potash and phosphoric acid, remains the same as for 1905.

The above schedule of trade values was adopted by representatives of the Massachusetts, Connecticut, Rhode Island, Maine, Vermont and New Jersey experiment stations, at a conference held during the month of February, 1906, and is based upon the condition of the fertilizer market in centers of distribution in New England, New York and New Jersey during the six months preceding March, 1906, and refers to the current market prices, in ton lots, of the leading standard raw materials which furnish nitrogen, phosphoric acid and potash, and which enter largely into the manufacture of our commercial fertilizers.

Table A, on a following page, gives the average composition of licensed commercial fertilizers for 1906.

Table B gives a compilation of analyses of the so-called special crop fertilizers, and shows the wide variation in the chemical composition of this class of goods, the variation in some cases amounting to 10 or 12 per cent. in some one element of plant food which is recommended and used by different manufacturers in compounding a fertilizer for some special crop. This is proof positive that the purchaser of commercial fertilizers must have some more reliable method of selecting his fertilizers than by using the manufacturers' trade names, which, being so contradictory, confuse rather than aid the intelligent buyer. No infallible rule can be laid down in selecting a fertilizer, as so much depends upon the method of crop rotation, the kind of farming in practice, and general soil conditions and requirements. The user of commercial fertilizers will, however, make no mistake in selecting a *high-grade* fertilizer; but whether to select a fertilizer containing a high percentage of some one element of plant food, and how to be guided in this matter, must rest with the individual consumer. The plant food requirements of different soils, as well as different crops, vary widely; and the farmer must discover what particular fertilizing element or elements will most benefit his soil, and select his fertilizer accordingly.

TABLE A. — *Average Analysis of Officially Collected Fertilizers for 1906 (Per Cent.).*

NATURE OF MATERIAL.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
							Total.		Available.			
		Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
General fertilizer,	10.18	3.14	2.71	4.18	3.42	2.91	10.51	8.91	7.60	7.30	5.30	5.05
Ground bone,	6.80	2.98	2.56	-	8.54	16.33	24.87	22.38	8.54	7.81	-	-
Tankage,	9.72	5.39	5.19	-	6.15	10.19	16.34	14.73	6.15	-	-	-
Dry ground fish,	8.26	8.14	8.24	-	3.86	3.95	7.82	6.80	3.86	-	-	-
Basic slag,	-	-	-	-	6.72	12.27	18.99	18.00	6.72	-	-	-
Dissolved bone black,	12.11	-	-	10.77	4.92	1.21	17.01	16.00	15.70	15.00	-	-
Dissolved bone,	6.61	2.46	1.65	5.60	8.42	3.08	17.10	14.00	14.02	12.00	-	-
Acid phosphate,	12.62	-	-	10.85	3.97	1.52	16.34	11.66	14.82	13.00	-	-
Wood ashes,	13.96	-	-	-	-	-	1.33	1.12	-	-	5.77	4.80
Nitrate of soda,	1.76	15.57	15.42	-	-	-	-	-	-	-	-	-
Sulfate of ammonia,	.76	20.78	19.00	-	-	-	-	-	-	-	-	-
Dried blood,	7.55	9.30	9.50	-	-	-	-	-	-	-	-	-
Cotton-seed meal,	6.91	6.69	6.46	-	-	-	-	-	-	-	-	-
Cleveland flax meal,	9.52	6.00	5.76	-	-	-	-	-	-	-	-	-
Chincha Peruvian guano,	10.65	7.33	7.06	2.49	4.80	2.72	10.01	8.50	7.29	6.50	1.88	2.00
Lobos Peruvian guano,	10.40	3.41	3.15	2.78	5.75	9.04	17.57	19.00	8.53	10.00	3.90	3.30
Carbonate of potash,	None.	-	-	-	-	-	-	-	-	-	67.10	67.00
Sulfate of potash,	.84	-	-	-	-	-	-	-	-	-	49.34	48.25
Muriate of potash,	1.36	-	-	-	-	-	-	-	-	-	50.42	50.00
Sulfate of potash-magnesia,	3.95	-	-	-	-	-	-	-	-	-	25.92	26.00
Kainit,	2.07	-	-	-	-	-	-	-	-	-	12.84	12.00

TABLE B. — *Compilation of Analysis of Officially Collected Fertilizers for 1906, Special Crop Brands (Per Cent.).*

NAME OF FERTILIZER.	Moisture.	Nitrogen in One Hundred Pounds.			Total Phosphoric Acid in One Hundred Pounds.			Available Phosphoric Acid in One Hundred Pounds.			Potassium Oxide in One Hundred Pounds.		
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.
Corn fertilizer,	10.77	4.16	1.61	2.61	16.64	9.22	11.55	9.66	5.12	8.39	10.94	1.80	4.00
Fruit and vine,	9.77	2.78	2.50	2.64	13.86	7.24	10.55	10.84	3.78	7.31	11.42	3.32	7.37
Grass fertilizer,	7.89	5.69	3.10	4.27	14.32	4.84	9.17	10.98	2.78	6.38	8.30	2.06	5.28
Market garden fertilizer,	9.77	4.68	2.03	3.19	14.00	7.16	10.65	10.08	5.76	7.63	12.08	2.06	6.67
Onion fertilizer,	10.72	4.31	3.62	3.88	12.10	7.88	10.18	9.98	6.50	7.80	7.98	6.28	6.95
Potato fertilizer,	10.80	5.62	1.32	2.81	15.46	6.70	10.61	9.72	4.16	7.68	10.14	3.10	6.09
Root crop fertilizer,	10.56	3.66	2.75	3.28	11.90	9.86	10.89	8.90	7.26	8.22	7.66	6.50	7.23
Tobacco fertilizer,	8.56	8.56	1.09	4.42	15.08	4.24	8.06	9.14	2.40	5.85	15.88	2.62	6.40

List of Manufacturers and Dealers who have secured Certificates for the Sale of Commercial Fertilizers in the State during the Past Year (May 1, 1906, to May 1, 1907), and the Brands licensed by Each.

The American Agricultural Chemical Co., Boston, Mass.: —
- High-grade Fertilizer with Ten Per Cent. Potash.
- Grass and Lawn Top-dressing.
- Tobacco Starter and Grower.
- Fine-ground Bone.
- Dissolved Bone Black.
- Muriate of Potash.
- Double Manure Salt.
- High-grade Sulfate of Potash.
- Nitrate of Soda.
- Dry Ground Fish.
- Plain Superphosphate.
- Sulfate of Ammonia.
- Kainit.
- Dried Blood.
- Fine-ground Tankage.
- Ground South Carolina Phosphate.
- High-grade Tobacco Manure.

The American Agricultural Chemical Co. (Bradley Fertilizer Co., branch), Boston, Mass.: —
- Bradley's Complete for Potatoes and Vegetables.
- Bradley's Complete for Corn and Grain.
- Bradley's Complete Manure with Ten Per Cent. Potash.
- Bradley's Complete Top-dressing Grass and Grain.
- Bradley's X. L. Superphosphate.
- Bradley's Potato Manure.
- Bradley's Potato Fertilizer.
- Bradley's Corn Phosphate.
- Bradley's Eclipse Phosphate.
- Bradley's Niagara Phosphate.
- Bradley's English Lawn Fertilizer.
- Bradley's Columbia Fish and Potash.
- Bradley's Abattoir Bone Dust.
- Bradley's Seeding-down Manure.
- Church's Fish and Potash.

The American Agricultural Chemical Co. (H. J. Baker & Bro., branch), New York, N. Y.: —
- Baker's A. A. Ammoniated Superphosphate.
- Baker's Complete Potato Manure.

The American Agricultural Chemical Co. (Clark's Cove Fertilizer Co., branch), Boston, Mass.: —
- Clark's Cove Bay State Fertilizer.
- Clark's Cove Bay State Fertilizer G. G.

The American Agricultural Chemical Co. (Clark's Cove Fertilizer Co., branch), Boston, Mass. — *Con.*
- Clark's Cove Great Planet Manure.
- Clark's Cove Potato Manure.
- Clark's Cove Potato Fertilizer.
- Clark's Cove King Philip Guano.

The American Agricultural Chemical Co. (Crocker Fertilizer and Chemical Co., branch), Buffalo, N. Y.: —
- Crocker's Potato, Hop and Tobacco Phosphate.
- Crocker's Corn Phosphate.
- Crocker's A. A. Complete Manure.

The American Agricultural Co. (Cumberland Bone Phosphate Co., branch), Boston, Mass.: —
- Cumberland Superphosphate.
- Cumberland Potato Fertilizer.

The American Agricultural Chemical Co. (L. B. Darling Fertilizer Co., branch), Pawtucket, R. I.: —
- Darling's Blood, Bone and Potash.
- Darling's Complete Ten Per Cent. Manure.
- Darling's Potato Manure.
- Darling's Farm Favorite.
- Darling's Potato and Root Crop Manure.
- Darling's General Fertilizer.

The American Agricultural Chemical Co. (Great Eastern Fertilizer Co., branch), Rutland, Vt.: —
- Great Eastern Northern Corn Special.
- Great Eastern Vegetable Vine and Tobacco.
- Great Eastern Garden Special.
- Great Eastern General.
- Great Eastern Grass and Oats Fertilizer.

The American Agricultural Chemical Co. (Pacific Guano Co., branch), Boston, Mass.: —
- Pacific High-grade General.
- Pacific Potato Special.
- Soluble Pacific Guano.
- Pacific Nobsque Guano.

The American Agricultural Chemical Co. (Packers' Union Fertilizer Co., branch), Rutland, Vt.: —
- Packers' Union Gardeners' Complete Manure.
- Packers' Union Animal Corn Fertilizer.
- Packers' Union Potato Manure.
- Packers' Union Universal Fertilizer.
- Packers' Union Wheat, Oats and Clover Fertilizer.

The American Agricultural Chemical Co. (Quinnipiac Co., branch), Boston, Mass.: —
- Quinnipiac Market-garden Manure.
- Quinnipiac Phosphate.
- Quinnipiac Potato Manure.
- Quinnipiac Potato Phosphate.
- Quinnipiac Corn Manure.
- Quinnipiac Climax Phosphate.
- Quinnipiac Onion Manure.

The American Agricultural Chemical Co. (Read Fertilizer Co., branch), New York, N. Y.: —
- Read's Practical Potato Special.
- Read's Farmer's Friend.
- Read's Standard.
- Read's High-grade Farmer's Friend.
- Read's Vegetable and Vine.

The American Agricultural Chemical Co. (Standard Fertilizer Co., branch), Boston, Mass.: —
- Standard Complete Manure.
- Standard Fertilizer.
- Standard Special for Potatoes.
- Standard Guano.

The American Agricultural Chemical Co. (Henry F. Tucker Co., branch), Boston, Mass.: —
- Tucker's Original Bay State Bone Superphosphate.
- Tucker's Special Potato.

The American Agricultural Chemical Co. (Williams & Clark Fertilizer Co., branch), Boston, Mass.: —
- Williams & Clark's High-grade Special.
- Williams & Clark's Americus Phosphate.
- Williams & Clark's Potato Phosphate.
- Williams & Clark's Potato Manure.
- Williams & Clark's Corn Phosphate.
- Williams & Clark's Royal Bone Phosphate.
- Williams & Clark's Prolific Crop Producer.

The American Agricultural Chemical Co. (M. E. Wheeler & Co., branch), Rutland, Vt.: —
- Wheeler's Corn Fertilizer.
- Wheeler's Potato Manure.
- Wheeler's Havana Tobacco Grower.
- Wheeler's Bermuda Onion Grower.
- Wheeler's Grass and Oats Fertilizer.

W. H. Abbott, Holyoke, Mass.: —
- Abbott's Tobacco Fertilizer.
- Abbott's Onion Fertilizer.
- Abbott's Animal Fertilizer.
- Abbott's Eagle Brand Fertilizer.

The American Cotton Oil Co., New York City: —
- Cotton-seed Meal.
- Cotton-hull Ashes.

The American Linseed Co., New York, N. Y.: —
- Cleveland Flax Meal.

The Armour Fertilizer Works, Baltimore, Md.: —
- Fruit and Root Fertilizer.
- Blood, Bone and Potash.
- High-grade Potato.
- All Soluble.
- Ammoniated Bone with Potash.
- Bone Meal.
- Complete Potato.
- Corn King.
- Market Garden.
- Grain Grower.

H. J. Baker & Bro., New York, N. Y.: —
- Castor Pomace.

Beach Soap Co., Lawrence, Mass.: —
- Beach's Advance Brand.
- Beach's Reliance Brand.

Berkshire Fertilizer Co., Bridgeport, Conn.: —
- Berkshire Complete Fertilizer.
- Berkshire Potato and Vegetable Phosphate.
- Berkshire Ammoniated Bone Phosphate.
- Berkshire Grass Fertilizer.

Joseph Breck & Sons, Boston, Mass.: —
- Breck's Lawn and Garden Dressing.
- Breck's Market-garden Manure.

Bowker Fertilizer Co., Boston, Mass.: —
- Stockbridge Special Manures.
- Bowker's Hill and Drill Phosphate.
- Bowker's Farm and Garden Phosphate.

Bowker Fertilizer Co., Boston, Mass. — *Con.*
- Bowker's Lawn and Garden Dressing.
- Bowker's Potato and Vegetable Fertilizer.
- Bowker's Fish and Potash (Square Brand).
- Bowker's Potato and Vegetable Phosphate.
- Bowker's Sure Crop Phosphate.
- Gloucester Fish and Potash.
- Bowker's High-grade Fertilizer.
- Bowker's Bone and Wood Ash Fertilizer.
- Bowker's Fish and Potash ("D" Brand).
- Bowker's Corn Phosphate.
- Bowker's Bone, Blood and Potash.
- Bowker's Early Potato Manure.
- Bristol Fish and Potash.
- Bowker's Fine-ground Fish.
- Bowker's Tobacco Ash Elements.
- Bowker's Wood Ashes.
- Bowker's Ground Bone.
- Bowker's Superphosphate.
- Bowker's Sulfate of Ammonia.
- Bowker's Nitrate of Soda.
- Bowker's Dissolved Bone Black.
- Bowker's Kainit.
- Bowker's Muriate of Potash.
- Bowker's Sulfate of Potash.
- Dried Blood.
- Bowker's Soluble Animal Fertilizer.
- Bowker's Tobacco Starter.
- Bowker's Tobacco Ash Fertilizer.
- Bowker's Market-garden Fertilizer.
- Bowker's Potash Bone.
- Bowker's Ten Per Cent. Manure.
- Bowker's Complete Mixture.
- Bowker's Ammoniated Food for Flowers.
- Bowker's Double Manure Salt.
- Bowker's Tankage.
- Bowker's Clover Brand Bone and Wood Ash Fertilizer.
- Bowker's Flour of Bone.
- Bowker's Market Bone.
- Bowker's Ground Phosphate Rock.
- Bowker's Ammoniated Dissolved Bone.
- Bowker's Square Brand Bone and Potash.
- Bowker's Potash or Staple Phosphate.
- Bowker's Special Fertilizer for Seeding Down.

F. W. Brode & Co., Memphis, Tenn.: —
- Owl Brand Cotton-seed Meal.

T. H. Bunch Co., Little Rock, Ark.: —
- Cotton-seed Meal.

The Buffalo Fertilizer Co., Buffalo, N. Y.: —
- Fish Guano.
- Farmer's Choice.
- York State Special.
- Vegetable and Potato.
- Garden Truck.
- High-grade Manure.

Charles M. Cox Co., Boston, Mass.: —
- Cotton-seed Meal.

Chicopee Rendering Co., Springfield, Mass.: —
- Farquhar's Lawn and Garden Dressing.
- Farquhar's Vegetable and Potato Fertilizer.

The Coe-Mortimer Co., New York, N. Y.: —
- New Englander Corn and Potato Fertilizer.
- Columbian Corn and Potato Fertilizer.
- Basic Slag.
- Excelsior Potato Fertilizer.
- Gold Brand Excelsior Guano.
- X X X Ammoniated Bone Phosphate.
- Nitrate of Soda.
- Celebrated Special Potato.
- High-grade Ammoniated Bone Superphosphate.
- Chincha Peruvian Guano.
- Lobos Peruvian Guano.

John C. Dow & Co., Boston, Mass.: —
- Dow's Pure Ground Bone.

Eastern Chemical Co., Boston, Mass.: —
- Imperial Plant Food.

R. & J. Farquhar & Co., Boston, Mass.: —
- Canada Unleached Hard-wood Ashes.
- Clay's London Fertilizer.

Fyfe, Fay & Plummer, Clinton, Mass.: —
- Hard-wood Canada Ashes.

C. B. Hastings, Ashmont, Mass.: —
- Ferti Flora.

Thomas Hersom & Co., New Bedford, Mass.: —
- Meat and Bone.
- Bone Meal.

The Home Soap Co., Worcester, Mass.: —
Ground Bone.

Hunter Brothers Milling Co., St. Louis, Mo.: —
Cotton-seed Meal.

John Joynt, Lucknow, Ontario, Can.: —
Unleached Hard-wood Ashes.

A. Klipstein & Co., New York, N. Y.: —
Carbonate of Potash.

Lister's Agricultural Chemical Works, Newark, N. J.: —
Lister's High-grade Special.
Lister's Success.
Lister's Special Corn.
Lister's Special Potato.
Lister's Potato Manure.
Lister's Oneida Special.
Lister's Bone and Potash.

Stephen Major, South Somerset, Mass.: —
Major's Bone Phosphate No. 1.

Edward MacMulkin, Boston, Mass.: —
Ideal Plant Food.

Swift's Lowell Fertilizer Co., Boston, Mass.: —
Swift's Lowell Bone Fertilizer.
Swift's Lowell Potato Phosphate.
Swift's Lowell Dissolved Bone and Potash.
Swift's Lowell Animal Brand.
Swift's Lowell Market-garden Manure.
Swift's Lowell Potato Manure.
Swift's Lowell Empress Brand.
Swift's Lowell Superior Fertilizer.
Swift's Lowell Special Grass Mixture.
Swift's Lowell Lawn Dressing.
Swift's Lowell Perfect Tobacco Grower.
Swift's Lowell Ground Bone.
Acid Phosphate.
Nitrate of Soda.
Muriate of Potash.
Tankage.
Dried Blood.
High-grade Sulfate of Potash.
Dissolved Bone Black.
Swift's Lowell Special Vegetable Fertilizer.

George E. Marsh & Co., Lynn, Mass.: —
Bone Meal.

Mapes Formula & Peruvian Guano Co., New York, N. Y.: —
Mapes' Grass and Grain Spring Top-dressing.
Mapes' Complete Manure for General Use.
Mapes' Fruit and Vine Manure.
Mapes' Cereal Brand.
Mapes' Lawn Top-dressing.
Mapes' Cauliflower and Cabbage Manure.
Mapes' Potato Manure.
Mapes' Tobacco Starter Improved.
Mapes' Tobacco Manure (Wrapper Brand).
Mapes' Economical Potato Manure.
Mapes' Average Soil Complete Manure.
Mapes' Vegetable Manure or Complete Manure for Light Soils.
Mapes' Corn Manure.
Mapes' Complete Manure ("A" Brand).
Mapes' Complete Manure Ten Per Cent. Potash.
Mapes' Top-dressing Improved, Half Strength.
Mapes' Tobacco Ash Constituents.

George L. Monroe & Sons, Oswego, N. Y.: —
Pure Canada Unleached Wood Ashes.

D. M. Moulton, Monson, Mass.: —
Ground Bone.

W. H. Nash, Boston, Mass.: —
Lime-Kiln Ashes.

National Fertilizer Co., Bridgeport, Conn.: —
Chittenden's Ammoniated Bone.
Chittenden's Universal.
Chittenden's Potato Phosphate.
Chittenden's Complete.
Chittenden's Fish and Potash.
Chittenden's Tobacco Starter.
Chittenden's Tobacco Grower.
Chittenden's Market Garden.
Chittenden's Tobacco Special.
Chittenden's Complete Tobacco.
Chittenden's High-grade Special Tobacco.

New England Fertilizer Co., Boston, Mass.: —
New England Corn Phosphate.
New England Potato Fertilizer.
New England Superphosphate.
New England High-grade Potato Fertilizer.

Olds & Whipple, Hartford, Conn.: —
Complete Tobacco Fertilizer.
Home Mixture for Onions.
Vegetable Potash.
Corn and Potato Fertilizer.
Cotton-seed Meal.

R. T. Prentiss, Holyoke, Mass.: —
Complete Fertilizers.

Parmenter & Polsey Fertilizer Co., Peabody, Mass.: —
Plymouth Rock Brand.
Strawberry Special.
Special Potato.
A. A. Brand.
P. & P. Potato.
Lawn Dressing.
P. & P. Grain Grower.
Star Brand.
Pure Ground Bone.
Nitrate of Soda.
Aroostook Special.

Rogers & Hubbard Co., Middletown, Conn.: —
Hubbard's Complete Phosphate.
Hubbard's Grass and Grain Fertilizer.
Hubbard's Market-garden Phosphate.
Hubbard's Oats and Top-dressing.
Hubbard's Potato Phosphate.
Hubbard's Soluble Corn and General Crops.
Hubbard's Soluble Potato Manure.
Hubbard's Soluble Tobacco Manure.
Hubbard's Raw Knuckle Bone Flour.
Hubbard's Strictly Pure Fine Bone.

Rogers Manufacturing Co., Rockfall, Conn.: —
All-round Fertilizer.
Complete Potato and Vegetable Fertilizer.
High-grade Complete Corn and Onion.
Fish and Potash.
High-grade Tobacco and Potato.
High-grade Oats and Top-dressing.
High-grade Grass and Grain.
High-grade Soluble Tobacco.
Pure Knuckle Bone.

Ross Brothers, Worcester, Mass.: —
Lawn and Garden Fertilizer.

N. Roy & Son, South Attleborough, Mass.: —
Potato Fertilizer.
Complete Animal Fertilizer.

Russia Cement Co., Gloucester, Mass.: —
Essex Dry Ground Fish.
Essex Complete for Corn, Grain and Grass.
Essex Complete for Potatoes, Roots and Vegetables.
Essex Market-garden and Potato Manure.
Essex Corn Fertilizer.
Essex A. 1. Superphosphate.
Essex X X X Fish and Potash.
Essex Odorless Lawn Dressing.
Essex Tobacco Starter.
Essex Special Tobacco Manure.
Essex Rhode Island Special for Potatoes.
Essex Grass and Top-dressing.
Essex Nitrate of Soda.

The Salisbury Cutlery Handle Co., Salisbury, Conn.: —
Ground Bone.

Sanderson's Fertilizer & Chemical Co., New Haven, Conn.: —
Sanderson's Formula "A."
Sanderson's Formula "B."
Sanderson's Top-dressing Grass and Grain.
Sanderson's Potato Manure.
Sanderson's Atlantic Coast Bone, Fish and Potash.
Sanderson's Fine-ground Fish.
Nitrate of Soda.
High-grade Sulfate of Potash.
Muriate of Potash.
Plain Superphosphate.
Walker's Complete Phosphate.

M. L. Shoemaker & Co., Limited, Philadelphia, Pa.: —
Swift Sure Superphosphate.
Swift Sure Bone Meal.

The Smith Agricultural Chemical Co. (Abbott and Martin Rendering Co., branch), Columbus, O.: —
Harvest King.
Tobacco and Potato Special.
Martin's Truck Fertilizer.

The Smith Agricultural Chemical Co. (Hardy Packing Co., branch), Columbus, O.: —
Tankage, Bone and Potash.
Tobacco and Potato Special.

Sterling Chemical Co., Cambridgeport, Mass.: —
- Sterlingworth Concentrated Plant Food.

Thomas L. Stetson, Randolph, Mass.: —
- Stetson's Ground Bone.

A. L. Warren, Northborough, Mass.: —
- Warren's Ground Bone.

Whitman & Pratt Rendering Co., Lowell, Mass.: —
- Vegetable Grower.
- All Crops Fertilizer.
- Corn Success.
- Potato Plowman.
- Ground Bone.

Wilcox Fertilizer Works, Mystic, Conn.: —
- Potato, Onion and Vegetable Manure.
- Potato Fertilizer.
- Complete Bone Superphosphate.
- Fish and Potash.
- High-grade Tobacco Special.
- Dry Ground Fish.

Sanford Winter, Brockton, Mass.: —
- Winter's Ground Bone.

J. M. Woodard & Bro., Greenfield, Mass.: —
- Tankage.

Part II. — Report on General Work in the Chemical Laboratory.

C. A. GOESSMANN.

1. Analyses of materials forwarded for examination.
2. Notes on wood ashes and lime ashes.

1. Analyses of Materials forwarded for Examination.

During the year 343 samples of miscellaneous substances have been received from farmers within our State. These samples have been analyzed as expeditiously as possible, the samples being taken up, as a rule, in the order of their arrival at this office; although precedence is sometimes given to farmers' clubs, grange organizations and private parties, who depend upon the results of our analysis as a basis for settlement for their fertilizers. We have most time at our disposal for this class of work from the middle of December until the first of April, as during this time we are not engaged in the annual inspection of commercial fertilizers. Whenever practical, it would be well for those who desire a speedy return of results of analyses to take advantage of this fact, and send samples for analysis before the beginning of our inspection season.

During the year we have been in co-operation with the Association of Official Agricultural Chemists, studying new methods of analyses of soils, fertilizers and insecticides. This is a very important part of the practical chemists' work, and time should be taken every year for this co-operative investigation.

The year has seen some new developments along the line of producing valuable agricultural compounds for fertilizing purposes. These developments have naturally inclined towards producing new compounds of our most expensive element of plant food, nitrogen. Statistics show that, at the present rate of consumption, it is only a matter of a few years before the supply of nitrate of soda from our present source will become exhausted. This will become a very serious matter, unless new deposits of nitrate are discovered, or science shows us an economical method of utilizing the inexhaustible supply of atmospheric nitrogen. Attempts have been made to manufacture nitric acid by an electrical method which utilizes the nitrogen of the air, and which has proven more or less successful. Attempts have also been made to combine the atmospheric nitrogen with lime to form cyanimid compounds. This method has also been successful, but whether these cyanimid compounds will prove practical fertilizers or not we are at present unable to say. It has long been known that cyanogen compounds are poisonous to plant growth; but they are easily decomposed, and it is possible that it may be found safe to use them by applying them to the soil some time previous to the planting of the crop.

During the year we have heard much about the use of ground feldspar and granitic rocks as a source of potash. In the early history of the use of artificial fertilizers, potash in the form of silicates was recommended. They were, however, found unsuitable as a source of potash, as they were not easily decomposed, and the more soluble forms of potash soon took their place. It is a well-known fact that many soils of granitic origin are benefited by an application of soluble potash compounds. In view of the above facts, we would caution the user of commercial fertilizers against purchasing ground feldspathic rocks as a source of potash. Through a process of electrolysis and endosmosis, investigators have succeeded in recovering 80 per cent. of the potash in feldspathic rocks. In this age of cheapening electrical power it may not be impossible that this process may be successfully employed to economically produce potash for our future needs in the fertilization of agricultural soils for farm crops.

Following is a partial list of materials forwarded by farmers during the year: —

Soils,	55	Leather dust,	1
Complete fertilizers,	45	Tobacco stems,	1
Wood ashes,	41	Kainit,	1
Cotton-seed meal,	28	Pigeon manure,	1
Nitrate of soda,	13	Clay,	1
Peruvian guano,	11	Bone soup,	1
Carbonate of potash,	7	Peat,	1
Sulfate of potash,	8	Wool washings,	1
Ground bones,	6	Arsenate of soda,	1
Dry ground fish,	6	London purple,	1
Fine-ground tankage,	6	Saltpeter waste,	1
Lime ashes,	6	Bone waste,	1
Paris green,	6	Horn waste,	1
Dried blood,	4	Coal ashes,	1
Dissolved bone black,	4	Sludge from filter beds,	1
Muriate of potash,	4	Hoof meal,	1
Cotton waste,	4	South Carolina rock phosphate,	1
Sheep manure,	4	Manure,	1
Lime,	3	Sulfate of ammonia,	1
Dissolved bone,	3	Steamed bone,	1
Sulfate of potash-magnesia,	3	Manure and lime,	1
Nitrate of potash,	3	Bone scrap,	1
Arsenate of lead,	3	Burned bone,	1
Acid phosphate,	4	Carbonate of potash-magnesia,	1
Phosphatic slag,	3	Calcium cyanimid,	1
Oyster-shell lime,	2	Washings from paper mill,	1
Linseed meal,	2	Soft coal soot,	1
Muck,	2	Castor pomace,	1
Granite,	2	Nitrogenous chalk,	1
Talc,	2	Peat and manure,	1
Cotton-hull ashes,	2	Wool waste,	1
Leather refuse,	2	River mud,	1
Glue refuse,	1	Woodland leaf mold,	1
Cave deposit,	1	Miscellaneous,	12
Carbonate of lime,	1		

2. Notes on Wood Ashes and Lime Ashes.

(a) *Wood Ashes.*

Forty-one samples of wood ashes have been forwarded for analysis by farmers during the past year. The majority of these ashes are used by the farmers in the Connecticut valley. The following table shows their chemical composition as compared with 1905: —

Analysis of Wood Ashes.

	Number of Samples.	
	1905.	1906.
Moisture from 1 to 10 per cent.,	15	8
Moisture from 10 to 20 per cent.,	20	19
Moisture from 20 to 30 per cent.,	7	10
Moisture above 30 per cent.,	1	0
Potassium oxide above 7 per cent.,	4	3
Potassium oxide from 6 to 7 per cent.,	4	7
Potassium oxide from 5 to 6 per cent.,	12	6
Potassium oxide from 4 to 5 per cent.,	13	9
Potassium oxide from 3 to 4 per cent.,	7	9
Potassium oxide below 3 per cent.,	3	2
Phosphoric acid above 2 per cent.,	7	1
Phosphoric acid from 1 to 2 per cent.,	32	31
Phosphoric acid below 1 per cent.,	4	6
Average per cent. of calcium oxide,	32.30	28.17
Insoluble matter below 10 per cent.,	9	3
Insoluble matter from 10 to 15 per cent.,	14	16
Insoluble matter above 15 per cent.,	20	18

Table showing Maximum, Minimum and Average Per Cents. of the Different Ingredients found in Wood Ashes, 1905 and 1906.

	Maximum.		Minimum.		Average.	
	1905.	1906.	1905.	1906.	1905.	1906.
Moisture at 100° C.,	32.05	26.17	.02	.65	13.45	14.78
Potassium oxide,	8.68	7.54	2.32	2.75	5.09	5.02
Phosphoric acid,	4.74	2.90	.38	.44	1.69	1.28
Calcium oxide,	49.24	35.60	21.17	19.28	32.30	28.17
Insoluble matter,	33.32	30.25	4.15	4.04	15.49	16.02

A comparison of the figures in the above tables shows that the ashes analyzed during the season contained, on the average, less potash, phosphoric acid and lime and more water and sand than during the previous year. This emphasizes the importance of buying this class of material on a statement of guarantee of potash, phosphoric acid and lime; also of patronizing those importers who have complied with our State laws, and have secured licenses for the sale of wood ashes in Massachusetts. A list of these importers will be found on a previous page of this report.

(*b*) *Lime Ashes.*

Table showing Maximum, Minimum and Average Per Cents. of the Different Ingredients found in Lime Ashes, 1905 and 1906.

	Maximum.		Minimum.		Average.	
	1905.	1906.	1905.	1906.	1905.	1906.
Moisture at 100° C.,	19.35	21.65	.05	none.	11.18	5.99
Potassium oxide,	4.80	3.72	1.02	1.44	2.46	2.54
Phosphoric acid,	1.58	1.16	.18	.34	.97	.71
Calcium oxide,	63.44	49.74	37.56	29.33	49.34	40.39
Insoluble matter,	28.93	34.93	3.21	4.04	8.99	9.51

The average composition of lime ashes is about the same as for the previous year.

REPORT OF THE CHEMIST.

DIVISION OF FOODS AND FEEDING.

J. B. LINDSEY.

Chemists: E. B. HOLLAND, P. H. SMITH, A. C. WHITTIER,[1] L. S. WALKER.[2]
Inspector of Feeds and Babcock Machines: F. G. HELYAR,[3] W. K. HEPBURN.
Dairy Tester: S. R. PARKER,[4] H. A. PARSONS.
In Charge of Feeding Experiments: R. F. GASKILL.
Clerk and Stenographer: MABEL C. SMITH.

PART I. — OUTLINE OF THE YEAR'S WORK.

- Correspondence.
- Summary of laboratory work.
- Water analysis.
- Dairy products and cattle feeds.
- Special chemical work.
- Execution of feed law.
- Execution of dairy law.
- The testing of pure-bred cows.
- Work completed.
- Work in progress.
- Changes in staff.

PART II. — WORK IN ANIMAL NUTRITION.

- The digestibility of cattle feeds.

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[1] Resigned July 1.
[2] Since July 1.
[3] Resigned October 1.
[4] Resigned June 1.

Part I. — Outline of the Year's Work.

J. B. LINDSEY.

Correspondence.

A considerable correspondence is carried on yearly with farmers, grain dealers and other station workers. Numerous questions are asked concerning feeds and methods of feeding. The execution of the dairy and feed law involves the exchange of many letters. Letters of all kinds, sent from Dec. 15, 1905, through Dec. 15, 1906, approximated 3,200.

Summary of Laboratory Work.

From Dec. 15, 1905, to Dec. 15, 1906, there have been received and examined 124 samples of water, 310 of milk, 1,799 of cream, 152 of feed stuffs and 2 miscellaneous. In connection with experiments made by this and other divisions of the station, there have been examined, in whole or in part, 336 samples of milk and cream and 187 of cattle feeds. There have also been collected and examined 703 samples of cattle feeds, in accordance with the requirements of the feed law. The total for the year has been 3,613, as compared with 4,042 in 1905 and 4,261 during 1904. Work with condensed milk, molasses, maple sugar, ash and nitrogen, not included in the above summary, has been carried on for the Association of Official Agricultural Chemists. Twenty-three candidates have been examined and given certificates to operate Babcock machines, and 2,457 pieces of Babcock glassware have been tested for accuracy of graduation.

Water Analysis.

The station continues to make sanitary analyses of drinking waters, at a charge of $3 each. Special jars are furnished, together with full instructions for collecting and forwarding the samples. An analysis of water sent in shippers' jars will not be made, neither will bacteriological nor mineral analyses be undertaken.

The character of the samples received has been much the same as that of those examined in previous years. They were mostly from wells or springs, which frequently were located in too close proximity to houses, barns and outbuildings, and received the drainage. Samples are often found contaminated with lead; the station can only repeat its warning that all lead pipe be discarded, and replaced with iron coated with asphaltum, or with galvanized-iron pipe.

Dairy Products and Cattle Feeds.

Farmers and dairymen continue to send samples of cream and skim milk to be tested for butter fat, and samples of whole milk to be tested for both solids and fat. More milk is being sold for market purposes than formerly, and less made into butter. The inspection of the quality of milk is more general and rigid from year to year. Dairymen wish to ascertain the composition of milk produced by individual cows and by their herds, and likewise to confirm analyses reported to them by the city milk inspectors and by contractors. This work is performed gratis, and the results reported promptly, together with such remarks and suggestions as special cases call for. One creamery sends all of the cream samples to be tested regularly, and others send occasional lots when not in condition to perform the work. A charge sufficient to cover the cost is made in such cases.

Samples of feeds (mostly concentrates) are received from farmers, as well as from local grain dealers and jobbers. The station willingly examines such material without charge, when it seems that the conditions warrant it, and promptly reports its findings with suggestions when necessary. It must be understood, however, that it cannot become the free chemists of jobbers and manufacturers who wish to have analyses made purely for commercial purposes.

Special Chemical Work.

This division has devoted some time to a study of methods used in chemical analysis, in co-operation with the Association of Official Agricultural Chemists. The work undertaken was as follows: —

1. A comparison of the Kjeldahl, Kjeldahl-Gunning and modified Gunning methods, for the determination of total organic nitrogen.

2. The determination of available organic nitrogen by the neutral permanganate and by the alkaline permanganate methods.

3. A study of the Babcock asbestos, dish and sand, and Gottlieb methods, Babcock centrifugal and Leach and Farrington modifications of the same, for the determination of fat in sweetened and unsweetened condensed milk.

4. Observations in the determination of lactose and sucrose in sweetened and unsweetened condensed milk, by aid of Fehling's solution, the copper being titrated with thiosulfate.

5. Determinations of moisture, ash, protein, dextrose and sucrose in massecuit, sugar and molasses. Considerable time was spent in a special study of different methods for the accurate determination of moisture in molasses, which has not been reported; it will be published when sufficient data have been secured to warrant the making of positive deductions.

6. Determinations of total, soluble and insoluble ash in pure and adulterated maple sugar, as well as the alkalinity of the soluble and insoluble ash.

The results of the above work were presented to the association, and became a part of their yearly report. It was carried out by Messrs. Holland and Smith, to whom due credit should be given.

In addition to the above, work is now in progress in determining the water and starch in 36 samples of potatoes.

Execution of the Feed Law (Acts of 1903, Chapter 122).

The methods employed in carrying out the provisions of this act have been essentially the same as in former years. The State has been thoroughly canvassed twice, the first time in January, February and March, and the second time in August, September and October. The inspector also spent the larger part of May in the most important grain-consuming portions of the State, and in addition made several short trips. There have been collected and examined during the year 703 samples of cattle and poultry feeds. Bulletin No. 108, containing the analyses of 365 samples collected during the autumn of 1905, was issued in January, 1906. Another bulletin is now being prepared for publication, and will be issued in December or early January. In addition to the regular yearly bulletin, the station sends out many letters to dealers and manufacturers concerning the values of feeds and explanatory of the feed law.

The only really adulterated feeds now on the market consist of mixtures of wheat bran and corn cobs. Such goods are usually properly guaranteed, but it is believed that unscrupulous dealers are inclined to remove the tags before selling, and dispose of them for genuine mixed wheat feeds.

Cotton-seed meal offered in local markets has shown a gradual decline in quality since 1902, while the price per ton has increased steadily since 1898. Gluten meal and germ oil meal are no longer offered. Distillers' dried grains are easily obtainable at reasonable prices. Brewers' dried grains of excellent quality have been placed in Massachusetts markets during the past year.

A number of proprietary grain mixtures or ready grain rations for dairy stock are now on sale, several of which are quite satisfactory; the price asked, however, is in excess of equally desirable mixtures which can be prepared by the dairymen from standard concentrates to be had of all local grain dealers.

Mixtures of corn, together with different amounts of oat residues, often designated stock foods, are widely distributed, and, judging from the number of brands, must find a ready sale. The corn is frequently of poor quality, being imperfectly developed, musty and sour. The price asked is usually in excess of their real value.

The number of brands of poultry foods, such as meat scraps, meat and bone meal, poultry meals and mashes, chick and scratching grains, is increasing from year to year. Poultrymen can prepare equally as desirable mashes or scratching mixtures for 25 cents less per hundred pounds. Full details concerning the great variety of cattle and poultry feeds now for sale in the markets of the State may be found by consulting the special feed bulletins.

Execution of the Dairy Law (Acts of 1901, Chapter 202).

The station has done its best to carry out the provisions of this law, which makes it obligatory for all creameries and milk depots in the State employing the Babcock test, or any other test for determining the value of milk or cream, to have all glassware used in making such determinations tested for accuracy of graduation. The law further requires that all parties intending to operate such machines be examined for competency by the proper station official. The station is also required once each year to send a competent party to each creamery and milk depot within the State where Babcock machines are in use, and pronounce upon their fitness for the work.

(*a*) *Inspection of Glassware.* — Each piece of glassware found to be correctly graduated has the letters "Mass Ex St" etched on. There were examined 2,457 pieces, of which 763, or 31.05 per cent., were condemned. This record shows gross carelessness on the part of some manufacturers.

(*b*) *Examination of Candidates.* — Twenty-three candidates have been examined during 1906. Some were well prepared, while others were refused a certificate on first trial and were obliged to take a second examination. The value of the law requiring the inspection of glassware and the examination of operators is made especially clear by the above records.

(*c*) *Inspection of Babcock Machines.* — The inspection of machines the present year has been in charge of Mr. William K. Hepburn, who makes the following report: —

The annual inspection of Babcock machines was made in November and December of 1906. Fifty-one places were either visited or heard from, but of these only 33 came under the law requiring inspection. Those not coming within the law have no machine in many cases, and as far as can be learned neither sell nor buy on the test basis.

Of the entire number, 28 are creameries and 23 milk depots. Nineteen of the creameries are co-operative, and 9 are either proprietary or managed by stock companies. The milk depots are in nearly every case proprietary. Thirty-three machines were inspected and found in good condition, only 1 needing minor repairs. Nearly all the machines in use have cast-iron frames, and of these 16 are Facile, 8 Agos and 3 Wizard. In addition to the above, there were in use 3 steam machines having galvanized frames and 3 electrical machines. In a few cases the machines still overheat the tests, but allowance is made for this by letting them run a little longer with the cover lifted.

Most of the glassware was found in good condition, although a few still use very dirty bottles, — a practice which cannot be too strongly condemned. Beside the regular inspection, four city milk inspectors were visited; they did not care to have their machines tested.

The following parties claim they do not pay on the Babcock basis, but by the space, can, 100 pounds or quart: —

Amherst Co-operative Creamery.
Fort River Creamery of Amherst.
Leominster Creamery.
Echo Farm Dairy of South Framingham.
Fitchburg Creamery.
Boston Dairy Company of Gardner.
James Lawrence Creamery of Groton.
Este Creamery of Marlborough.
F. D. Shove Creamery of West Stockbridge.
Wachusett Creamery of Worcester.
Worcester Dairy Company.

The following is a list of the most important creameries and milk depots now in operation: —

1. *Creameries.*

Location.	Name.	President or Manager.
Amherst, ...	Amherst Co-operative, .	F. J. Humphrey, agent.
Amherst, ...	Fort River, ...	E. A. King.
Ashfield, ...	Ashfield Co-operative, .	G. G. Henry, manager.
Belchertown, . . .	Belchertown Co-operative,	M. G. Ward, president.
Cheshire (P. O. Adams), .	Greylock Co-operative, .	C. J. Fales, president.
Cheshire, ...	Highland, ...	C. W. Prince.
Cheshire, ...	West Shore, ...	S. W. Curtis.
Cummington, . . .	Cummington Co-operative,	W. E. Partridge, manager.
Easthampton, . . .	Hampton Co-operative, .	W. A. Wright, superintendent.
Egremont (P. O. North Egremont).	Egremont Co-operative, .	H. O. Harrington, manager.
Heath, ...	Cold Spring, ...	I. W. Stetson & Son.
Hinsdale, ...	Hinsdale Creamery Company.	W. C. Solomon, manager.
Lee, ...	Lee Co-operative, . .	P. A. Agnew, manager.
Leominster, ...	Leominster, ...	G. S. Wass & Co.
Montague, ...	Montague Creamery, . .	F. A. Rist, manager.
Monterey, ...	Berkshire Hills Co-operative.	D. A. Campbell, manager.
New Salem (P. O. Millington).	New Salem Co-operative, .	W. A. Moore, superintendent.
North Brookfield, . .	North Brookfield, . .	H. A. Richardson.
Northfield, ...	Northfield Co-operative, .	L. R. Smith, superintendent.
Orange (P. O. North Orange).	Orange Co-operative, . .	C. E. Dunbar, manager.
Sandisfield (P. O. New Boston).	Berkshire Co-operative, .	L. A. Bonnel, manager.
Shelburne, ...	Shelburne, ...	C. Williams, manager.
Uxbridge, ...	Farnum's Dairy, . . .	Geo. Farnum.
Warren, ...	Worcester County, . .	Gustal Hallberg, manager.
Westfield, ...	Wyben Spring Co-operative.	C. H. Wolcott, manager.
West Newbury, . . .	West Newbury Co-operative.	R. S. Brown, manager.
Williamsburg, . . .	Williamsburg Co-operative,	D. T. Clark, manager.
Worthington (P. O. Ringville).	Worthington Co-operative,	M. R. Bates, superintendent.

2. *Milk Depots.*

Location.	Name.	President or Manager.
Beverly,	Cherry Hill Farm,	Henry Fielden, superintendent.
Boston (P. O. Roxbury),	Alden Bros.,	
Boston (P. O. Charlestown).	Boston Dairy Company,	W. A. Graustein, president.
Boston (P. O. Charlestown).	H. P. Hood & Sons,	
Boston,	Walker-Gordon Laboratory.	R. A. Hubbard, manager.
Boston (P. O. Charlestown).	D. Whiting & Sons,	Geo. Whiting, manager.
Cambridge,	C. Brigham Company,	J. R. Blair, superintendent.
Conway,	Boston Dairy Company,	C. P. Hassel, manager.
Everett,	N. E. Dairy Company,	F. H. Adams, manager.
Framingham (P. O. South Framingham).	Echo Farm Dairy,	J. Turner.
Fitchburg,	Fitchburg Creamery,	G. S. Learned.
Gardner,	Boston Dairy Company,	W. Fitzsimmons, manager.
Groton,	Lawrence Creamery,	M. P. Swallow, manager.
Lynn,	H. P. Hood & Sons,	E. W. Park, manager.
Marlborough,	Este's Creamery,	F. S. Este.
North Adams,	W. H. Freeman Company,	W. G. McKay, manager.
Sheffield,	Willow Brook Dairy,	G. W. Patterson, manager.
Southborough,	Deerfoot Farm Dairy,	S. H. Howes, superintendent.
Springfield,	Springfield Co-operative Milk Association.	F. B. Allen, manager.
Springfield,	Tait Bros.,	H. J. Tait, president.
West Stockbridge,	F. D. Shove Creamery,	C. E. Hardy, manager.
Worcester,	Wachusett Creamery,	E. H. Thayer & Co.
Worcester,	Worcester Dairy Company,	G. R. Bryant, manager.

The Testing of Pure-bred Cows.

Breeders of Jersey and Guernsey cows in Massachusetts continue to make yearly milk and butter fat tests of their stock under the rules of their respective national cattle clubs. This division of the station assists in the work by furnishing reputable parties who monthly visit each herd where tests are in progress, weigh each milking during twenty-four or forty-eight hours, and test the same by the Babcock for the butter fat percentage. The cost of such work consists of the tester's time at $2 to $2.50 a day, together with his travelling expenses, board and breakage. The station receives its pay from the Jersey or Guernsey clubs. There have been completed during the year 24 Guernsey and 38 Jersey records, and at present there are 8 Guernseys and 32 Jerseys undergoing yearly tests. Tests are likewise being conducted for the National Holstein-Friesian Association. These are mostly seven-day tests for milk and butter fat. Occasionally breeders test their animals for thirty and even ninety days. The test of the Holstein cow De Kol Creamelle No. 59158, belonging to Mr. D. W. Field, which yielded in one hundred days 10,017 pounds of milk containing 284.088 pounds of fat, was made by Mr. A. D. Guiel of this station. During the year 72 Holsteins have been tested, requiring the services of five men at different times during the year. The station does not publish the results obtained, but reports the same to the several cattle clubs, and keeps a duplicate record on file. It must be understood that the making of appointments for tests, the furnishing of apparatus, the securing of the necessary competent men and the verifying of the results require considerable time and thought, and necessarily interfere with the other work of this department.

Work completed.

Molasses. — There has been completed a repeated experiment with Porto Rico molasses as a food for dairy stock. Digestion tests have likewise been made, in which it is shown that molasses depresses the digestibility of the other foods with which it is fed. The entire results will be published in bulletin form. Porto Rico molasses contains some 1,100 to 1,150 pounds of digestible matter to the ton, and has about 80 per cent. of the nutritive value of corn meal.

Digestion Experiments with Sheep. — A large number of digestion experiments have been completed with sheep, and are published as Part II. of this report. Among the feeds tested may be mentioned sorghum fodder, Green Diamond sugar feed, different amounts of molasses, red and white wheats and feed barley.

The Physiological and Economical Value of Protein in Milk Secretion. — Three experiments have been completed concerning the protein requirements of dairy cows, and it is intended to publish the results in the next annual report. It was not possible to collate the data and prepare the same for publication in time for the present report.

Work in Progress.

Alfalfa Meal. — An experiment is at present in progress to study the value of alfalfa meal as a substitute for wheat bran in milk production. It is understood to be the intention of feed jobbers in the near future to place alfalfa meal upon the market in liberal quantities as a competitor of bran, claiming it to be equal in feeding value and superior in its effect upon the general health and condition of the animal. The indications are that these claims cannot be fully substantiated.

The Effect of Molasses upon the Digestibility of Other Feed Stuffs. — German investigators have long since established the fact that the addition of considerable quantities of starch, sugar and roots depresses the digestibility of the other feeds entering into the composition of the ration. In our previous studies with Porto Rico molasses, as published elsewhere in this report, it has been shown that when molasses constituted some 25 per cent. of the dry matter of the ration, a depression of some 15 per cent. was caused in the digestibility of the latter. Other experiments are now in progress to note if smaller quantities of molasses (10 per cent. of the dry matter of the total ration) will cause relatively as large a depression as twice and thrice that amount.

The Digestibility of Proprietary Grain Rations. — Numerous grain mixtures are now upon the market as ready rations for dairy stock. The station is ascertaining the composition and particularly the digestibility of these rations as compared with home mixtures that the dairymen can prepare by purchasing the high-grade concentrates to be had in all local markets. It is believed that most of these proprietary mixtures are not as economical nor as efficient for milk production as the home mixtures.

Early Amber Sorghum. — The station has continued its observations with this plant as a summer forage crop. Different seedsmen report anywhere from 50 to 100 pounds of seed to be necessary for an acre when sown broadcast. Three twentieth-acre plots were fertilized alike, and the sorghum sown broadcast at the rate of 100, 80 and 60 pounds to the acre. The yields were nearly identical in each case, being at the rate of 20 tons of green material to the acre (harvested September 3). On another twentieth-acre plot the seed was drilled in at the rate of 15 pounds to the acre, and a yield of 19 tons to the acre was secured. This plot, however, was very weedy, and it was not possible to separate the weeds from the sorghum before weighing the crop. It is evident that when sown broadcast (which appeared to be the most economical way for forage purposes) much less seed is required to the acre than is ordinarily recommended. It is intended to repeat these trials with smaller quantities of seed.

Alfalfa. — Observations have been continued on alfalfa as a forage crop. A small piece seeded in the spring of 1905 came through the winter in good condition, and yielded three crops the present season, aggregating 3.65 tons of hay to the acre (figured at 15 per cent. moisture). Cuttings were made June 25, August 3 and September 2. A growth of six or more inches has been allowed to remain as a mulch during the winter.

A second piece, one-sixth of an acre in area, on which alfalfa had been for two years previously, but which had run out, was plowed in the spring of 1906, manured at the rate of 6 cords to the acre, limed with burnt lime at the rate of 1 ton to the acre, a fine seed bed made, and seeded with seed procured from F. E. Dawley, Fayetteville, N. Y. (locally known as Stillwell seed), and a light seeding of oats (3/4 bushel to the acre). The seed came up well, and the combined alfalfa and oats were cut during July for forage. A second cutting was made in September. A third growth of six inches has been left as a mulch. It remains to be seen if this piece as well as the other above mentioned will withstand the present winter, and continue to grow without being replaced by clover and grasses. A fuller report will be made later.

Leaming v. Pride of the North Corn. — The comparative values of these two standard varieties are being studied, to ascertain if one has any particular advantage over the other for grain and silage purposes. Accurate determinations of composition and total yields, as well as of composition and yields of stalk, leaves, husks, grain and cob, have been made. The digestibility of the two varieties has also been determined. The experiment will be repeated if necessary during the season of 1907, and the completed data published as soon as possible thereafter.

Clover. — Clover was seeded together with peas and oats, barnyard millet and sorghum the present season, to see if it would not develop after these crops had been removed for soiling. If such were the case, it would save plowing and replanting, and the ground would be immediately occupied by another valuable forage crop. The clover came up well in all cases, but naturally was outstripped by the more rapidly growing annuals. After the three seedings of peas and oats had been successively cut, the clover began to grow; but a considerable growth of weeds and wild grasses also appeared, so that the heavy cutting which was made about the middle of September contained rather more grass than clover. It is possible that the clover will come in well in the spring. The millet and the sorghum grew so dense that the clover was nearly all killed out, hence it did not appear practicable to attempt its growth with such forage crops.

Changes in Staff.

Mr. S. R. Parker, who was employed for two years as dairy tester, resigned June 1, to accept a position as superintendent of agriculture at the Kamehameha Schools, Honolulu, H. T. His place was temporarily filled by the appointment of Mr. J. G. Cook, and later by Mr. H. A. Parsons, who at present fills the position most acceptably. On August 1 Mr. Cook resigned, to take the position of superintendent of the farm connected with the State Asylum for the Insane at Northampton. Mr. A. C. Whittier, who so acceptably filled the position of assistant chemist during one year, severed his connection with this division July 1, to accept a similar and more lucrative position with the Maine Experiment Station. This position was filled by the appointment of Mr. L. S. Walker, a graduate of the college in 1905. Mr. F. G. Helyar, inspector of feeds and of Babcock machines, resigned October 1, to take charge of the agricultural department connected with Mt. Hermon School, Northfield, Mass. Mr. W. K. Hepburn has been appointed to succeed him. While the writer is always pleased to see the young men connected with this division called to more responsible positions, it must be acknowledged that such changes seriously interfere with the work of the station. As a rule, it is believed it would be better economy to pay larger salaries, and retain the services of those who have proved themselves efficient workers.

Part II. — Work in Animal Nutrition.

J. B. LINDSEY, E. B. HOLLAND AND P. H. SMITH.

The Digestibility of Cattle Foods.

The digestion experiments herein reported were made during the autumn, winter and early spring of 1904–05 and 1905–06, and are known as Series X and XI. The usual method was employed, an illustrated description of which is to be found in the eleventh report of the Massachusetts Experiment Station. The full data are here presented, with the exception of the daily production of manure and the daily water consumption, in which cases, to economize space, averages only are given. The periods extended over fourteen days, the first seven of which were preliminary, collection of fæces being made during the last seven. Ten grams of salt were given each sheep daily, with water *ad libitum.* Three lots of Southdown wethers were employed in the several trials, and were known as the Old Sheep, Young Sheep, and Paige Sheep. The former were fully six years of age, and the latter two lots three to four years.

Series X.

The results obtained in this series on the whole can be pronounced satisfactory. In periods I., II., III. and IV. the same hay was used as in the year preceding, and the digestion coefficients employed in calculating the results of these several periods were as follows: [1] —

[1] See also seventeenth report of this station, page 46.

	Old Sheep II. and III.	Young Sheep I.	Young Sheep II.	Young Sheep III.
Dry matter,	58.50	49.89	54.34	51.53
Ash,	22.00	13.86	22.60	16.55
Protein,	42.50	37.37	37.72	36.36
Fiber,	61.00	49.98	55.85	53.13
Nitrogen-free extract,	64.00	56.29	59.77	57.02
Fat,	46.50	38.24	44.19	36.97

In all of the remaining periods a new lot of hay was used, and the following coefficients were employed, being the average of those secured for each group of sheep: —

	Old Sheep.	Young Sheep.	Paige Sheep.
Dry matter,	60.72	57.07	57.98
Ash,	45.50	43.64	40.52
Protein,	53.69	47.37	53.61
Fiber,	63.79	57.55	59.06
Nitrogen-free extract,	63.08	61.11	61.41
Fat,	50.24	51.71	47.76

The composition of the old hay used in the first four periods was taken to be the same as was shown by the two analyses made in the preceding year. The composition of the new hay represents the average of three analyses. The average of the several analyses follows: —

	Old Hay, 1903–04.	New Hay, 1904–05.
Ash,	6.44	8.20
Protein,	6.24	8.69
Fiber,	32.48	32.14
Nitrogen-free extract,	52.70	48.56
Fat,	2.14	2.41

Composition of Feed Stuffs (Per Cent.).

[Dry Matter.]

Feeds.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.
Soy bean fodder,	9.17	21.69	27.83	37.75	3.56
Blomo feed,	10.73	17.23	13.14	58.28	0.62
Malt sprouts,	6.58	28.65	15.29	47.70	1.78
Sucrene dairy feed,	6.17	18.48	14.11	56.95	4.29
Holstein sugar feed,	7.31	13.73	10.88	65.14	2.94
Macon sugar feed,	6.83	15.16	10.20	66.11	1.70
Hominy feed,	2.78	11.59	5.28	71.54	8.81
Buckwheat middlings,	4.82	28.23	8.95	50.61	7.39
Oat middlings,	2.61	17.72	2.56	69.47	7.64
Eureka silage corn stover,	6.96	8.00	36.49	47.16	1.39
Waste Eureka silage corn stover, Sheep II.,	8.50	6.71	41.89	41.89	1.01
Waste Eureka silage corn stover, Sheep III.,	7.45	6.02	42.84	42.48	1.21
Pride of the North corn stover,	6.77	7.23	34.45	50.01	1.54
Waste Pride of the North corn stover, Sheep II.	7.64	4.27	40.94	45.65	1.50
Waste Pride of the North corn stover, Sheep III.	6.88	3.76	40.74	47.14	1.48
Digestion hay fed to Paige Sheep IV.,	7.82	8.56	32.35	48.75	2.52
Digestion hay fed to Young Sheep,	8.43	8.70	32.17	48.33	2.37
Digestion hay fed to Old Sheep and Paige Sheep V.	8.35	8.80	31.89	48.62	2.34
Average for digestion hay (three trials),	8.20	8.69	32.14	48.56	2.41

Composition of Fæces (Per Cent.).

[Dry Matter.]

Old Sheep II.

Periods.	Feeds.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.
II.,	Blomo feed,	15.41	11.93	25.59	44.81	2.26
IV.,	Sucrene feed,	11.92	12.32	26.50	47.05	2.21
V.,	Eureka silage corn stover,	7.96	8.75	34.10	48.16	1.03
VII.,	Pride of the North corn stover,	9.54	8.81	30.27	50.17	1.21
IX.,	Digestion hay,	11.48	10.22	29.56	45.71	3.03
XI.,	Macon sugar feed,	13.17	12.90	27.09	44.26	2.58

Composition of Fæces (Per Cent.) — Concluded.

Old Sheep III.

Periods.	Feeds.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.
II.,	Blomo feed,	16.33	13.38	23.99	43.92	2.38
IV.,	Sucrene feed,	12.53	13.04	24.84	47.34	2.25
V.,	Eureka silage corn stover,	8.67	9.73	30.51	50.05	1.04
VII.,	Pride of the North corn stover,	10.62	9.41	27.95	50.84	1.18
IX.,	Digestion hay,	11.68	10.52	29.23	45.67	2.90
XI.,	Macon sugar feed,	13.57	13.75	26.40	43.90	2.38

Young Sheep I.

Periods.	Feeds.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.
I.,	Soy bean fodder,	13.22	10.02	36.33	37.43	3.00
III.,	Malt sprouts,	12.97	11.19	27.80	45.42	2.62
VIII.,	Digestion hay,	10.92	10.26	32.09	44.01	2.72
X.,	Holstein sugar feed,	13.10	12.80	28.36	43.50	2.24
XIII.,	Buckwheat middlings,	11.52	11.74	32.08	41.79	2.87

Young Sheep II.

Periods.	Feeds.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.
I.,	Soy bean fodder,	13.19	10.36	36.24	37.20	3.01
III.,	Malt sprouts,	13.11	11.72	26.74	45.93	2.50
VIII.,	Digestion hay,	11.57	11.18	30.46	44.06	2.73
X.,	Holstein sugar feed,	13.06	12.80	27.49	44.32	2.33
XIII.,	Buckwheat middlings,	11.23	12.84	31.65	41.58	2.70

Young Sheep III.

Periods.	Feeds.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.
I.,	Soy bean fodder,	13.40	9.72	36.36	37.64	2.88
III.,	Malt sprouts,	12.93	11.20	28.13	45.28	2.46
VIII.,	Digestion hay,	10.75	10.60	32.81	43.29	2.55
X.,	Holstein sugar feed,	11.65	11.42	30.23	44.41	2.29
XIII.,	Buckwheat middlings,	10.62	11.31	32.98	42.26	2.83

Paige Sheep IV.

Periods.	Feeds.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.
VI.,	Digestion hay,	11.61	9.90	30.66	44.91	2.92
XII.,	Hominy feed,	12.17	12.75	27.63	43.68	3.77
XIV.,	Oat middlings,	12.52	12.52	28.81	42.82	3.33

Paige Sheep V.

Periods.	Feeds.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.
IX.,	Digestion hay,	11.23	9.24	31.93	44.49	3.11
XII.,	Hominy feed,	11.02	11.69	28.64	44.93	3.72
XIV.,	Oat middlings,	11.81	12.39	29.35	43.31	3.14

Dry Matter Determinations made at Time of weighing out the Different Foods, and Dry Matter in Manure excreted, determined from Air-dry Fæces (Per Cent.).

Old Sheep II.

Periods.	English Hay.	Blomo Feed.	Sucrene Feed.	Eureka Silage Corn Stover.	Pride of the North Corn Stover.	Macon Sugar Feed.	Waste.	Fæces.
II., . .	87.70	81.77	–	–	–	–	–	91.35
IV., . .	87.35	–	86.87	–	–	–	–	93.61
V., . .	–	–	–	37.11	–	–	43.15	94.16
VII., . .	–	–	–	–	81.87	–	88.89	94.22
IX., . .	89.77	–	–	–	–	–	–	95.03
XI., . .	90.30	–	–	–	–	94.45	–	93.96

Old Sheep III.

II., . .	87.70	81.77	–	–	–	–	–	91.42
IV., . .	87.35	–	86.87	–	–	–	–	93.64
V., . .	–	–	–	37.11	–	–	45.63	93.96
VII., . .	–	–	–	–	81.87	–	85.63	94.03
IX., . .	89.77	–	–	–	–	–	–	94.84
XI., . .	90.30	–	–	–	–	94.45	–	93.57

Dry Matter Determinations, etc. — Continued.

Young Sheep I.

Periods.	English Hay.	Soy Bean Fodder.	Malt Sprouts.	Holstein Sugar Feed.	Buckwheat Middlings.	Waste.	Fæces.
I., ...	88.40	20.64	–	–	–	–	89.51
III., . . .	88.02	–	84.68	–	–	–	93.09
VIII., . . .	88.52	–	–	–	–	–	93.97
X., . . .	89.90	–	–	91.66	–	–	94.15
XIII., . . .	90.55	–	–	–	90.74	–	94.40

Young Sheep II.

I., ...	88.40	20.64	–	–	–	–	89.44
III., . . .	88.02	–	84.68	–	–	–	92.93
VIII., . . .	88.52	–	–	–	–	–	94.01
X., . . .	89.90	–	–	91.66	–	–	94.19
XIII., . . .	90.55	–	–	–	90.74	–	93.91

Dry Matter Determinations, etc. — Continued.

Young Sheep III.

Periods.	English Hay.	Soy Bean Fodder.	Malt Sprouts.	Holstein Sugar Feed.	Buckwheat Middlings.	Waste.	Fæces.
I., ...	88.40	20.64	-	-	-	-	89.54
IV., ...	88.02	-	84.68	-	-	-	93.13
VIII., ...	88.52	-	-	-	-	-	93.91
X., ...	89.90	-	-	91.66	-	-	94.35
XIII., ...	90.55	-	-	-	90.74	-	94.28

Dry Matter Determinations, etc. — Concluded.

Paige Sheep IV.

Periods.	English Hay.	Hominy Feed.	Oat Middlings.	Waste.	Fæces.
VI., ...	88.35	-	-	-	93.35
XII., ...	90.62	90.94	-	-	94.09
XIV., ...	90.45	-	91.07	-	93.73
Paige Sheep V.					
IX., ...	89.77	-	-	-	95.08
XII., ...	90.62	90.94	-	-	94.20
XIV., ...	90.45	-	91.07	-	93.52

Average Daily Amount of Manure excreted and Water drank (Grams).

Old Sheep II.

Periods.	Character of Ration.	Manure excreted daily.	Sample Air Dry.	Water drank daily.
II.,	Blomo feed, ...	671	32.80	1,306
IV.,	Sucrene feed, ...	751	31.15	1,144
V.,	Eureka silage corn stover, ...	765	31.07	lost.
VII.,	Pride of the North corn stover, . . .	1,058	37.63	1,667
IX.,	Digestion hay, ...	775	32.54	1,643
XI.,	Macon sugar feed, ...	739	31.99	1,592
	Old Sheep III.			
II.,	Blomo feed, ...	675	30.83	1,578
IV.,	Sucrene feed, ...	867	32.31	1,606
V.,	Eureka silage corn stover, ...	921	28.91	804
VII.,	Pride of the North corn stover, . . .	1,123	34.40	2,500
IX.,	Digestion hay, ...	1,107	34.30	2,430
XI.,	Macon sugar feed, ...	1,155	31.21	2,227

Average Daily Amount of Manure excreted and Water drank (Grams) — Concluded.

Young Sheep I.

Periods.	Character of Ration.	Manure excreted daily.	Sample Air Dry.	Water drank daily.
I.,	Soy bean fodder, ...	615	30.28	188
III.,	Malt sprouts, ...	870	30.43	1,392
VIII.,	Digestion hay, ...	961	33.17	1,693
X.,	Holstein sugar feed, ...	1,008	29.21	1,608
XIII.,	Buckwheat middlings, ...	743	28.62	1,689

Young Sheep II.

Periods.	Character of Ration.	Manure excreted daily.	Sample Air Dry.	Water drank daily.
I.,	Soy bean fodder, ...	573	30.70	1,169
III.,	Malt sprouts, ...	746	30.48	2,334
VIII.,	Digestion hay, ...	984	30.86	2,471
X.,	Holstein sugar feed, ...	868	28.04	2,249
XIII.,	Buckwheat middlings, ...	882	27.91	2,410

Young Sheep III.

Periods.	Character of Ration.	Manure excreted daily.	Sample Air Dry.	Water drank daily.
I.,	Soy bean fodder, ...	638	32.68	1,666
III.,	Malt sprouts, ...	791	30.86	2,486
VIII.,	Digestion hay, ...	1,152	33.02	2,500
X.,	Holstein sugar feed, ...	743	29.30	2,335
XIII.,	Buckwheat middlings, ...	699	29.59	2,486

Paige Sheep IV.

Periods.	Character of Ration.	Manure excreted daily.	Sample Air Dry.	Water drank daily.
VI.,	Digestion hay, ...	678	32.15	1,138
IX.,	Digestion hay, ...	-	-	-
XII.,	Hominy feed, ...	596	25.37	1,901
XIV.,	Oat middlings, ...	598	24.85	1,924

Paige Sheep V.

Periods.	Character of Ration.	Manure excreted daily.	Sample Air Dry.	Water drank daily.
VI.,	Digestion hay, ...	-	-	-
IX.,	Digestion hay, ...	699	31.41	1,924
XII.,	Hominy feed, ...	630	26.31	1,666
XIV.,	Oat middlings, ...	661	25.85	1,814

Weights of Animals at Beginning and End of Period (Pounds).

Old Sheep II.

Periods.	Character of Ration.	Beginning.	End.
II.,	Blomo feed,	154.75	152.00
IV.,	Sucrene feed,	156.50	157.75
V.,	Eureka silage corn stover,	156.50	154.00
VII.,	Pride of the North corn stover,	154.50	157.00
IX.,	Digestion hay,	158.25	157.25
XI.,	Macon sugar feed,	160.00	157.75

Old Sheep III.

II.,	Blomo feed,	163.00	160.00
IV.,	Sucrene feed,	164.25	162.25
V.,	Eureka silage corn stover,	163.25	163.00
VII.,	Pride of the North corn stover,	164.50	161.00
IX.,	Digestion hay,	167.00	165.25
XI.,	Macon sugar feed,	164.00	164.25

Young Sheep I.

I.,	Soy bean fodder,	101.50	99.75
III.,	Malt sprouts,	109.50	109.75
VIII.,	Digestion hay,	120.00	116.00
X.,	Holstein sugar feed,	116.00	114.25
XIII.,	Buckwheat middlings,	113.00	114.00

Young Sheep II.

I.,	Soy bean fodder,	102.50	101.00
III.,	Malt sprouts,	110.50	108.50
VIII.,	Digestion hay,	122.00	120.00
X.,	Holstein sugar feed,	115.75	116.00
XIII.,	Buckwheat middlings,	115.25	116.00

Young Sheep III.

I.,	Soy bean fodder,	97.00	95.75
III.,	Malt sprouts,	102.25	101.50
VIII.,	Digestion hay,	111.00	107.50
X.,	Holstein sugar feed,	106.00	106.00
XIII.,	Buckwheat middlings,	106.50	106.50

Weights of Animals, etc. — Concluded.

Paige Sheep IV.

Periods.	Character of Ration.	Beginning.	End.
VI.,	Digestion hay,	156.00	155.50
IX.,	Digestion hay,	–	–
XII.,	Hominy feed,	154.50	152.00
XIV.,	Oat middlings,	155.50	155.00

Paige Sheep V.

Periods.	Character of Ration.	Beginning.	End.
VI.,	Digestion hay,	–	–
IX.,	Digestion hay,	133.25	137.75
XII.,	Hominy feed,	140.00	140.25
XIV.,	Oat middlings,	141.00	143.25

Period I.

Young Sheep I.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
350 grams English hay fed,	309.40	19.93	19.31	100.49	163.05	6.62
1,800 grains soy bean fodder fed,	371.52	34.07	80.58	103.39	140.25	13.23
Amount consumed,	680.92	54.00	99.89	203.88	303.30	19.85
302.84 grams manure excreted,	271.07	35.84	27.16	98.48	101.46	8.13
Grams digested,	409.85	18.16	72.73	105.40	201.84	11.72
Minus hay digested,	154.36	2.76	7.22	50.22	91.78	2.55
Soy bean fodder digested,	255.49	15.40	65.51	55.18	110.06	9.17
Per cent. digested,	68.77	45.20	81.30	53.37	78.47	69.31

Young Sheep II.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Amount consumed as above,	680.92	54.00	99.89	203.88	303.30	19.85
307.13 grams manure excreted,	274.70	36.23	28.46	99.55	102.19	8.27
Grams digested,	406.22	17.77	71.43	104.33	201.11	11.58
Minus hay digested,	168.13	4.50	7.28	56.12	97.45	2.93
Soy bean fodder digested,	238.09	13.27	64.15	48.21	103.66	8.65
Per cent. digested,	64.09	38.95	79.61	46.63	73.91	65.38

Period I. — Concluded.

Young Sheep III.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Amount consumed as above, . . .	680.92	54.00	99.89	203.88	303.30	19.85
326.78 grams manure excreted, . .	292.60	39.21	28.44	106.39	110.13	8.43
Grams digested, ...	388.32	14.79	71.45	97.49	193.17	11.42
Minus hay digested, ...	159.43	3.30	7.08	53.39	92.97	2.45
Soy bean fodder digested, . . .	228.89	11.49	64.37	44.10	100.20	8.97
Per cent. digested, ...	61.61	33.72	79.88	42.65	71.44	67.80
Average per cent. three sheep digested,	64.82	39.29	80.26	47.55	74.61	67.50

Average nutritive ratio of rations for three sheep, 1:4.54.

Period II.

Old Sheep II.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
500 grams English hay fed, . . .	438.50	28.24	27.36	142.42	231.09	9.38
400 grams Blomo feed fed, . . .	327.08	35.10	56.36	42.98	190.62	2.03
Amount consumed, ...	765.58	63.34	83.72	185.40	421.71	11.41
328.04 grams manure excreted, . .	299.66	46.18	35.75	76.68	134.28	6.77
Grams digested, ...	465.92	17.16	47.97	108.72	287.43	4.64
Minus hay digested, ...	256.52	6.21	11.63	86.88	147.90	4.36
Blomo feed digested, ...	209.40	10.95	36.34	21.84	139.53	.28
Per cent. digested, ...	64.02	31.20	64.48	50.81	73.20	13.79

Old Sheep III.

Amount consumed as above, . . .	765.58	63.34	83.72	185.40	421.71	11.41
308.33 grams manure excreted, . .	281.88	46.03	37.72	67.62	123.80	6.71
Grams digested, ...	483.70	17.31	46.00	117.78	297.91	4.70
Minus hay digested, ...	256.52	6.21	11.63	86.88	147.90	4.36
Blomo feed digested, ...	227.18	11.10	34.37	30.90	150.01	.34
Per cent. digested, ...	69.46	31.62	60.98	71.89	78.70	16.75
Average per cent. two sheep digested,	66.74	31.41	62.73	61.35	75.95	15.27

Average nutritive ratio of rations for two sheep, 1:8.86.

Period III.

Young Sheep I.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
600 grams English hay fed,	528.12	34.01	32.95	171.53	278.32	11.30
200 grams malt sprouts fed,	169.36	11.14	48.52	25.90	80.78	3.01
Amount consumed,	697.48	45.15	81.47	197.43	359.10	14.31
304.24 grams manure excreted,	283.22	36.73	31.69	78.74	128.64	7.42
Grams digested,	414.26	8.42	49.78	118.69	230.46	6.89
Minus hay digested,	263.48	4.71	12.31	85.73	156.67	4.32
Malt sprouts digested,	150.78	3.71	37.47	32.96	73.79	2.57
Per cent. digested,	89.03	33.30	77.23	100+	91.35	85.38

Young Sheep II.

Amount consumed as above,	697.48	45.15	81.47	197.43	359.10	14.31
304.81 grams manure excreted,	283.26	37.14	33.20	75.74	130.10	7.08
Grams digested,	414.22	8.01	48.27	121.69	229.00	7.23
Minus hay digested,	286.98	7.69	12.43	95.80	166.35	4.99
Malt sprouts digested,	127.24	.32	35.84	25.89	62.65	2.24
Per cent. digested,	75.13	2.87	73.87	100.00	77.56	74.42

Young Sheep III.

Amount consumed as above,	697.48	45.15	81.47	197.43	359.10	14.31
308.60 grams manure excreted,	287.40	37.16	32.19	80.85	130.13	7.07
Grams digested,	410.08	7.99	49.28	116.56	228.97	7.24
Minus hay digested,	272.14	5.63	12.08	91.13	158.70	4.18
Malt sprouts digested,	137.94	2.36	37.20	25.45	70.27	3.06
Per cent. digested,	81.45	21.18	76.67	98.26	86.99	100+
Average per cent. three sheep digested,	81.87	19.12	75.92	99.42	85.30	86.60

Average nutritive ratio of rations for three sheep, 1:7.42.

Period IV.

Old Sheep II.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
600 grams English hay fed,	524.10	33.75	32.70	170.23	276.20	11.22
300 grams Sucrene dairy feed fed,	260.61	16.08	48.16	36.77	148.42	11.18
Amount consumed,	784.71	49.83	80.86	207.00	424.62	22.40
311.47 grams manure excreted,	291.57	34.76	35.92	77.27	137.18	6.44
Grams digested,	493.14	15.07	44.94	129.73	287.44	15.96
Minus hay digested,	306.60	7.43	13.90	103.84	176.77	5.22
Sucrene dairy feed digested,	186.54	7.64	31.04	25.89	110.67	10.74
Per cent. digested,	71.58	47.51	64.45	70.41	74.57	96.06

Old Sheep III.

Amount consumed as above,	784.71	49.83	80.86	207.00	424.62	22.40
323.07 grams manure excreted,	302.52	37.91	39.45	75.15	143.21	6.81
Grams digested,	482.19	11.92	41.41	131.85	281.41	15.59
Minus hay digested,	306.60	7.43	13.90	103.84	176.77	5.22
Sucrene dairy feed digested,	175.59	4.49	27.51	27.01	104.64	10.37
Per cent. digested,	67.38	27.92	57.12	73.46	70.50	92.75
Average per cent. two sheep digested,	69.48	37.72	60.79	71.94	72.54	94.41

Average nutritive ratio of rations for two sheep, 1:10.4.

Period V.

Old Sheep II.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
1,800 grams Eureka silage corn stover,	667.98	46.49	53.44	243.75	315.02	9.28
Minus 89 grams waste,	38.40	3.26	2.58	16.09	16.09	.38
Amount consumed,	629.58	43.23	50.86	227.66	298.93	8.90
310.74 grams manure excreted,	292.59	23.29	25.60	99.77	140.91	3.01
Grams digested,	336.99	19.94	25.26	129.89	158.02	5.89
Per cent. digested,	53.53	46.13	49.67	56.18	52.86	66.18

Period V. — Concluded.

Old Sheep III.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
1,800 grams Eureka silage corn stover,	667.98	46.49	53.44	243.75	315.02	9.28
Minus 133.20 grams waste, . . .	60.78	4.53	3.66	26.04	25.82	0.74
Amount consumed, ...	607.20	41.96	49.78	217.71	289.20	8.54
289.07 grams manure excreted, . .	271.61	23.55	26.43	82.87	135.94	2.82
Grams digested, ...	335.59	18.41	23.35	134.84	153.26	5.72
Per cent. digested, ...	55.27	43.88	46.91	61.94	52.99	66.98
Average per cent. two sheep digested,	54.40	45.01	48.29	59.06	52.93	66.58

Average nutritive ratio of rations for two sheep, 1: 12.3.

Period VI.

Paige Sheep IV.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
800 grams English hay fed, . . .	706.80	55.27	60.50	228.65	344.57	17.81
321.50 grams manure excreted, . .	300.12	34.84	29.71	92.02	134.78	8.76
Grams digested, ...	406.68	20.43	30.79	136.63	209.79	9.05
Per cent. digested, ...	57.54	36.96	50.89	59.76	60.88	50.81

Nutritive ratio of ration, 1: 11.9.

Period VII.

Old Sheep II.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
1,000 grams Pride of the North corn stover.	818.70	55.43	59.19	282.04	409.43	12.61
Minus 74.64 grams waste, . . .	66.35	5.07	2.83	27.16	30.29	1.00
Amount consumed, ...	752.35	50.36	56.36	254.88	379.14	11.61
376.31 grams manure excreted, . .	354.56	33.83	31.24	107.33	177.88	4.29
Grams digested, ...	397.79	16.53	25.12	147.55	201.26	7.32
Per cent. digested, ...	52.87	32.82	44.57	57.89	53.08	63.05

Period VII. — Concluded.

Old Sheep III.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
1,000 grams Pride of the North corn stover.	818.70	55.43	59.19	282.04	409.43	12.61
Minus 115.45 grams waste, . . .	98.86	6.80	3.72	40.28	46.60	1.46
Amount consumed, ...	719.84	48.63	55.47	241.76	362.83	11.15
344.01 grams manure excreted, . .	323.47	34.35	30.44	90.41	164.45	3.82
Grams digested, ...	396.37	14.28	25.03	151.35	198.38	7.33
Per cent. digested, ...	55.06	29.36	45.12	62.60	54.68	65.75
Average per cent. two sheep digested,	53.97	31.09	44.85	60.25	53.88	64.40

Average nutritive ratio of rations for two sheep, 1:14.6.

Period VIII.

Young Sheep I.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
800 grams English hay fed, . . .	708.16	59.70	61.61	227.82	342.25	16.78
331.74 grams manure excreted, . .	311.74	34.04	31.98	100.04	137.20	8.48
Grams digested, ...	396.42	25.66	29.63	127.78	205.05	8.30
Per cent. digested, ...	55.98	42.98	48.09	56.09	59.91	49.46

Young Sheep II.

800 grams English hay fed, . . .	708.16	59.70	61.61	227.82	342.25	16.78
308.60 grams manure excreted, . .	290.11	33.57	32.43	88.37	127.82	7.92
Grams digested, ...	418.05	26.13	29.18	139.45	214.43	8.86
Per cent. digested, ...	59.03	43.77	47.36	61.21	62.65	52.80

Young Sheep III.

800 grams English hay fed, . . .	708.16	59.70	61.61	227.82	342.25	16.78
330.18 grams manure excreted, . .	310.07	33.33	32.87	101.73	134.23	7.91
Grams digested, ...	398.09	26.37	28.74	126.09	208.02	8.87
Per cent. digested, ...	56.21	44.17	46.65	55.35	60.78	52.86
Average per cent. three sheep digested,	57.07	43.64	47.37	57.55	61.11	51.71

Average nutritive ratio of rations for three sheep, 1:12.3.

Period IX.

Old Sheep II.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
900 grams English hay fed,	807.93	67.46	71.10	257.65	392.82	18.91
325.43 grams manure excreted,	309.26	35.50	31.61	91.42	141.36	9.37
Grams digested,	498.67	31.96	39.49	166.23	251.46	9.54
Per cent. digested,	61.72	47.36	55.54	64.52	64.01	50.45

Old Sheep III.

900 grams English hay fed,	807.93	67.46	71.10	257.65	392.82	18.91
343 grams manure excreted,	325.30	38.00	34.22	95.09	148.56	9.43
Grams digested,	482.63	29.46	36.88	162.56	244.26	9.47
Per cent. digested,	59.74	43.67	51.87	63.09	62.18	50.08

Paige Sheep V.

800 grams English hay fed,	718.16	59.97	63.20	229.02	349.17	16.80
314.13 grams manure excreted,	298.67	33.54	27.60	95.37	132.88	9.29
Grams digested,	419.49	26.43	35.60	133.65	216.29	7.51
Per cent. digested,	58.41	44.07	56.33	58.36	61.94	44.70
Average per cent. three sheep digested,	60.73	45.52	53.71	63.81	63.10	50.27

Average nutritive ratio of rations for three sheep, 1:11.3.

Period X.

Young Sheep I.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
500 grams English hay fed,	449.50	36.86	39.06	144.47	218.28	10.83
300 grams Holstein sugar feed,	274.98	20.10	37.75	29.92	179.12	8.08
Amount consumed,	724.48	56.96	76.81	174.39	397.40	18.91
292.11 grams manure excreted,	275.02	36.03	35.20	78.00	119.63	6.16
Grams digested,	449.46	20.93	41.61	96.39	277.77	12.75
Minus hay digested,	256.53	16.09	18.50	83.14	133.39	5.60
Holstein sugar feed digested,	192.93	4.84	23.11	13.25	144.38	7.15
Per cent. digested,	70.16	24.08	61.22	44.28	80.61	88.49

Period X. — Concluded.

Young Sheep II.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Amount consumed as above, . . .	724.48	56.96	76.81	174.39	397.40	18.91
280.41 grams manure excreted, . .	264.12	34.49	33.81	72.61	117.06	6.15
Grams digested, ...	460.36	22.47	43.00	101.78	280.34	12.76
Minus hay digested, ...	256.53	16.09	18.50	83.14	133.39	5.60
Holstein sugar feed digested, . .	203.83	6.38	24.50	18.64	146.95	7.16
Per cent. digested, ...	74.13	31.74	64.90	62.30	82.04	88.61

Young Sheep III.

Amount consumed as above, . . .	724.48	56.96	76.81	174.39	397.40	18.91
293.03 grams manure excreted, . .	276.47	32.21	31.57	83.58	122.78	6.33
Grams digested, ...	448.01	24.75	45.24	90.81	274.62	12.58
Minus hay digested, ...	256.53	16.09	18.50	83.14	133.39	5.60
Holstein sugar feed digested, . .	191.48	8.66	26.74	7.67	141.23	6.98
Per cent. digested, ...	69.63	43.08	70.83	25.64	78.85	86.39
Average per cent. three sheep digested,	71.31	32.97	65.65	44.07	80.50	87.83

Average nutritive ratio of rations for three sheep, 1:9.3.

Period XI.

Old Sheep I.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
600 grams English hay fed, . . .	541.80	44.43	47.08	174.13	263.10	13.06
300 grams Macon sugar feed, . .	283.35	19.35	42.96	28.90	187.32	4.82
Amount consumed, ...	825.15	63.78	90.04	203.03	450.42	17.88
319.90 grams manure excreted, . .	300.58	39.59	38.77	81.43	133.04	7.75
Grams digested, ...	524.57	24.19	51.27	121.60	317.38	10.13
Minus hay digested, ...	328.98	20.22	25.28	111.08	165.96	6.56
Macon sugar feed digested, . . .	195.59	3.97	25.99	10.52	151.42	3.57
Per cent. digested, ...	69.03	20.52	60.50	36.40	80.83	74.07

Period XI. — Concluded.

Old Sheep III.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Amount consumed as above, . . .	825.15	63.78	90.04	203.03	450.42	17.88
312.14 grams manure excreted, . .	292.07	39.63	40.16	77.11	128.22	6.95
Grams digested, ...	533.08	24.15	49.88	125.92	322.20	10.93
Minus hay digested, ...	328.98	20.22	25.28	111.08	165.96	6.56
Macon sugar feed digested, . . .	204.10	3.93	24.60	14.84	156.24	4.37
Per cent. digested, ...	72.03	20.31	57.26	51.35	83.41	90.66
Average per cent. two sheep digested,	70.53	20.42	58.88	43.88	82.12	82.37

Average nutritive ratio of rations for two sheep, 1: 9.2.

Period XII.

Paige Sheep IV.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
550 grams English hay fed, . . .	498.41	40.87	43.31	160.19	242.03	12.01
300 grams hominy feed, ...	272.22	7.57	31.55	14.37	194.75	23.98
Amount consumed, ...	770.63	48.44	74.86	174.56	436.78	35.99
253.67 grams manure excreted, . .	238.68	29.05	30.43	65.95	104.26	9.00
Grams digested, ...	531.95	19.39	44.43	108.61	332.52	26.99
Minus hay digested, ...	288.98	16.56	23.22	94.61	148.63	5.74
Hominy feed digested, ...	242.97	2.83	21.21	14.00	183.89	21.25
Per cent. digested, ...	89.26	37.38	67.23	97.43	94.42	88.62

Paige Sheep V.

Amount consumed as above, . . .	770.63	48.44	74.86	174.56	436.78	35.99
263.07 grams manure excreted, . .	247.81	27.31	28.97	70.97	111.34	9.22
Grams digested, ...	522.82	21.13	45.89	103.59	325.44	26.77
Minus hay digested, ...	288.98	16.56	23.22	94.61	148.63	5.74
Hominy feed digested, ...	233.84	4.57	22.67	8.98	176.81	21.03
Per cent. digested, ...	85.90	60.37	71.85	62.49	90.79	87.70
Average per cent. two sheep digested,	87.58	48.88	69.54	79.96	92.61	88.16

Average nutritive ratio of rations for two sheep, 1: 10.9.

Period XIII.

Young Sheep I.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
550 grams English hay fed, ...	498.03	40.84	43.28	160.07	241.84	12.00
250 grams buckwheat middlings, . .	226.85	10.93	64.04	20.30	114.81	16.76
Amount consumed, ...	724.88	51.77	107.32	180.37	356.65	28.76
286.23 grams manure excreted, . .	270.20	31.13	31.72	86.68	112.92	7.75
Grams digested, ...	454.68	20.64	75.60	93.69	243.73	21.01
Minus hay digested, ...	284.23	17.82	20.50	92.12	147.79	6.21
Buckwheat middlings digested, . .	170.45	2.82	55.10	1.57	95.94	14.80
Per cent. digested, ...	75.14	25.80	86.04	7.73	83.56	88.31

Young Sheep II.

Amount consumed as above, . . .	724.88	51.77	107.32	180.37	356.65	28.76
279.07 grams manure excreted, . .	262.07	29.43	33.65	82.95	108.97	7.08
Grams digested, ...	462.81	22.34	73.67	97.42	247.68	21.68
Minus hay digested, ...	284.23	17.82	20.50	92.12	147.79	6.21
Buckwheat middlings digested, . .	178.58	4.52	53.17	5.30	99.89	15.47
Per cent. digested, ...	78.72	41.35	83.03	26.11	87.00	92.30

Young Sheep III.

Amount consumed as above, . . .	724.88	51.77	107.32	180.37	356.65	28.76
295.90 grams manure excreted, . .	278.97	29.63	31.55	92.00	117.89	7.89
Grams digested, ...	445.91	22.14	75.77	88.37	238.76	20.87
Minus hay digested, ...	284.23	17.82	20.50	92.12	147.79	6.21
Buckwheat middlings digested, . .	161.68	4.32	55.27	–	90.97	14.66
Per cent. digested, ...	71.27	39.52	86.31	–	79.24	87.47
Average per cent. three sheep digested,	75.04	35.56	85.13	16.92[1]	83.27	89.36

Average nutritive ratio of rations for three sheep, 1: 5.1.

[1] Average two sheep.

Period XIV.

Paige Sheep IV.

Daily Record.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
550 grams English hay fed,	497.48	40.79	43.23	159.89	241.58	11.99
300 grams oat middlings,	273.21	7.13	48.41	6.99	189.80	20.87
Amount consumed,	770.69	47.92	91.64	166.88	431.38	32.86
248.47 grams manure excreted,	232.89	29.16	29.16	67.10	99.72	7.76
Grams digested,	537.80	18.76	62.48	99.78	331.66	25.10
Minus hay digested,	288.44	16.53	23.18	94.43	148.35	5.73
Oat middlings digested,	249.36	2.23	39.30	5.35	183.31	19.37
Per cent. digested,	91.27	31.28	81.18	76.54	96.58	92.81

Paige Sheep V.

Amount consumed as above,	770.69	47.92	91.64	166.88	431.38	32.86
258.53 grams manure excreted,	241.78	28.55	29.96	70.96	104.71	7.59
Grams digested,	528.91	19.37	61.68	95.92	326.67	25.27
Minus hay digested,	288.44	16.53	23.18	94.43	148.35	5.73
Oat middlings digested,	240.47	2.84	38.50	1.49	178.32	19.54
Per cent. digested,	88.02	39.83	79.53	21.32	93.95	93.63
Average per cent. two sheep digested,	89.65	35.56	80.36	48.93	95.27	93.22

Average nutritive ratio of rations for two sheep, 1:7.8.

Summary of Coefficients.

Coefficients determined on —	Sheep Number.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Soybean fodder,	Young Sheep I.,	68.77	45.20	81.30	53.37	78.47	69.31
	Young Sheep II.,	64.09	38.95	79.61	46.63	73.91	65.38
	Young Sheep III.,	61.61	33.72	79.88	42.65	71.44	67.80
	Average,	64.82	39.29	80.26	47.55	74.61	67.50
Blomo feed,	Old Sheep II.,	64.02	31.20	64.48	50.81	73.20	13.79
	Old Sheep III.,	69.46	31.62	60.98	71.89	78.70	16.75
	Average,	66.74	31.41	62.73	61.35	75.95	15.27
Malt sprouts,	Young Sheep I.,	89.03	33.30	77.23	100+	91.35	85.38
	Young Sheep II.,	75.13	2.87	73.87	100+	77.56	74.42
	Young Sheep III.,	81.45	21.18	76.67	98.26	86.99	100+
	Average,	81.87	19.12	75.92	99.42	85.30	86.60
Sucrene dairy feed.	Old Sheep II.,	71.58	47.51	64.45	70.41	74.57	96.06
	Old Sheep III.,	67.38	27.92	57.12	73.46	70.50	92.75
	Average,	69.48	37.72	60.79	71.94	72.54	94.41

Summary of Coefficients — Concluded.

Coefficients determined on —	Sheep Number.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Holstein sugar feed.	Young Sheep I., .	70.16	24.08	61.22	44.28	80.61	88.49
	Young Sheep II.,	74.13	31.74	64.90	62.30	82.04	88.61
	Young Sheep III.,	69.63	43.08	70.83	25.64	78.85	86.39
	Average, . .	71.31	32.97	65.65	44.07	80.50	87.83
Macon sugar feed.	Old Sheep II., .	69.03	20.52	60.50	36.40	80.83	74.07
	Old Sheep III., .	72.03	20.31	57.26	51.35	83.41	90.66
	Average, . .	70.53	20.42	58.88	43.88	82.12	82.37
Hominy feed, .	Paige Sheep IV.,	89.26	37.38	67.23	97.43	94.42	88.62
	Paige Sheep V., .	85.90	60.37	71.85	62.49	90.79	87.70
	Average, . .	87.58	48.88	69.54	79.96	92.61	88.16
Buckwheat middlings.	Young Sheep I., .	75.14	25.80	86.04	7.73	83.56	88.31
	Young Sheep II.,	78.72	41.35	83.03	26.11	87.00	92.30
	Young Sheep III.,	71.27	39.52	86.31	–	79.24	87.47
	Average, . .	75.04	35.56	85.13	16.92	83.27	89.36
Oat middlings,	Paige Sheep IV.,	91.27	31.28	81.18	76.54	96.58	92.81
	Paige Sheep V., .	88.02	39.83	79.53	21.32	93.95	93.63
	Average, . .	89.65	35.56	80.36	48.93	95.27	93.22
Eureka silage corn stover.	Old Sheep II., .	53.53	46.13	49.67	56.18	52.86	66.18
	Old Sheep III., .	55.27	43.88	46.91	61.94	52.99	66.98
	Average, . .	54.40	45.01	48.29	59.06	52.93	66.58
Pride of the North corn stover.	Old Sheep II., .	52.87	32.82	44.57	57.89	53.08	63.05
	Old Sheep III., .	55.06	29.36	45.12	62.60	54.68	65.75
	Average, . .	53.97	31.09	44.85	60.25	53.88	64.40
English hay, .	Paige Sheep IV.,	57.54	36.96	50.89	59.76	60.88	50.81
	Paige Sheep V., .	58.41	44.07	56.33	58.36	61.94	44.70
	Average, . .	57.98	40.52	53.61	59.36	61.44	47.76
English hay, .	Young Sheep I., .	55.98	42.98	48.09	56.09	59.91	49.46
	Young Sheep II.,	59.03	43.77	47.36	61.21	62.65	52.80
	Young Sheep III.,	56.21	44.17	46.65	55.35	60.78	52.86
	Average, . .	57.07	43.64	47.37	57.55	61.11	51.71
English hay, .	Old Sheep II., .	61.72	47.36	55.54	64.52	64.01	50.45
	Old Sheep III., .	59.74	43.67	51.87	63.09	62.18	50.08
	Average, . .	60.73	45.52	53.71	63.81	63.10	50.27

Discussion of the Results.

The most important results obtained from the experiments reported in the previous pages are discussed under the following headings: —

Soy Bean Fodder (Brook's Medium Green). — This fodder was grown upon a twentieth-acre plat which had produced soy beans for two years previously. The crop was fertilized in the same way as that used in a digestion trial the previous year, and yielded at the rate of 6 tons to the acre. The fodder was cut from time to time as needed during the first fourteen days of September, the period proper lasting from the 8th to the 14th. The plants were fully podded and the beans quite well developed, but the foliage was still green. In common with other legumes at a similar stage of growth, the soy bean fodder showed a high protein percentage, and moderate percentages of fiber and extract matter.

Summary of Digestion Coefficients (Per Cent.).

	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Young Sheep I., . . .	–	1	68.77	45.20	81.30	53.37	78.47	69.31
Young Sheep II., . . .	–	1	64.09	38.95	79.61	46.63	73.91	65.38
Young Sheep III., . . .	–	1	61.61	33.72	79.88	42.65	71.44	67.80
Average (1904), ...	1	3	64.82	39.29	80.26	47.55	74.61	67.50
Average (1903), ...	1	3	63.53	21.05	82.96	38.90	77.82	65.42
Average, both trials, . .	2	6	64.17	30.17	81.61	43.42	76.22	66.46
Average, all trials seeding, .	4	12	65.00	28.00	78.00	45.00	77.00	55.00
Clover for comparison, . .	3	7	66.00	–	70.00	54.00	72.00	64.00
Cowpea fodder for comparison,	2	4	68.00	23.00	76.00	60.00	81.00	59.00

The 1904 trial was made with one lot of sheep, and the 1903 trial with another. The results of both trials agree as closely as could be expected. The soy bean fodder appears to be slightly less digestible than that of other legumes, due in all probability to the tough, woody stems which are characteristic of the plant. Note the low digestibility of the fiber and the high digestibility of the protein.

Blomo Feed. — This feed, put out by the Blomo Manufacturing Company of New York, consisted of a fibrous material resembling ground corn stalks or cut hay, together with fresh blood and molasses. It was quite dark in color, coarse in appearance and rather sticky to the touch. Many samples contained an excess of moisture, which caused it to spoil during the warm season. The sample under examination contained, in dry matter, some 17 per cent. protein, 13 per cent. fiber and only a trace of fat.

Summary of Digestion Coefficients (Per Cent.).

	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Old Sheep II.,	1	1	64.02	31.20	64.48	50.81	73.20	13.79
Old Sheep III.,	1	1	69.46	31.62	60.98	71.89	78.70	16.75
Average,	1	2	66.74	31.41	62.73	61.35	75.95	15.27
Oats for comparison,	3	13	71.00	–	80.00	30.00	76.00	83.00
Rowen for comparison,	4	16	64.00	–	69.00	66.00	64.00	47.00

The parallel tests do not agree quite as closely as one could wish, the cause of the disagreement being due primarily to the fact that Sheep II. was not able to digest the fiber as fully as Sheep III. The percentage of fat is so small (less than 1 per cent.) that its digestibility is of minor consequence. It is understood that the Blomo feed was intended to be used chiefly as an oat substitute for horses. A comparison of the digestion coefficients of the two feeds proves the Blomo to be not quite as fully digested as the oats. The advantages, therefore, if any, of the Blomo feed would be due to the favorable effect of the molasses, and in its furnishing a change from the regular corn and oat diet. At the price asked Blomo could not be considered an economical feed for dairy stock. Its digestion coefficients do not vary greatly from those of a good quality of rowen, and it is doubtful if it would produce any more favorable results.

Malt Sprouts. — The sprouts were of good color, and contained nearly 29 per cent. of crude protein, 33.47 per cent. of which was in the amido form.

Summary of Digestion Coefficients (Per Cent.).

Period III.

	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Young Sheep I.,	1	1	89.03	33.30	77.23	100+	91.35	85.38
Young Sheep II.,	1	1	75.13[1]	2.87	73.87	100.00	77.56	74.42
Young Sheep III.,	1	1	81.45	21.18	76.67	98.26	86.99	100.00
Average,	1	3	81.87	19.12	75.92	99.42	85.30	86.60
Average, all trials, made in Massachusetts.	2	4	81.00	19.00	76.00	100.00	83.00	80.00
German trials,[2]	6	12	72.00[3]	–	80.00	55.00	73.00	71.00

The results with the three sheep show wide variations, especially in case of the total dry matter, ash and extract matter, and it is evident that difficulty was experienced in digesting the sprouts. Similar results were experienced in a previous trial,[4] two sheep digesting but 60 per cent. of the dry matter and a third 78 per cent. The results secured with the two former sheep were discarded. The high fiber coefficients in the present experiment indicate that the addition of the nitrogenous sprouts increased the digestibility of the hay fiber.

The results of German experiments likewise show especially wide variations in the digestibility of the organic matter, fiber and extract matter. The latter experiments do not show as high an average digestibility for fiber as do our own trials. It seems probable that these differences may be due largely to the character of the sprouts employed. Böhmer [5] states that light-colored sprouts show a higher degree of digestibility than dark-brown sprouts derived from slightly scorched malt. Kellner [6] has shown that, while the organic matter of the sprouts has a reasonably high digestibility because of the presence of considerable quantities of amids, cane sugar and organic acids, a definite amount does

[1] The fæces from Sheep II. were somewhat soft for a few days during the collection, which was an evidence of indigestion.

[2] Kellner's Die Ernährung der Landw. Nutzthiere, page 570.

[3] Organic matter.

[4] See sixteenth report of this station, page 77.

[5] Kraftfuttermittel, page 206.

[6] *Loco citato*, pages 160, 357.

not have as great a feeding effect as does a like amount contained in the cereals.

Sucrene Dairy Feed. — This is one of the so-called sugar feeds, consisting of wheat, corn, oats and barley products (or by-products), light oats, cotton-seed meal or other protein concentrate, and one-fourth to one-third molasses. The sample tested contained (in dry matter) 18.48 per cent. protein and 14.11 per cent. fiber.

Summary of Digestion Coefficients (Per Cent.).

Period IX.

	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Old Sheep II., ...	1	1	71.58	47.51	64.45	70.41	74.57	96.06
Old Sheep III., ...	1	1	67.38	27.92	57.12	73.46	70.50	92.75
Average, ...	1	2	69.48	37.72	60.79	71.94	72.54	94.41
Wheat bran for comparison, .	8	18	62.00	-	77.00	21.00	69.00	66.00
Flour middlings for comparison.	1	2	83.00	-	85.00	36.00	88.00	85.00
Gluten feed for comparison, .	5	11	85.00	-	85.00	76.00	89.00	83.00

The sugar feed may be said to be but moderately digestible. In total dry matter it is rather more digestible than bran, but the protein in the latter has noticeably higher digestion coefficients. It is decidedly less digestible than either flour middlings or gluten feed, and either of the two latter feeds would furnish digestible matter and especially digestible protein for less money than the Sucrene feed.

Holstein Sugar Feed. — This feed appeared to be a mixture of cereal products or by-products, molasses and some cotton-seed meal. It contained rather less water than the Sucrene, but was coarser and rather more sticky to handle.

Summary of Digestion Coefficients (Per Cent.).

Period X.

	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Young Sheep I.,	1	1	70.16	24.08	61.22	44.28	80.61	88.49
Young Sheep II.,	1	1	74.13	31.74	64.90	62.30	82.04	88.61
Young Sheep III.,	1	1	69.63	43.08	70.83	25.64	78.85	86.39
Average,	1	3	71.31	32.97	65.65	44.07	80.50	87.83

The dry matter of the Holstein feed was about as digestible as that contained in the Sucrene feed. Its fiber was rather less digestible and its extract matter had a higher digestibility than that contained in the latter feed.

Macon Sugar Feed. — This feed was furnished by Chapin & Co., and shipped from St. Louis. In appearance it quite closely resembled the Sucrene feed. The sample contained rather less protein and fiber and noticeably more extract matter than the Sucrene.

Summary of Digestion Coefficients (Per Cent.).

Period XI.

	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Old Sheep II.,	1	1	69.03	20.52	60.50	36.40	80.83	74.07
Old Sheep III.,	1	1	72.03	20.31	57.26	51.35	83.41	90.66
Average,	1	2	70.53	20.42	58.88	43.88	82.12	82.37

The results secured with the Macon feed do not vary materially from those obtained with the Sucrene and Holstein feeds. The fiber in the Macon is rather less and the extract matter more digestible than that contained in the Sucrene. In general it may be said that the digestibility of the three sugar feeds resembles each other quite closely.[1]

[1] The economic value of these feeds will be more fully discussed in a future bulletin on the value of molasses and molasses feeds.

Eureka Silage Corn Stover. — This was derived from Eureka corn [1] grown on an experiment plat of the station during 1904, and cured in the stock out of doors. The corn was cut September 15, the ears at the time being only partially developed (kernels forming). The digestion experiment was made with the entire plant, minus the ears. In spite of the fact that the corn was well cured, it contained 62.89 per cent. water.

Pride of the North Corn Stover. — This corn was grown the same season, on a plat near by the Eureka, and received the same treatment. It was fairly well eared. The digestion test was made with the entire plant, minus the ears.

Summary of Digestion Coefficients (Per Cent.).

Periods V and VII.

		Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Eureka.	Old Sheep II.,	1	1	53.53	46.13	49.67	56.18	52.86	66.18
	Old Sheep III.,	1	1	55.27	43.88	46.91	61.94	52.99	66.98
	Average,	1	2	54.40	45.01	48.29	59.06	52.93	66.58
Pride of the North.	Old Sheep II.,	1	1	52.87	32.82	44.57	57.89	53.08	63.05
	Old Sheep III.,	1	1	55.06	29.36	45.12	62.60	54.68	65.75
	Average,	1	2	53.97	31.09	44.85	60.25	53.88	64.40
Average, all trials, for corn stover.		11	31	57.00	41.00	36.00	64.00	59.00	70.00

Both varieties of corn stover were equally well digested. The digestion coefficients are slightly lower than the average results of all trials.

English Hay. — This hay consisted largely of Kentucky blue grass (*Poa pratensis*), with an admixture of timothy, sweet vernal grass and red clover. It was cut June 20, when the blue grass and clover were in blossom, and carefully cured. The hay was used in connection with the several experiments reported in this series.

[1] See eighteenth report of this station, pages 86–93.

Summary of Coefficients (Per Cent.).

Periods.		Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
VI.,	Paige Sheep IV.,	1	1	57.54	36.96	50.89	59.76	60.88	50.81
	Paige Sheep V.,	1	1	58.41	44.07	56.33	58.36	61.94	44.70
	Average,	1	2	57.98	40.52	53.61	59.06	61.44	47.76
IX.,	Old Sheep II.,	1	1	61.72	47.36	55.54	64.52	64.01	50.45
	Old Sheep III.,	1	1	59.74	43.67	51.87	63.09	62.18	50.08
	Average,	1	2	60.72	45.50	53.69	63.79	63.08	50.24
VIII.,	Young Sheep I.,	1	1	55.98	42.98	48.09	56.09	59.91	49.46
	Young Sheep II.,	1	1	59.03	43.77	47.36	61.21	62.65	52.80
	Young Sheep III.,	1	1	56.21	44.17	46.65	55.35	60.78	52.86
	Average,	1	3	57.07	43.64	47.37	57.55	61.11	51.71
	Average, all sheep,	1	7	58.38	43.28	50.96	59.76	61.77	50.16
	Average, all previous trials.	15	60	60.00	47.00	57.00	60.00	61.00	50.00
	Average, timothy hay.	24	58	55.00	39.00	48.00	50.00	62.00	50.00

The so-called "Old Sheep" gave slightly higher coefficients than the other two lots. The former are some six years and the latter four years old. This difference in ability to digest, especially between the old and young sheep, has been noticed repeatedly. The hay gave about the same digestion coefficients as those secured with similar lots in previous trials. Hay of this character, designated "cow hay" by farmers, tests higher in protein, is rather more digestible, and probably requires less energy for its digestion than timothy hay.

Hominy Feed. — This material consisted of the hull, germ and some of the gluten and starch of the Indian corn. The sample appeared to be of good average quality.

Summary of Digestion Coefficients (Per Cent.).

Period XII.

	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Paige Sheep IV., ...	1	1	89.26	37.38	67.23	97.43	94.42	88.62
Paige Sheep V., ...	1	1	85.90	60.37	71.85	62.49	90.79	87.70
Average, ...	1	2	87.58	48.88	69.54	79.96	92.61	88.16
Average, 1903,[1]	1	3	80.75	22.74	67.48	–	85.97	91.61
Average, 1904,[1]	1	3	79.42	38.26	58.07	38.12	87.66	94.09
Average, all trials, ...	3	8	81.96	35.10	64.47	79.96	88.26	91.68
Corn meal for comparison, .	–	–	89.00	–	70.00	–	94.00	91.00

[1] Seventeenth report of this station, page 75.

The results of the two trials in the present experiment agree fairly well one with the other, and the average of the two are nearly equal to the coefficients for corn meal. The coefficients secured with the several sheep in the two previous experiments (1903 and 1904) showed marked differences. While these variations may have been due partially to the quality of the two different lots of hominy (which, however, could not be detected by chemical analysis), it seems probable that the chief cause for the lack of agreement is to be found in the sheep themselves. The writer has frequently noticed that after sheep have been used in digestion work for a number of months their power to digest becomes temporarily weakened. This condition is more noticeable with some sheep than with others, and evidently depends largely upon individuality. The digestion coefficients for hominy secured with the Old Sheep (1903) were obtained in one of a series of experiments extending from the autumn of 1902 to March 1903. The hominy meal period was the last of the series, and the digestibility of the dry matter varied from 71 to 91 per cent. The coefficients reported with the Young Sheep (1904) (75 to 86 per cent. of dry matter digestible) were obtained in a series extending from the autumn of 1903 to the spring of 1904. These sheep were used for the first time in this series, and were alternated to an extent with the Old

Sheep. The hominy feed was used in the last of four experiments made with these sheep during the series. While the latter results agree better than those secured with the Old Sheep, they were not as satisfactory as could be desired.

The average of all trials show the dry matter to be 82 per cent. digestible. It is believed, however, that the coefficients secured with the Paige Sheep (fully reported in the present trial) more closely represent the digestibility of the best grades of hominy feed. Allowing hominy feed to contain 91 per cent. and corn meal 86 per cent. of dry matter, and applying the average digestion coefficients secured for hominy and corn meal, the former would contain 1,492 pounds and the latter 1,541 pounds digestible dry matter in one ton. By using the coefficients secured with the Paige Sheep, the hominy is shown to contain 1,565 pounds of digestible dry matter in a ton. It may therefore safely be assumed that a ton of standard hominy feed has fully as much digestible matter as is contained in a like quantity of an average quality of corn meal. Hominy contains rather more protein and noticeably more fat than clear corn, and for some purposes may be considered a preferable feed.

Oat Middlings, occasionally found upon the market, is presumably the fine residue from the oatmeal factories. It contains but a few per cent. of fiber, about 9 per cent. of water, 16 per cent. of protein and 6 per cent. of fat.

Summary of Digestion Coefficients (Per Cent.).

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Paige Sheep I., ...	1	1	91.27	31.28	81.18	76.54	96.58	92.81
Paige Sheep II., . . .	1	1	88.02	39.83	79.53	21.32	93.95	93.63
Average, ...	1	2	89.65	35.56	80.36	48.93	95.27	93.22
Average fine wheat middlings for comparison.	2	4	82.00	–	88.00	36.00	88.00	86.00

The oat middlings are shown to be quite thoroughly digested, especially the starchy matter and fat; the protein had also a relatively high digestibility. The small amount of fiber present renders its degree of digestibility comparatively unimportant. Judged from composition and digestibility, this oat by-product would be a few per cent. more valuable than average wheat flour middlings for ordinary feeding purposes. It ought to make a valuable feed for young calves.

Buckwheat Middlings. — This material is the residue from small mills which prepare buckwheat flour for human use. It consisted of the middlings and a small portion of the bran. Genuine buckwheat middlings should contain 25 per cent. of protein, 7 per cent. of fat and not over 10 per cent. of fiber. Samples found in the market known as buckwheat feed frequently show a considerable admixture of the bran and analyze as high as 25 per cent. of fiber. Buckwheat bran is very indigestible, and consequently such material is quite inferior in feeding value to the straight middlings.

Summary of Digestion Coefficients (Per Cent.).

Period XIII.

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Young Sheep I.,	1	1	75.14	25.80	86.04	7.74	83.56	88.31
Young Sheep II.,	1	1	78.72	41.35	83.03	26.11	87.00	92.30
Young Sheep III.,	1	1	71.27	39.52	86.31	–	79.24	87.47
Average,	1	3	75.04	35.56	85.13	16.92[1]	83.27	89.36
Gluten feed for comparison,	7	13	86.00	–	85.00	76.00	89.00	83.00

Sheep III. did not digest the middlings quite as well as the other two sheep. The material, as is shown by the coefficients obtained for the dry matter, appeared to be fairly well digested, although not as fully as the easily digested gluten feed. The protein had a high digestibility, being equal to other high-grade protein concentrates. It is evident from the analysis, from the digestion coefficients obtained and from the retail price of the article ($26 to $28 a ton) that genuine buckwheat middlings is an economical source of dry matter and digestible protein.[1]

[1] Average, two trials.

[2] It is not advisable to feed over 3 pounds of this material daily to mature dairy stock; larger quantities are likely to cause illness.

Series XI.

This series was begun August 12, 1905, with Early Amber Sorghum, and continued until April 7, 1906. The Paige Sheep worked especially well in this series, and were used in the larger number of the experiments. The digestion hay used in periods III. and IV. was the new hay described in the previous series, to which the reader is referred for composition and digestion coefficients. The composition of the hay used in all other periods is given in the table of analyses. The coefficients employed were the following: —

	Old Sheep II. and III.	Young Sheep I., II. and III.	Paige Sheep IV. and V.
Dry matter,	67.87	65.92	65.48
Ash,	49.17	51.95	44.60
Protein,	62.31	61.98	61.53
Fiber,	76.30	72.87	73.81
Nitrogen-free extract,	66.39	64.66	64.46
Fat,	52.37	54.23	50.20

Composition of Feed Stuffs (Per Cent.).

[Dry Matter.]

Feeds.	Ash.	Protein.	Fiber.	Nitrogen-free Extract Matter.	Fat.
English hay (used in 1904–05 experiments),	8.20	8.69	32.14	48.56	2.41
Early Amber Sorghum fodder,	6.06	6.24	29.28	56.00	2.42
Pride of the North corn fodder,	5.56	8.83	23.11	60.24	2.26
Porto Rico molasses,	8.45	3.94	–	87.61	–
English hay (new lot, 1905–06),	6.75	12.23	33.45	44.67	2.90
Gluten feed,	1.67	24.98	7.22	63.34	2.79
Porto Rico molasses,	9.22	3.94	–	86.84	–
Green Diamond sugar feed,	9.88	13.71	15.27	58.47	2.67
Sea Island cotton-seed meal,	5.20	27.31	19.67	41.47	6.35
Red wheat meal,	1.92	9.96	2.99	82.83	2.80
Leaming corn silage,	6.07	10.19	26.06	54.89	2.79
White winter wheat meal,	1.90	13.07	2.38	80.49	2.16
Feed barley (ground),	3.27	14.60	6.19	73.90	2.04

Composition of Fæces (Per Cent.).

[Dry Matter.]

Periods.	Feeds.	Ash.	Protein.	Fiber.	Nitrogen-free Extract Matter.	Fat.
	Young Sheep I.					
IX.,	English hay (1905–06), ...	9.82	13.27	26.90	46.01	4.00
XII.,	Red wheat meal, ...	9.91	15.66	24.82	45.61	4.00
XV.,	White winter wheat, ...	10.39	14.70	24.51	46.02	4.38
	Young Sheep II.					
IX.,	English hay (1905–06), ...	9.68	14.55	25.28	46.62	3.87
XV.,	White winter wheat, ...	11.60	15.20	24.26	45.16	3.78
	Young Sheep III.					
IX.,	English hay (1905–06), ...	9.07	13.14	27.65	46.32	3.82
XII.,	Red wheat meal, ...	9.24	15.08	25.85	46.02	3.81
XV.,	White winter wheat, ...	9.15	14.24	26.30	46.23	4.08
	Old Sheep II.					
II.,	Pride of the North corn fodder, .	11.86	11.17	27.55	47.68	1.74
VI.,	English hay (1905–06), . . .	10.80	14.70	23.99	46.27	4.24
XIII.,	Leaming corn-silage, ...	10.48	13.70	25.15	47.75	2.92
	Old Sheep III.					
II.,	Pride of the North corn fodder, .	12.86	11.18	27.68	46.35	1.93
VI.,	English hay (1905–06), . . .	10.57	14.03	25.31	45.74	4.35
X.,	Green Diamond sugar feed, . .	14.70	13.68	24.47	44.42	2.73
XIII.,	Leaming corn silage, ...	10.39	13.02	25.14	48.47	2.98
	Paige Sheep IV.					
I.,	Early Amber Sorghum, . . .	11.28	11.13	27.02	47.44	3.13
III.,	Porto Rico molasses, ...	12.16	10.72	29.32	44.87	2.93
IV.,	Porto Rico molasses, ...	13.66	11.47	27.13	44.86	2.88
V.,	English hay (1905–06), ...	11.18	14.10	24.20	46.24	4.28
VII.,	Gluten feed, ...	10.55	15.33	22.35	47.20	4.57
VIII.,	Gluten feed and molasses, . . .	11.15	16.36	21.26	47.44	3.79
XI.,	Sea Island cotton-seed meal, . .	8.67	14.17	32.75	41.31	3.10
XIV.,	Green Diamond sugar feed, . .	13.02	12.79	25.41	45.59	3.19
XVI.,	Feed barley, ...	12.50	13.86	23.08	46.46	4.10

Composition of Fæces — Concluded.

[Dry Matter.]

Paige Sheep V.

Periods.	Feeds.	Ash.	Protein.	Fiber.	Nitrogen-free Extract Matter.	Fat.
I.,	Early Amber Sorghum, . . .	11.06	9.39	31.21	45.75	2.59
III.,	Porto Rico molasses, ...	11.83	10.53	30.33	44.47	2.84
IV.,	Porto Rico molasses, ...	12.87	11.49	28.95	43.94	2.75
V.,	English hay (1905–06), . . .	10.49	13.17	26.51	45.74	4.09
VII.,	Gluten feed, ...	10.63	15.05	22.84	46.84	4.64
VIII.,	Gluten feed and molasses, . . .	10.82	16.21	22.09	47.15	3.73
XI.,	Sea Island cotton-seed meal, . .	9.33	15.20	29.46	42.86	3.15
XVI.,	Feed barley, ...	11.14	13.86	25.39	45.75	3.86

Dry Matter Determinations made at the Time of weighing out the Different Foods, and Dry Matter in Air-dry Fæces (Per Cent.).

Paige Sheep IV.

Periods.	English Hay.	Early Amber Sorghum.	Porto Rico Molasses.	Gluten Feed.	Sea Island Cotton-seed Meal.	Green Diamond Sugar Feed.	Feed Barley.	Fæces.
I.,	-	16.35	-	-	-	-	-	87.84
III.,	88.15	-	71.49	-	-	-	-	92.84
IV.,	87.22	-	72.12	-	-	-	-	92.33
V.,	88.65	-	-	-	-	-	-	92.22
VII.,	88.55	-	-	90.03	-	-	-	93.47
VIII.,	88.92	-	72.67	92.02	-	-	-	92.50
XI.,	90.92	-	-	-	90.97	-	-	93.16
XIV.,	90.17	-	-	-	-	89.62	-	94.42
XVI.,	89.35	-	-	-	-	-	89.07	92.96

Paige Sheep V.

I.,	-	16.35	-	-	-	-	-	87.69
III.,	88.15	-	71.49	-	-	-	-	93.14
IV.,	87.22	-	72.12	-	-	-	-	92.16
V.,	88.65	-	-	-	-	-	-	92.14
VII.,	88.55	-	-	90.03	-	-	-	93.61
VIII.,	88.92	-	72.67	92.02	-	-	-	92.36
XI.,	90.92	-	-	-	90.97	-	-	92.98
XVI.,	89.35	-	-	-	-	-	89.07	92.80

Dry Matter Determinations, etc. — Concluded..

Young Sheep I.

Periods.	English Hay.	Pride of the North Corn Fodder.	Green Diamond Sugar Feed.	Red Wheat Meal.	Leaming Corn Silage.	White Wheat Meal.	Fæces.
IX., . . .	90.35	-	-	-	-	-	94.99
XII., . . .	88.92	-	-	87.43	-	-	94.25
XV., . . .	89.60	-	-	-	-	87.80	93.27
Young Sheep II.							
IX., . . .	90.35	-	-	-	-	-	94.72
XV., . . .	89.60	-	-	-	-	87.80	92.91
Young Sheep III.							
IX., . . .	90.35	-	-	-	-	-	94.86
XII., . . .	88.92	-	-	87.43	-	-	94.17
XV., . . .	89.60	-	-	-	-	87.80	93.09
Old Sheep II.							
II., . . .	-	22.61	-	-	-	-	89.28
VI., . . .	88.97	-	-	-	-	-	93.54
XIII., . . .	90.17	-	-	-	21.44	-	94.12
Old Sheep III.							
II., . . .	-	22.61	-	-	-	-	89.09
VI., . . .	88.97	-	-	-	-	-	93.52
X., . . .	88.95	-	91.95	-	-	-	94.09
XIII., . . .	90.17	-	-	-	21.44	-	94.19

Average Daily Amount of Manure excreted and Water drank (Grams).

Paige Sheep IV.

Periods.	Character of Food or Ration.	Manure excreted daily.	One-tenth Manure Air Dry.	Water drank daily.
I.,	Early Amber Sorghum, ...	500	41.06[1]	49
III.,	Hay and Porto Rico molasses, . . .	674	31.10	1,725
IV.,	Hay and Porto Rico molasses, . . .	738	33.34	2,114
V.,	English hay, ...	610	26.11	1,781
VII.,	Hay and gluten feed, ...	460	20.82	1,498
VIII.,	Hay, gluten feed and molasses, . . .	635	25.84	1,843
XI.,	Hay and Sea Island cotton-seed meal, . .	607	29.67	2,095
XIV.,	Hay and Green Diamond sugar feed, . .	598	27.45	2,241
XVI.,	Hay and feed barley, ...	478	20.32	1,644

[1] One-fifth of daily amount excreted.

Average Daily Amount of Manure excreted and Water drank (Grams) — Concluded.

Paige Sheep V.

Periods.	Character of Food or Ration.	Manure excreted daily.	One-tenth Manure Air Dry.	Water drank daily.
I.,	Early Amber Sorghum, ...	591	43.80[1]	55
III.,	Hay and Porto Rico molasses, . . .	745	32.86	1,995
IV.,	Hay and Porto Rico molasses, . . .	855	34.12	2,014
V.,	English hay, ...	623	27.02	1,642
VII.,	Hay and gluten feed, ...	459	20.01	1,318
VIII.,	Hay, gluten feed and molasses, . . .	655	25.86	1,953
XI.,	Hay and Sea Island cotton-seed meal, . .	673	26.70	2,138
XIV.,	Hay and Green Diamond sugar feed, . .	–	–	–
XVI.,	Hay and feed barley, ...	705	21.50	1,644

[1] One-fifth of daily amount excreted.

Young Sheep I.

IX.,	English hay (new lot), ...	635	27.46	2,170
XII.,	Hay and red wheat meal, ...	557	20.98	2,025
XV.,	Hay and white winter wheat, . . .	488	21.86	2,038

Young Sheep II.

IX.,	English hay (new lot), ...	779	26.96	2,341
XII.,	Hay and red wheat meal, ...	–	–	–
XV.,	Hay and white winter wheat, . . .	1,077	24.15	2,338

Young Sheep III.

IX.,	English hay (new lot), ...	695	28.35	2,495
XII.,	Hay and red wheat meal, ...	617	22.32	2,352
XV.,	Hay and white winter wheat, . . .	537	22.99	2,495

Old Sheep II.

II.,	Pride of the North corn fodder, . . .	624	25.62	80
VI.,	English hay (1905–06), ...	613	26.21	1,694
X.,	Hay and Green Diamond sugar feed, . .	–	–	–
XIII.,	Hay and Leaming corn silage, . . .	747	24.04	1,974

Old Sheep III.

II.,	Pride of the North corn fodder, . . .	820	28.12	60
VI.,	English hay (1905–06), ...	608	28.80	1,544
X.,	Hay and Green Diamond sugar feed, . .	676	27.08	2,329
XIII.,	Hay and Leaming corn silage, . . .	537	22.42	1,309

Weights of Animals at Beginning and End of Period (Pounds).

Paige Sheep IV.

Periods.	Character of Food or Ration.	Beginning.	End.
I.,	Early Amber Sorghum, ...	147.00	146.50
III.,	Hay and Porto Rico molasses, ...	144.00	142.00
IV.,	Hay and Porto Rico molasses, ...	145.50	150.00
V.,	English hay, ...	142.00	144.00
VII.,	Hay and gluten feed, ...	141.50	141.00
VIII.,	Hay, gluten feed and molasses, ...	145.00	142.00
XI.,	Hay and Sea Island cotton-seed meal, . .	144.00	145.00
XIV.,	Hay and Green Diamond sugar feed, . . .	145.50	148.50
XVI.,	Hay and feed barley, ...	148.00	143.50

Paige Sheep V.

Periods.	Character of Food or Ration.	Beginning.	End.
I.,	Early Amber Sorghum, ...	124.25	126.00
III.,	Hay and Porto Rico molasses, ...	124.00	122.00
IV.,	Hay and Porto Rico molasses, ...	122.50	125.50
V.,	English hay, ...	122.00	121.50
VII.,	Hay and gluten feed, ...	118.50	120.00
VIII.,	Hay, gluten feed and molasses, ...	125.50	122.50
XI.,	Hay and Sea Island cotton-seed meal, . .	124.50	123.50
XIV.,	Hay and Green Diamond sugar feed, . .	–	–
XVI.,	Hay and feed barley, ...	124.50	117.00

Young Sheep I.

Periods.	Character of Food or Ration.	Beginning.	End.
IX.,	English hay (1905–06), ...	121.00	119.00
XII.,	Hay and red wheat meal, ...	118.00	117.00
XV.,	Hay and white winter wheat, ...	119.50	118.00

Young Sheep II.

Periods.	Character of Food or Ration.	Beginning.	End.
IX.,	English hay (1905–06), ...	111.00	113.00
XII.,	Hay and red wheat meal, ...	–	–
XV.,	Hay and white winter wheat, ...	–	–

Young Sheep III.

Periods.	Character of Food or Ration.	Beginning.	End.
IX.,	English hay (1905–06), ...	113.00	110.00
XII.,	Hay and red wheat meal, ...	109.00	109.00
XV.,	Hay and white winter wheat, ...	110.00	108.50

Weights of Animals at Beginning and End of Period (Pounds) — Concluded.

Old Sheep II.

Periods.	Character of Food or Ration.	Beginning.	End.
II.,	Pride of the North corn fodder,	160.00	154.00
VI.,	English hay (1905-06),	154.00	150.00
X.,	Hay and Green Diamond sugar feed,	–	–
XIII.,	Hay and Leaming corn silage,	154.50	155.00

Old Sheep III.

Periods.	Character of Food or Ration.	Beginning.	End.
II.,	Pride of the North corn fodder,	151.50	150.00
VI.,	English hay (1905-06),	146.50	145.00
X.,	Hay and Green Diamond sugar feed,	145.00	147.50
XIII.,	Hay and Leaming corn silage,	152.00	152.00

Early Amber Sorghum. — Period I.

Paige Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
3,600 grams Sorghum fodder fed,	588.60	35.67	36.73	172.34	329.62	14.24
205.30 grams manure excreted,	180.34	20.34	20.07	48.73	85.55	5.64
Grams digested,	408.26	15.33	16.66	123.61	244.07	8.60
Per cent. digested,	69.36	42.98	45.36	71.72	74.04	60.39

Paige Sheep V.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
3,600 grams Sorghum fodder fed,	588.60	35.67	36.73	172.34	329.62	14.24
219 grams manure excreted,	192.04	21.24	18.03	59.94	87.86	4.97
Grams digested,	396.56	14.43	18.70	112.40	241.76	9.27
Per cent. digested,	67.37	40.45	50.91	65.22	73.35	65.10
Average per cent. for both sheep,	68.37	41.72	48.14	68.47	73.70	62.75

Average nutritive ratio of rations for two sheep, 1:21.5.

Pride of the North Corn Fodder. — *Period II.*

Old Sheep II.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
3,600 grams Pride of the North corn fodder fed.	813.96	45.26	71.87	188.11	490.33	18.40
256.23 grams manure excreted, . .	228.76	27.13	25.55	63.02	109.07	3.98
Grams digested, ...	585.20	18.13	46.32	125.09	381.26	14.42
Per cent. digested, ...	71.89	40.06	64.45	66.50	77.76	78.37

Old Sheep III.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
3,600 grams Pride of the North corn fodder fed.	813.96	45.26	71.87	188.11	490.33	18.40
281.19 grams manure excreted, . .	250.51	32.22	28.01	69.34	116.11	4.83
Grams digested, ...	563.45	13.04	43.86	118.77	374.22	13.57
Per cent. digested, ...	69.22	28.81	61.03	63.14	76.32	73.75
Average per cent. for both sheep, .	70.56	34.43	62.74	64.82	77.04	76.06

Average nutritive ratio of rations for two sheep, 1:11.8.

Porto Rico Molasses. — *Period III.*

Paige Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
800 grams English hay fed, . . .	705.20	57.83	61.28	226.65	342.45	17.00
150 grams molasses fed, ...	107.24	9.06	4.23	–	93.95	–
Amount consumed, ...	812.44	66.89	65.51	226.65	436.40	17.00
311 grams manure excreted, . . .	288.73	35.11	30.95	84.66	129.55	8.46
Grams digested, ...	523.71	31.78	34.56	141.89	306.85	8.54
Minus hay digested, ...	408.87	23.43	32.85	133.86	210.30	8.12
Molasses digested, ...	114.84	8.35	1.71	8.03	96.55	.42
Per cent. digested, ...	107.09	92.16	40.43	–	102.76	–

Paige Sheep V.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Amount consumed as above, . .	812.44	66.89	65.51	226.65	436.40	17.00
328.60 grams manure excreted, . .	306.06	36.21	32.23	92.83	136.10	8.69
Grams digested, ...	506.38	30.68	33.28	133.82	300.30	8.31
Minus hay digested, ...	408.87	23.43	32.85	133.86	210.30	8.12
Molasses digested, ...	97.51	7.25	.43	–	90.00	.19
Per cent. digested, ...	90.93	80.02	10.17	–	95.80	–
Average per cent. for both sheep, .	99.01	86.09	25.30	–	99.28	–

Average nutritive ratio of rations for two sheep, 1:13.6.

Porto Rico Molasses. — Period IV.

Paige Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
800 grams English hay fed, . . .	697.76	57.22	60.64	224.26	338.82	16.82
250 grams molasses fed, ...	180.30	15.24	7.10	-	157.96	-
Amount consumed, ...	878.06	72.46	67.74	224.26	496.78	16.82
333.40 grams manure excreted, . .	307.83	42.05	35.31	83.51	138.09	8.87
Grams digested, ...	570.23	30.41	32.43	140.75	358.69	7.95
Minus hay digested, ...	404.56	23.19	32.51	132.44	208.07	8.03
Molasses digested, ...	165.67	7.22	—.08	8.31	150.62	-
Per cent. digested, ...	91.89	47.38	-	-	95.35	-

Paige Sheep V.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Amount consumed as above, . .	878.06	72.46	67.74	224.26	496.78	16.82
341.2 grams manure excreted, . .	314.45	40.47	36.13	91.03	138.17	8.65
Grams digested, ...	563.61	31.99	31.61	133.23	358.61	8.17
Minus hay digested, ...	404.56	23.19	32.51	132.44	208.07	8.03
Molasses digested, ...	159.05	8.80	.10	.79	150.54	.14
Per cent. digested, ...	88.21	57.74	-	-	95.30	-
Average per cent. for both sheep, .	90.05	52.56	-	-	95.33	-

Average nutritive ratio of rations for two sheep, 1: 16.

English Hay. — Period V.

Paige Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
800 grams English hay fed, . . .	709.20	47.87	86.74	237.23	316.80	20.57
261.10 grams manure excreted, . .	240.79	26.92	33.95	58.27	111.34	10.31
Grams digested, ...	468.41	20.95	52.79	178.96	205.46	10.26
Per cent. digested, ...	66.05	43.76	60.86	75.44	64.85	49.88

Paige Sheep V.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
800 grams English hay fed, . . .	709.20	47.87	86.74	237.23	316.80	20.57
270.20 grams manure excreted, . .	248.96	26.12	32.79	66.00	113.87	10.18
Grams digested, ...	460.24	21.75	53.95	171.23	202.93	10.39
Per cent. digested, ...	64.90	45.44	62.20	72.18	64.06	50.51
Average per cent. for both sheep, .	65.48	44.60	61.53	73.81	64.46	50.20

Average nutritive ratio of rations for two sheep, 1: 7.5.

English Hay. — Period VI.

Old Sheep II.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
900 grams English hay fed, . . .	800.73	54.05	97.93	267.84	357.69	23.22
262.10 grams manure excreted, . .	245.17	26.48	36.04	58.82	113.44	10.40
Grams digested, ...	555.56	27.57	61.89	209.02	244.25	12.82
Per cent. digested, ...	69.38	51.01	63.20	78.04	68.29	55.21
Old Sheep III.						
900 grams English hay fed, . . .	800.73	54.05	97.93	267.84	357.69	23.22
288 grams manure excreted, . . .	269.34	28.47	37.79	68.17	123.20	11.72
Grams digested, ...	531.39	25.58	60.14	199.67	234.49	11.50
Per cent. digested, ...	66.36	47.33	61.41	74.55	65.56	49.53
Average per cent. for both sheep, .	67.87	49.17	62.31	76.30	66.39	52.37

Average nutritive ratio of rations for two sheep, 1: 7.7.

Gluten Feed. — Period VII.

Paige Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
600 grams English hay fed, . . .	531.30	35.86	64.98	177.72	237.33	15.41
200 grams gluten feed fed, . . .	180.06	3.01	44.98	13.00	114.05	5.02
Amount consumed, ...	711.36	38.87	109.96	190.72	351.38	20.43
208.20 grams manure excreted, . .	194.60	20.53	29.83	43.49	91.85	8.89
Grams digested, ...	516.76	18.34	80.13	147.23	259.53	11.54
Minus hay digested, ...	347.90	15.99	39.98	131.18	152.98	7.74
Gluten feed digested, ...	168.86	2.35	40.15	16.05	106.55	3.80
Per cent. digested, ...	93.78	78.07	89.26	123.46	93.42	75.70
Paige Sheep V.						
Amount consumed as above, . .	711.36	38.87	109.96	190.72	351.38	20.43
200.10 grams manure excreted, . .	187.31	19.91	28.19	42.78	87.74	8.69
Grams digested, ...	524.05	18.96	81.77	147.94	263.64	11.74
Minus hay digested, ...	347.90	15.99	39.98	131.18	152.98	7.74
Gluten feed digested, ...	176.15	2.97	41.79	16.76	110.66	4.00
Per cent. digested, ...	97.83	98.67	92.91	128.92	97.03	79.68
Average per cent. for both sheep, .	95.81	88.37	91.09	126.19	95.23	77.69

Average nutritive ratio of rations for two sheep, 1: 5.4.

Porto Rico Molasses. — Period VIII.

Paige Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
600 grams English hay fed, ...	533.52	36.01	65.25	178.46	238.32	15.47
200 grams gluten feed fed, ...	184.04	3.07	45.97	13.29	116.57	5.13
250 grams molasses fed, ...	181.68	16.75	7.16	–	157.77	–
Amount consumed, ...	899.24	55.83	118.38	191.75	512.66	20.60
258.40 grams manure excreted, . .	239.02	26.65	39.10	50.82	113.39	9.06
Grams digested, ...	660.22	29.18	79.28	140.93	399.27	11.54
Minus hay and gluten feed digested, .	521.24	18.44	81.05	–	262.12	–
Molasses digested, ...	138.98	10.74	–	–	137.15	–
Per cent. digested, ...	76.50	64.12	–	–	86.93	–

Paige Sheep V.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Amount consumed as above, . .	899.24	55.83	118.38	191.75	512.66	20.60
258.60 grams manure excreted, . .	238.84	25.84	38.72	52.76	112.61	8.91
Grams digested, ...	660.40	29.99	79.66	138.99	400.05	11.69
Minus hay and gluten feed digested, .	528.63	19.06	82.70	–	266.27	–
Molasses digested, ...	131.77	10.93	–	–	133.78	–
Per cent. digested, ...	72.53	65.25	–	–	84.80	–
Average per cent. for both sheep, .	74.52	64.69	–	–	85.87	–

Average nutritive ratio of rations for two sheep, 1: 7.1.

English Hay. — Period IX.

Young Sheep I.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
850 grams English hay fed, . . .	767.98	51.84	93.92	256.89	342.96	22.27
274.60 grams manure excreted, . .	260.84	25.61	34.61	70.17	120.01	10.43
Grams digested, ...	507.14	26.23	59.31	186.72	222.95	11.84
Per cent. digested, ...	66.04	50.60	63.15	72.68	65.01	53.17

Young Sheep II.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
850 grams English hay fed, . . .	767.98	51.84	93.92	256.89	342.96	22.27
269.60 grams manure excreted, . .	255.37	24.72	37.16	64.56	119.05	9.88
Grams digested, ...	512.61	27.12	56.76	192.33	223.91	12.39
Per cent. digested, ...	66.75	52.31	60.43	74.87	65.29	55.64

English Hay — Concluded.

Young Sheep III.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
850 grams English hay fed, . . .	767.98	51.84	93.92	256.89	342.96	22.27
283.50 grams manure excreted, . .	268.93	24.39	35.34	74.36	124.57	10.27
Grams digested, ...	499.05	27.45	58.58	182.53	218.39	12.00
Per cent. digested, ...	64.98	52.95	62.37	71.05	63.68	53.88
Average per cent. for three sheep, .	65.92	51.95	61.98	72.87	64.66	54.23

Average nutritive ratio of rations for three sheep, 1:7.5.

Green Diamond Sugar Feed. — Periods X. and XIV.

Old Sheep III.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
400 grams Green Diamond sugar feed fed.	367.80	36.34	50.43	56.16	215.05	9.82
500 grams English hay fed, . . .	444.75	30.02	54.39	148.77	198.67	12.90
Amount consumed, ...	812.55	66.36	104.82	204.93	413.72	22.72
270.80 grams manure excreted, . .	254.80	37.46	34.86	62.35	113.18	6.96
Grams digested, ...	557.75	28.90	69.96	142.58	300.54	15.76
Minus hay digested, ...	301.85	14.76	33.89	113.51	131.90	6.76
Sugar feed digested, ...	255.90	14.14	36.07	29.07	168.64	9.00
Per cent. digested, ...	69.58	38.91	71.52	51.76	78.42	91.65

Paige Sheep IV.

300 grams Green Diamond sugar feed,	268.86	26.56	36.86	41.05	157.20	7.18
500 grams English hay fed, . . .	450.85	30.43	55.14	150.81	201.39	13.07
Amount consumed, ...	719.71	56.99	92.00	191.86	358.59	20.25
274.5 grams manure excreted, . .	259.18	33.75	33.15	65.86	118.16	8.27
Grams digested, ...	460.53	23.24	58.85	126.00	240.43	11.98
Minus hay digested, ...	295.21	13.57	33.93	111.31	129.82	6.56
Sugar feed digested, ...	165.32	9.67	24.92	14.69	110.61	5.42
Per cent. digested, ...	61.49	36.41	67.61	35.79	70.36	75.49
Average per cent. for both sheep, .	65.54	37.66	69.57	43.78	74.39	83.57

Average nutritive ratio of rations for two sheep, 1: 6.8.

Sea Island Cotton-seed Meal. — Period XI.

Paige Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
200 grams Sea Island cotton-seed meal fed.	181.94	9.46	49.69	35.79	75.45	11.55
650 grams English hay fed, . . .	590.98	39.89	72.28	197.68	263.99	17.14
Amount consumed, ...	772.92	49.35	121.97	233.47	339.44	28.69
296.70 grams manure excreted, . .	276.41	23.96	39.17	90.52	114.18	8.57
Grams digested, ...	496.51	25.39	82.80	142.95	225.26	20.12
Minus hay digested, ...	386.97	17.79	44.47	145.91	170.17	8.60
Cotton-seed meal digested, . . .	109.54	7.60	38.33	–	55.09	11.52
Per cent. digested, ...	60.21	80.34	77.14	–	73.02	99.74

Paige Sheep V.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Amount consumed as above, . .	772.92	49.35	121.97	233.47	339.44	28.69
267 grams manure excreted, . . .	248.23	23.16	37.73	73.13	106.39	7.82
Grams digested, ...	524.69	26.19	84.24	160.34	233.05	20.87
Minus hay digested, ...	386.97	17.79	44.47	145.91	170.17	8.60
Cotton-seed meal digested, . . .	137.72	8.40	39.77	14.43	62.88	12.27
Per cent. digested, ...	75.69	88.79	80.04	40.32	83.34	100+
Average per cent. for both sheep, .	67.95	84.56	78.39	40.32	78.18	100

Average nutritive ratio of rations for two sheep, 1:5.1.

Red Wheat Meal. — Period XII.

Young Sheep I.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
550 grams English hay fed, . . .	489.06	33.01	59.81	163.59	218.46	14.18
300 grams red wheat meal fed, . .	262.29	5.04	26.12	7.84	215.94	7.34
Amount consumed, ...	751.35	38.05	85.93	171.43	434.40	21.52
209.80 grams manure excreted, . .	197.74	19.60	30.97	49.08	90.19	7.91
Grams digested, ...	553.61	18.45	54.96	122.35	344.21	13.61
Minus hay digested, ...	322.39	17.15	37.07	119.21	141.26	7.69
Red wheat meal digested, . . .	231.22	1.30	17.89	3.14	202.95	5.92
Per cent. digested, ...	88.15	25.79	68.49	40.05	93.98	80.65

Red Wheat Meal — Concluded.

Young Sheep III.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Amount consumed as above, . .	751.35	38.05	85.93	171.43	434.40	21.52
223.20 grams manure excreted, . .	210.19	19.42	31.70	54.33	96.73	8.01
Grams digested, ...	541.16	18.63	54.23	117.10	337.67	13.51
Minus hay digested, ...	322.39	17.15	37.07	119.21	141.26	7.69
Red wheat meal digested, . . .	218.77	1.48	17.16	–	196.41	5.82
Per cent. digested, ...	83.41	29.37	65.70	–	90.96	79.29
Average per cent. for both sheep, .	85.78	27.58	67.10	–	92.47	79.97

Average nutritive ratio of rations for two sheep, 1: 9.

Leaming Corn Silage. — Period XIII.

Old Sheep II.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
400 grams English hay fed, . . .	360.68	24.35	44.11	120.65	161.12	10.46
1,600 grams corn silage fed, . . .	343.04	20.82	34.96	89.40	188.29	9.57
Amount consumed, ...	703.72	45.17	79.07	210.05	394.41	20.03
240.40 grams manure excreted, . .	226.26	23.71	31.00	56.90	108.04	6.61
Grams digested, ...	477.46	21.46	48.07	153.15	241.37	13.42
Minus hay digested, ...	244.79	11.97	27.48	92.06	106.97	5.48
Corn silage digested, ...	232.67	9.49	20.59	61.09	134.40	7.94
Per cent. digested, ...	67.82	45.58	58.89	68.33	71.38	82.97

Old Sheep III.

Amount consumed as above, . .	703.72	45.17	79.07	210.05	349.41	20.03
224.20 grams manure excreted, . .	211.17	21.94	27.49	53.09	102.35	6.29
Grams digested, ...	492.55	23.23	51.58	157.96	247.06	13.74
Minus hay digested, ...	244.79	11.97	27.48	92.06	106.97	5.48
Corn silage digested, ...	247.76	11.26	24.10	65.90	140.09	8.26
Per cent. digested, ...	72.22	54.08	68.93	73.71	74.40	86.31
Average per cent. for both sheep, .	70.02	49.83	63.91	71.02	72.89	84.64

Average nutritive ratio of rations for two sheep, 1: 8.6.

White Winter Wheat Meal. — Period XV.

Young Sheep I.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
600 grams English hay fed, . . .	537.60	36.29	65.75	179.83	240.15	15.59
250 grams wheat meal fed, . . .	219.50	4.17	28.69	5.22	176.68	4.74
Amount consumed, ...	757.10	40.46	94.44	185.05	416.83	20.33
218.60 grams manure excreted, . .	203.89	21.18	29.97	49.97	93.83	8.93
Grams digested, ...	553.21	19.28	64.47	135.08	323.00	11.40
Minus hay digested, ...	354.39	18.85	40.75	131.04	155.28	8.45
Wheat meal digested, ...	198.82	.43	23.72	4.04	167.72	2.95
Per cent. digested, ...	90.58	10.31	82.68	77.39	94.93	62.24

Young Sheep III.

Amount consumed as above, . .	757.10	40.46	94.44	185.05	416.83	20.33
229.90 grams manure excreted, . .	214.01	19.58	30.48	56.28	98.94	8.73
Grams digested, ...	543.09	20.88	63.96	128.77	317.89	11.60
Minus hay digested, ...	354.39	18.85	40.75	131.04	155.28	8.45
Wheat meal digested, ...	188.70	2.03	23.21	–	162.61	3.15
Per cent. digested, ...	85.97	48.68	80.90	–	92.04	66.46
Average per cent. for both sheep, .	88.28	29.50	81.79	–	93.49	64.35

Average nutritive ratio of rations for two sheep, 1: 7.4.

Feed Barley Meal. — Period XVI.

Paige Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
550 grams English hay fed, . . .	491.43	33.17	60.10	164.38	219.52	14.25
250 grams feed barley fed, . . .	222.68	7.28	32.51	13.78	164.56	4.54
Amount consumed, ...	714.11	40.45	92.61	178.16	384.08	18.79
203.20 grams manure excreted, . .	188.89	23.61	26.18	43.60	87.76	7.74
Grams digested, ...	525.22	16.84	66.43	134.56	296.32	11.05
Minus hay digested, ...	321.79	14.79	36.98	121.33	141.50	7.15
Feed barley digested, ...	203.43	2.05	29.45	13.23	154.82	3.90
Per cent. digested, ...	91.36	28.16	90.06	96.01	94.08	85.90

Feed Barley Meal — Concluded.

Paige Sheep V.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Amount consumed as above,	714.11	40.45	92.61	178.16	384.08	18.79
215 grams manure excreted,*	199.52	22.23	27.65	50.66	91.28	7.70
Grams digested,	514.59	18.22	64.95	127.50	292.80	11.09
Minus hay digested,	321.79	14.79	36.98	121.33	141.50	7.15
Feed barley digested,	192.80	3.43	27.97	6.17	151.30	3.94
Per cent. digested,	86.58	47.12	86.10	44.78	91.94	86.78
Average per cent. for both sheep,	88.97	37.64	88.08	70.40	93.01	86.34

Average nutritive ratio of rations for two sheep, 1:6.8.

Summary of Coefficients.

Food.	Sheep and Number.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Early Amber Sorghum.	Paige Sheep IV.,	69.36	42.98	45.36	71.72	74.04	60.39
	Paige Sheep V.,	67.37	40.45	50.91	65.22	73.35	65.10
	Average,	68.37	41.72	48.14	68.47	73.70	62.75
Pride of the North corn fodder.	Old Sheep II.,	71.89	40.06	64.45	66.50	77.76	78.37
	Old Sheep III.,	69.22	28.81	61.03	63.14	76.32	73.75
	Average,	70.56	34.43	62.74	64.82	77.04	76.06
Porto Rico molasses.	Paige Sheep IV.,	107.09	92.16	40.43	-	102.76	-
	Paige Sheep V.,	90.93	80.02	10.17	-	95.80	-
	Average,	99.01	86.09	25.30	-	99.28	-
Porto Rico molasses.	Paige Sheep IV.,	91.89	47.38	-	-	95.35	-
	Paige Sheep V.,	88.21	57.74	-	-	95.30	-
	Average,	90.05	52.56	-	-	95.33	-
English hay,	Paige Sheep IV.,	66.05	43.76	60.86	75.44	64.85	49.88
	Paige Sheep V.,	64.90	45.44	62.20	72.18	64.06	50.51
	Average,	65.48	44.60	61.53	73.81	64.46	50.20
English hay,	Old Sheep II.,	69.38	51.01	63.20	78.04	68.29	55.21
	Old Sheep III.,	66.36	47.33	61.41	74.55	65.56	49.53
	Average,	67.87	49.17	62.31	76.30	66.39	52.37

Summary of Coefficients — Concluded.

Food.	Sheep and Number.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Gluten feed,	Paige Sheep IV.,	93.78	78.07	89.26	123.46	93.42	75.70
	Paige Sheep V.,	97.83	98.67	92.91	128.92	97.03	79.68
	Average,	95.81	88.37	91.09	126.19	95.23	77.69
Porto Rico molasses.	Paige Sheep IV.,	76.50	64.12	-	-	86.93	-
	Paige Sheep V.,	72.53	65.25	-	-	84.80	-
	Average,	74.52	64.69	-	-	85.87	-
English hay,	Young Sheep I.,	66.04	50.60	63.15	72.68	65.01	53.17
	Young Sheep II.,	66.75	52.31	60.43	74.87	65.29	55.64
	Young Sheep III.,	64.98	52.95	62.37	71.05	63.68	53.88
	Average,	65.92	51.95	61.98	72.87	64.66	54.23
Green Diamond sugar feed.	Old Sheep III.,	69.58	38.91	71.52	51.76	78.42	91.65
	Paige Sheep IV.,	61.49	36.41	67.61	35.79	70.36	75.49
	Average,	65.54	37.66	69.57	43.78	74.39	83.57
Sea Island cotton-seed meal.	Paige Sheep IV.,	60.21	80.34	77.14	-	73.02	99.74
	Paige Sheep V.,	75.69	88.79	80.04	40.32	83.34	100+
	Average,	67.95	84.56	78.39	40.32	78.18	100.00
Red wheat meal,	Young Sheep I.,	88.15	25.79	68.49	40.05	93.98	80.65
	Young Sheep III.,	83.41	29.37	65.70	-	90.96	79.29
	Average,	85.78	27.58	67.10	-	92.47	79.97
Leaming corn silage.	Old Sheep II.,	67.82	45.58	58.89	68.33	71.38	82.97
	Old Sheep III.,	72.22	54.08	68.93	73.71	74.40	86.31
	Average,	70.02	49.83	63.91	71.02	72.89	84.64
White winter wheat meal.	Young Sheep I.,	90.58	10.31	82.68	77.39	94.93	62.24
	Young Sheep III.,	85.97	48.68	80.90	-	92.04	66.46
	Average,	88.28	29.50	81.79	-	93.49	64.35
Feed barley meal.	Paige Sheep IV.,	91.36	28.16	90.06	96.01	94.08	85.90
	Paige Sheep V.,	86.58	47.12	86.10	44.78	91.94	86.78
	Average,	88.97	37.64	88.08	70.40	93.01	86.34

Discussion of the Results.

Early Amber Sorghum. — This seed was sown broadcast May 25 at the rate of 60 pounds to the acre, and the crop was cut for soiling. It made a satisfactory growth, yielding at the rate of 19 tons to the acre. The digestion trial began August 13, as the sorghum was heading out, and the fæces were collected August 20 to 26, when the plants were fully headed and the seed forming, at which period it is probably at its best for soiling purposes.

Summary of the Coefficients (Per Cent.).

Period I.

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Paige Sheep IV., . . .	1	1	69.36	42.98	45.36	71.72	74.04	60.39
Paige Sheep V., . . .	1	1	67.37	40.45	50.91	65.22	73.35	65.10
Average, ...	1	2	68.37	41.72	48.14	68.47	73.70	62.75
Barnyard millet for comparison.	3	6	70.00	56.00	65.00	73.00	71.00	58.00
Corn fodder (immature) for comparison.	5	14	68.00	42.00	66.00	65.00	71.00	68.00

The two trials with the sheep agree quite well with each other, and likewise with millet and corn fodder at a similar stage of growth. The protein only seems to be less digestible than that contained in the other two fodders. Sorghum is eaten well by dairy cattle, is available just before corn is sufficiently mature to be at its best, and is considered a satisfactory addition to the list of soiling crops for Massachusetts. A fuller discussion of the merits of this plant for soiling will be presented later.

Pride of the North Dent Corn Fodder. — The samples were taken from a large field of exceptionally thrifty and well-eared fodder. The stalks were quite stout and the ears fully developed. Sampling was begun September 5, and the fæces were collected September 13 to 19, at which time the grain was in the dough and denting. The entire plant was cut fine before being fed. It contained 77.4 per cent. water and 8.83 per cent. protein in dry matter.

Summary of the Coefficients (Per Cent.).

Period II.

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Old Sheep II., ...	1	1	71.89	40.06	64.45	66.50	77.76	78.37
Old Sheep III., ...	1	1	69.22	28.81	61.03	63.14	76.32	73.75
Average, ...	1	2	70.56	34.43	62.74	64.82	77.04	76.06
Average all experiments, Dent corn fodder for comparison.	9	17	68.00	34.00	53.00	57.00	73.00	74.00

The two sheep consumed the fodder readily, suffered no digestion disturbances and gave closely agreeing results. The average coefficients secured with the two sheep agree as closely as could be expected with the average of all results for mature Dent fodder. The present experiment shows in a very satisfactory manner the degree of digestibility of an excellent variety of Dent fodder that will mature in Massachusetts.

Porto Rico Molasses. — Molasses from Porto Rico has been freely offered in Massachusetts for cattle feeding at a cost of 13 cents a gallon of 12 pounds in barrel lots. The material, while dark colored, was of a satisfactory quality. It contained 20 to 28 per cent. of water (about 24 per cent. average), and in its natural condition about 3 per cent. of crude protein (largely amids), 6.3 per cent. of ash, and the balance cane and invert sugars and allied substances (extract matter). It can be safely assumed that molasses, being quite soluble in water, is easily digested and resorbed in the digestive tract. Three digestion experiments were made by feeding different quantities of the molasses in combination with hay, and hay and gluten feed, in order to note its effect upon the digestion of the other feed stuffs.[1]

[1] It is a well-known fact that the addition of excessive quantities of starch and sugar causes a distinct depression in digestibility of the other feed stuffs. See summary in Kellner (already cited), page 48.

Summary of the Coefficients (Per Cent.).

Period III.

[800 grams hay, 150 grams molasses and 10 grams salt.]

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Paige Sheep IV., ...	1	1	107.09	92.16	40.43	-	102.76	-
Paige Sheep V., ...	1	1	90.93	80.02	10.17	-	95.80	-
Average, ...	1	2	99.01	86.09	25.30	-	99.28	-

The results show that apparently Sheep IV. digested rather more, and Sheep V. some 9 per cent. less, than the quantity fed. The average coefficients for the two sheep indicate that the dry matter of the molasses was fully digested. It is probably true, however, that in case of Sheep IV. the addition of 150 grams of molasses to the hay ration increased the digestibility of the dry matter of the hay some 7 per cent., and in case of Sheep V. decreased the digestibility of the hay about a like amount. The results can be still further explained by the following figures: —

Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Digested of 800 grams hay fed alone (grams).	408.87	23.43	32.85	133.86	210.30	8.12
Digested of 800 grams hay + 150 grams molasses.	523.71	31.78	34.56	141.89	306.85	8.54
Minus 150 grams molasses fed, assumed to be all digested (grams).	107.24	9.06	4.23	-	93.95	-
Leaves for 800 grams hay digested when fed with molasses.	416.47	22.72	30.33	141.89	212.90	8.54
Difference, ...	+7.60	—.71	—2.52	+8.03	+2.60	+.42

It will be seen that in case of Sheep IV. the feeding of 150 grams of molasses with 800 grams of hay increased the digestibility of the hay 7.6 grams. By this method of feeding the digestibility of the fiber, extract matter and fat in the hay was increased 11.05 grams and the digestibility of the ash and protein depressed 3.23 grams. If 150 grams of molasses increased the digestibility of the hay 7.32 grams (7.60), 100 grams of molasses would increase it 5.1 grams.

Sheep V.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Digestion of 800 grams hay fed alone (grams).	408.87	23.43	32.85	133.86	210.30	8.12
Digested of 800 grams hay + 150 grams molasses (grams).	506.38	30.68	33.28	133.82	300.30	8.31
Minus 150 grams molasses fed assumed to be all digested (grams).	107.24	9.06	4.23	–	93.95	–
Leaves for 800 grams hay digested when fed with molasses.	399.14	21.62	29.05	133.82	206.35	8.31
Difference, ...	—9.73	—1.81	—3.80	—.04	—3.95	+.19

Sheep V. digested 9.36 (9.73) grams less hay when the latter was fed with the molasses than when it was fed alone, or 100 grams of molasses caused a depression of 6.05 grams in the digestibility of the hay. The results secured in this particular experiment (Period III.) are contradictory, and definite conclusions cannot be drawn other than to conclude that this quantity of molasses was well assimilated, without causing any serious digestion depression.

Period IV.

[800 grams hay + 250 grams molasses + 10 grams salt.]

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Paige Sheep IV., . . .	1	1	91.89	47.38	–	–	95.35	–
Paige Sheep V., . . .	1	1	88.21	57.54	–	–	95.30	–
Average, ...	1	2	90.05	52.56	–	–	95.33	–

It seems apparent that 90 per cent. of the total dry matter of the molasses was digested, equivalent to one-half of the ash, none of the protein and 95 per cent. of the extract matter. That these results are more apparent than real can be shown from the following: —

Average, Sheep IV. and V.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Digested of 800 grams hay fed alone (grams).	404.56	23.19	32.51	132.44	208.07	8.03
Digested of 800 grams hay + 250 grams molasses (grams).	566.92	31.20	32.04	136.99	358.65	8.06
Minus 250 grams molasses fed, assumed to be all digested (grams).	180.30	15.24	7.10	-	157.96	-
Leaves for 800 grams hay digested when fed with molasses.	386.62	15.96	24.94	136.99	200.69	8.06
Difference, ...	—17.94	—7.23	—7.57	+4.55	—7.38	+.03

The average results for the two sheep show that 17.94 (17.60) grams less hay were digested when 250 grams of molasses were fed than when the hay was fed by itself; or 100 grams of molasses caused a depression of 7.2 grams in the digestibility of the dry matter of the hay. The molasses depressed the digestibility of the ash, protein and extract matter of the hay. Excluding the ash, 100 grams of molasses caused a depression of 4.1 grams in the digestibility of the organic matter of the hay. Molasses and hay naturally would not make a satisfactory combination for any kind of farm stock. A more suitable ration would consist of hay, a protein concentrate and molasses; consequently, the digestibility of the latter was tested in combination with hay and gluten feed, with the following results: —

Period VIII.

[600 grams hay, 200 grams gluten feed, 250 grams molasses, 10 grams salt.]

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Paige Sheep IV., . . .	1	1	76.50	64.12	-	-	86.93	-
Paige Sheep V., . . .	1	1	72.53	65.25	-	-	84.80	-
Average, ...	1	2	74.52	64.59	-	-	85.87	-

It is apparent from the above results that the sheep digested only some 75 per cent. of the total dry matter of the molasses. By assuming that the entire quantity of molasses fed was digested, the following results are secured: —

Average, Sheep IV and V.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Digested of hay and gluten feed when fed *without* molasses (grams).	524.97	18.75	81.88	148.40	264.22	11.74
Digested of hay and gluten feed fed with molasses.	660.31	29.58	79.47	139.96	399.66	11.61
Minus 250 grams molasses fed, assumed to be all digested (grams).	181.68	16.75	7.16	-	157.77	-
Hay and gluten feed digested when fed *with* molasses (grams).	478.63	12.83	72.31	139.96	241.89	11.61
Difference, ...	—46.34	—5.92	—9.57	—8.44	—22.33	—.13

The average results for the two sheep show that 46.34 grams less of the dry matter of the hay and gluten feed were digested with than without the molasses; or 100 grams of molasses caused a depression of 18.5 grams in the digestibility of the hay and gluten ration. Excluding the ash, 100 grams of molasses caused a depression of 3.8 grams protein and 12.3 non-protein substances.

When 250 grams of molasses were fed in connection with hay, the digestion depression for organic matter was at the rate of 4 grams per 100 grams molasses; and when fed in connection with hay and a nitrogenous concentrate, the digestion depression was 16.1 grams. It is intended to repeat the latter experiment by feeding different quantities of molasses with hay and gluten feed, in order to see if the depression continues as high as that observed in the present test.

The average of three complete analyses of Porto Rico molasses has shown it to contain, in round numbers, 24 per cent. of water, 6.25 per cent. ash, 2.75 per cent. protein and 67 per cent. carbohydrates. Inasmuch as the so-called protein is practically all in amido or other forms which are of no value as sources of nutrition, it may be said that the food value of molasses consists in its 67 per cent. of carbohydrates. Applying the digestion coefficient of 86, obtained for the digestibility of the extract matter when the molasses was fed in combination with hay and gluten feed, one obtains 58 per cent. of digestible carbohydrates, equivalent to 1,160 pounds in a ton.

By deducting 16 grams, or 16 pounds (for the digestion depression), from the 70 per cent. of total organic matter, molasses may be said to contain 54 per cent. of digestible organic matter, equivalent to 1,080 pounds in a ton. In the light of the above results, it is evident that 2,000 pounds of Porto Rico molasses contain between 1,080 and 1,160 of easily digestible carbohydrates, and that its crude protein has little or no value as a source of nutrition.[1]

Kellner [2] considers the value of beet sugar molasses to consist in its 55 per cent. of digestible carbohydrates, allowance being made for the digestion depression. Lehmann,[3] as a result of three digestion experiments (9 single trials), feeding hay, cotton-seed or palm-nut meal, and 200, 300 and 400 grams of molasses, secured a digestion depression of 11 per cent., or 11 grams, per 100 grams of molasses fed. Deducting this from the 71 per cent. of organic matter, he declares the value of the beet molasses to consist in its 60 per cent. of digestible carbohydrates.

English Hay. — This hay consisted largely of Kentucky blue grass (*Poa pratensis*), with an admixture of more or less red clover. It was cut when in bloom, well cured, and used in periods V., VI., VII., VIII., IX., XI., XII., XIII., XIV., XV. and XVI.

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1 One is not likely to feed over 3 pounds of molasses daily to dairy stock or to horses, which is equivalent to approximately 10 per cent. of the dry matter of the total ration. In our digestion experiment with hay and gluten feed, molasses constituted 20 per cent. of the dry matter of the ration; and in Lehmann's experiments, 25 per cent. If only 10 per cent. of the total dry matter in the daily ration should consist of molasses, the question naturally arises as to whether this amount would cause so much of a depression as when larger quantities were fed. This matter is being investigated.

2 Kellner (already cited), page 350.

3 Landw. Jahrbücher, Vol. XXV. Erganzungsband 11, 1894, pages 117–120.

Summary of the Coefficients (Per Cent.).

Periods V., VI., IX.

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Paige Sheep IV., . . .	1	1	66.05	43.76	60.86	75.44	64.85	49.88
Paige Sheep V., . . .	1	1	64.90	45.44	62.20	72.18	64.06	50.51
Average, ...	1	2	65.48	44.60	61.53	73.81	64.46	50.20
Old Sheep II., ...	1	1	69.38	51.01	63.20	78.04	68.29	55.21
Old Sheep III., ...	1	1	66.36	47.33	61.41	74.55	65.56	49.53
Average, ...	1	2	67.87	49.17	62.31	76.30	66.39	52.37
Young Sheep I., . . .	1	1	66.04	50.60	63.15	72.68	65.01	53.17
Young Sheep II., . . .	1	1	66.75	52.31	60.43	74.87	65.29	55.64
Young Sheep III., . . .	1	1	64.98	52.95	62.37	71.05	63.68	53.88
Average, ...	1	3	65.92	51.95	61.98	72.87	64.66	54.23
Average, seven sheep, . .	1	7	66.35	49.05	61.95	75.55	65.10	52.55
Average all previous trials, similar hay for comparison.	15	60	60.00	47.00	57.00	60.00	61.00	50.00

The three lots of sheep digested the hay quite uniformly. The Old Sheep gave slightly higher digestion coefficients than the other two lots, — a condition which has been noticed in previous trials. The hay proved to have a higher digestibility than the average of previous lots; the high digestibility of the fiber indicates that the lignin substances were only slightly developed, or, in other words, that the grass was tender and comparatively immature.

Gluten Feed. — The sample of gluten feed, consisting of the gluten, skins, starchy matter and broken germs of the Indian corn, was in good condition, although a little below the average in protein.

Summary of Coefficients (Per Cent.).

Period VIII.

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Paige Sheep IV., . . .	1	1	93.78	78.07	89.26	123.46	93.42	75.70
Paige Sheep V., . . .	1	1	97.83	98.67	92.91	128.92	97.03	79.68
Average, ...	1	2	95.81	88.37	91.09	126.19	95.23	77.69
Average previous trials for comparison.	7	13	86.00	–	85.00	76.00	89.00	83.00

The gluten feed appears to have been thoroughly digested, showing higher coefficients than the average of previous trials. It is probable that the addition of the gluten to the hay ration somewhat increased the digestibility of the latter. It not being possible, however, to ascertain to what extent this increase took place, one is compelled to deduct from the total ration the hay digested (using the coefficients obtained for the hay when fed by itself), thus causing most of the gluten coefficients to appear too high [1] (note especially the fiber).

Green Diamond Sugar Feed. — This sugar feed has a similar appearance and is of the same general type as those already reported (see this report, pages 236, 237). Period X. started with two sheep, but the fæces produced by one sheep were so soft that it was not possible to complete the test. Another trial with another sheep was also unsatisfactory. A third trial, in Period XIV., with Paige Sheep IV., was satisfactorily completed.

Summary of Coefficients (Per Cent.).

Periods X. and XIV.

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Old Sheep III., ...	1	1	69.58	38.91	71.52	51.76	78.42	91.65
Paige Sheep IV., . . .	1	1	61.49	36.41	67.61	35.79	70.36	75.49
Average, ...	1	2	65.54	37.66	69.57	43.78	74.39	83.57
Average of three other sugar feeds (Series X.).	3	6	70.44	30.37	61.77	53.30	78.40	88.20
Average all trials, . . .	4	8	69.21	32.20	63.72	50.92	77.40	87.04

[1] The addition of a concentrated feed rich in protein tends to improve the digestibility of the total ration, especially the fiber. (See Kellner, *loco citato*, pages 51–53.)

Sheep III. digested the feed rather better than Sheep IV. Attention has already been called to the fact that the Old Sheep had a slightly stronger digestion than the others, but why the difference should be so noticeable is difficult to explain.

The protein in the sample of Green Diamond experimented with was better digested than that in the several other sugar feeds. The results secured with Sheep III. and the average results of all trials agree closely; and it may safely be said that this feed has about the same type of composition and a like degree of digestibility as the other sugar feeds examined. The average results of all trials show the sugar feeds to be only moderately digestible, being noticeably less so than either flour middlings or gluten feed.

Sea Island Cotton-seed Meal. — This meal contained a large quantity of hulls, showing only 24–25 per cent. of protein, 5–6 per cent. of fat and some 18 per cent. of fiber. It is claimed that the hulls of this variety of seed are thin, and that it is not possible (or profitable) to thoroughly separate them from the meats.

Summary of Coefficients (Per Cent.).

Period XI.

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Paige Sheep IV., ...	1	1	60.21	80.34	77.14	–	73.02	99.74
Paige Sheep V., ...	1	1	75.69	88.79	80.04	40.32	83.34	100+
Average, ...	1	2	67.95	84.56	78.59	40.32	78.18	100.00
Similar material (Maine), .	1	2	62.00	–	73.00	38.00	68.00	90.00
Cotton-seed meal (high grade),	4	12	79.00	84.00	84.00	35.00	78.00	94.00

Sheep IV. was not able to digest the meal as fully as was Sheep V. The cause of this difference is due largely to the indigestible character of the tough, woody fiber. The coefficients secured at the Maine station for a similar meal are somewhat lower than those obtained in the present experiment.

The fat in the low-grade meal is shown to be nearly all available, while the protein is somewhat less digestible than that contained in a high-grade meal; the chief difference, however, in the digestibility of the two grades is to be found in the total dry and extract matter, decidedly lower coefficients being secured from the low-grade meal containing a high fiber percentage. Cotton-seed meal of first quality should contain in 2,000 pounds about 700 to 760 pounds protein, 44 pounds fiber, 380 pounds extract matter and 192 pounds fat, or 1,346 pounds digestible organic matter in one ton. A low-grade meal will contain 380 pounds protein, 144 pounds fiber, 540 pounds extract matter and 142 pounds fat, or 1,206 pounds digestible organic matter in a ton. The low-grade meal contains only about one-half as much of the most valuable ingredient (digestible protein) as does the high-grade meal. The former meal will likewise require considerably more energy for its digestion.

Leaming Corn Silage. — The Leaming corn is a large dent, that will usually mature its grain in Massachusetts. The silage was in nice condition, and was made from matured and well-eared corn. The sheep ate the silage well, continued in good condition, and during the entire trial left only 25 and 40 grams each of the hard butts.

Period XIII.

[400 grams hay, 1,600 grams silage, 10 grams salt.]

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Old Sheep II., ...	1	1	67.82	45.58	58.89	68.33	71.38	82.97
Old Sheep III., ...	1	1	72.22	54.08	68.93	73.71	74.40	86.31
Average, ...	1	2	70.02	49.83	63.91	71.02	72.89	84.64
Dent silage, mature, all trials for comparison.	9	25	66.00	37.00	50.00	64.00	71.00	82.00

The two sheep showed closely agreeing results except in case of the protein, Sheep III. digesting 10 per cent. more than Sheep II. The Leaming corn is highly esteemed by many farmers for silage purposes; and the fact that it will generally mature its grain, together with its high degree of digestibility, as shown by the above coefficients, shows the preference to be a wise one. The average results of the two trials are rather higher than the general average of all experiments with different varieties of Dent corn.

Red and White Wheat and Barley Meals. — The several grains were purchased of local dealers. Neither variety of wheat was suitable for milling; the former contained some shrunken berries and a few weed seeds, and the latter, while fairly plump, was off color. The barley was known as "feed barley;" it was not plump and full, and was a trifle musty. The grains were sold as food for poultry, and may be considered of a fairly satisfactory quality for such a purpose. The red wheat retailed at $1.65, the white at $1.80 and the barley at $1.30 per hundred pounds. The analyses and the digestion trials were made for the purpose of ascertaining their relative values for feeding purposes.

Composition (Per Cent.).

Feed.	Water.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.
Red wheat,	12	1.69	8.76	2.64	72.45	2.46
White wheat,	12	1.67	11.50	2.11	70.84	1.90
Feed barley,	11	2.91	12.99	5.52	65.78	1.80

Each of the two samples of wheat contained a trifle less than 12 per cent. water, and the results were therefore calculated to that basis for comparison. The white wheat tested a little better than the red, containing nearly 3 per cent. more protein and a little less fiber. It is doubtful, however, if these figures would hold true in all cases. In fact, it is well known that both climate and soil have great influence on the quality of wheat and gradually modify varieties.

The barley showed rather more protein than is usually found in this grain. It is probable that it had not been fully ripened when cut, thus preventing the most complete development of the starch.

Summary of Coefficients (Per Cent.).

Periods XII., XV. and XVI.

[Red Wheat.]

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Young Sheep I.,	1	1	88.15	25.79	68.49	40.05	93.98	80.65
Young Sheep III.,	1	1	83.41	29.37	65.70	–	90.96	79.29
Average,	1	2	85.78	27.58	67.10	–	92.47	79.97
[White Wheat.]								
Young Sheep I.,	1	1	90.58	10.31	82.68	77.39	94.93	62.24
Young Sheep III.,	1	1	85.97	48.68	80.90	–	92.04	64.35
Average,	1	2	88.28	29.50	81.79	–	93.49	63.30
Average, both varieties,	2	4	87.03	28.54	74.44	–	93.00	71.30
[Feed Barley.]								
Paige Sheep IV.,	1	1	91.36	28.16	90.06	96.01	94.08	85.90
Paige Sheep V.,	1	1	86.58	47.12	86.10	44.78	91.94	86.78
Average,	1	2	88.97	37.64	88.08	76.40	93.01	86.34
Corn for comparison,	9	21	88.00	–	66.00	–	92.00	91.00

The grains were ground in each case before being fed. Both varieties of wheat were well digested; the white wheat appeared to have been slightly better digested than the red. The barley was likewise quite fully digested, showing 89 per cent. of digestible dry matter and 88 per cent. of digestible protein. The ratio of digestible protein to carbohydrates in the red wheat was 1 to 9; in the white wheat, 1 to 7.4; and in the barley, 1 to 6.8. The increased digestibility of the protein in the white wheat and feed barley over that contained in the red wheat is due probably to the relatively higher percentage of protein in the latter two grains, and consequently in the two total rations.[1] It is believed that the protein in ordinary grains (maize, wheat and barley) is equally and quite fully digested, providing it is fed in a ration having a ratio of 1 to 8 or less; and that the apparent

[1] For every 100 grams of dry matter fed, a reasonably definite amount of nitrogenous metabolic by-products are egested, mixed with the fæces, whether the ration is rich or poor in protein. It follows, therefore, that the smaller the amount of protein in the total ration the smaller will be the amount of protein left (digested) after these by-products which are included in the fæces have been deducted.

low coefficient (see present red wheat protein coefficient, and average protein coefficients for maize) is due largely to the above-mentioned cause.[1] A further study of the coefficients of wheat, barley and corn, as given on the previous pages, shows the extract matter to have practically the same degree of digestibility.[2]

On the basis of composition and of the digestion coefficients secured, the white variety of wheat is shown to be some 9 per cent. more valuable than the red. Whether this would hold true as a general rule is not known. Other things being equal, the higher the protein content of the wheat the more valuable it is.

Taking the value of all the ingredients into consideration (protein, fiber, extract matter and fat), an average quality of "feed barley" appears to be about as valuable as an average quality of white wheat, and both grains figure slightly more valuable than maize (8 per cent.). Kellner[3] considers these three grains to have very nearly equal relative values, and as sources of carbohydrates this estimate must be correct. Brooks[4] has called attention to the fact that, with a plentiful supply of animal protein, corn gives rather better results than wheat for egg production, and at less relative cost. In view of their composition and digestibility, it would seem as if there were no reason to expect any particular difference in the feeding effect of these two grains. It is possible, however, that the energy required for the digestion of the wheat might be greater than that required to digest the corn. It is well known that poultry are particularly fond of corn and moderately so of wheat, but do not care especially for barley. This fact should not be overlooked in comparing the relative merits of corn, wheat and barley for this class of stock.

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[2] The digestion experiments thus far made with poultry show the dry matter in corn to be 87, protein 84 and extract matter 92 per cent. digestible; and in wheat dry matter 84, protein 77 and extract matter 89 per cent. digestible. In other words, poultry digest the two grains to about the same extent as sheep.

[3] *Loco citato*, page 561.

[4] Eighteenth report of this station, page 152.

REPORT OF THE BOTANIST.

G. E. STONE; ASSISTANT, N. F. MONAHAN.

Outline of Work.

The work of this department has been devoted during the past year to lines of investigation pertaining to scientific and practical problems. Attention has been given to the spraying of potatoes, and to a study of the stimulating or tonic influence of the Bordeaux mixture on the photosynthesis of plants. It has long been recognized by many observers that Bordeaux mixture, besides possessing valuable fungicidal properties, exerts a tonic effect on plant assimilation. The factors underlying the cause of this favorable influence upon assimilation, however, are not well understood, and investigations are to be continued relating to this problem.

A continuation of our studies of a remedy for tomato rot under glass has been carried on, and it will be necessary to continue these investigations still further before a report is made. It is hoped that the necessary funds for a new greenhouse will be appropriated this winter by the Legislature, in order that this work and other problems associated with greenhouse culture may be investigated. There is a large amount of money invested in greenhouses at the present time in Massachusetts, and we believe we are within the limits of safety when we state that the square feet of greenhouse space in Massachusetts has been doubled within the past five years. Little attention has been given to this line of investigation by other stations, and the market-garden and florist industry is important enough, in this State at least, to receive considerable attention.

During the past summer tests have been made of some blight-resisting cantaloupes which were originated in Colorado. It is hoped that further observations may be made on cantaloupes, with the idea of securing blight-resisting types, since at the present time crops of melons free from blight are a rarity in Massachusetts.

Some bacterial investigations have been carried on which possess a bearing on various problems, but it is not deemed advisable to report on this work at the present time.

This also holds true in regard to some minor experiments with electricity as related to plants. Extensive observations have been made in regard to the bearing of light upon plant growth, more particularly in regard to greenhouse construction and other problems.

During the coming year we expect to take up the study of some climatic influences which affect the production of both greenhouse and out-door crops. The production of crops is so intimately associated with such factors as light, heat, moisture, etc., — factors which are scarcely appreciated except by skilled greenhouse growers, — that a more extensive study of them would prove of value.

During the year a large number of mechanical analyses of soils have been made by this department, most of which were rose soils. These analyses were made for expert rose growers, who desired to secure suitable soils for the growth of American Beauty and other roses.

Seed Work.

There is a constantly increasing demand upon this department for work pertaining to seed germination, seed separation and purity testing of seeds. The department is not at present sufficiently well equipped for purity testing, since the best work in this line can be done only by a specialist, or by one who is able to devote considerable study to the subject.

Most of our seed separation is done for tobacco and onion growers of the Connecticut valley, and for this work the department has installed efficient appliances. It is hoped that market gardeners will eventually separate their seed, since in growing such crops as lettuce, celery, radishes, etc., this practice would prove valuable.

The following table gives a condensed statement of the work done by this department on seeds during the year: —

Records of Seed Work for 1906.

	Number of Samples.	Number of Seed.	Weight (Pounds).	Good Seed (Per Cent.).	Discarded Seed (Per Cent.).
Germination tests,	126	19,567	-	58.8	-
Purity test,	18	-	-	-	-
Seed separation: —					
Onion,	13	-	129.6	83.8	16.2
Tobacco,	74	-	24.1	80.3	19.7
Total,	231	-	-	-	-

The average percentage of germination of onion seed was 79.5; of sweet corn, 71.9; and the highest percentage of onion seed germination was 100, while the same percentage was obtained with samples of sweet corn. The lowest percentage of germination of onion was 28; that of sweet corn, 25. In practically all cases 200 seeds were employed in each test, and smaller numbers were used only when the number of seeds sent in was less. Occasionally more than one test was made, and the average in such cases was taken. The onion seeds tested during 1906 were particularly good, being much better than those we have tested during previous years. Both onion and tobacco seed were separated by air. Only 2 per cent. of seed was discarded by the process of air separation from the best tobacco seed sent in, while from the poorest samples 37 per cent. was discarded. In the case of the best onion seed, 8 per cent. was discarded by the use of a winnowing machine, while only 20 per cent. was discarded from the poorest samples of onion seeds.

Prevalence of Fungi, etc.

One of the peculiarities of the different seasons is that no two are alike as regards the prevalence of certain pathogenic fungi. The potato has been comparatively free from disease during the past season; but there was more or less trouble with celery, particularly in the summer, when there was a period of rather dry weather; and later in the fall there was much complaint of celery blight. Pear and apple blight were unusually prevalent this year, more so than they have been for some time. An unusually large number of samples of pear and apple blight were sent in to the station for diagnosis during the spring and early summer. More or less defoliation of apple trees has occurred, resulting in part from the late spring frosts, which caused blisters on the leaves; and from the use of spraying mixtures.

A considerable amount of trouble is being experienced in the defoliation of apple trees at the present time in various parts of the United States, which is presumably caused by spraying. Some of this trouble is to be found in our State, and we surmise that it may be due in some cases to the use of inferior Paris green in Bordeaux mixture, and in other cases to the Bordeaux itself. The Baldwin apple spot has been more or less prevalent during the past season, and some trouble has been experienced from apple scab.

A widely distributed and common trouble has occurred on apple trees during the past season, which is termed sun scald. This was more noticeable on small branches, particularly on those which were shaded. This same diseased condition was noticeable on other fruit trees, such as the peach and plum; and on some wild shrubs, like the cornels. The effect of sun scald was in some instances of an insignificant nature; while in others it resulted in a partial girdling of some of the branches, which was followed by a poor development of the foliage, and in some cases many of the twigs died.

Sun scald is the result of a non-ripening of the wood; and it is significant that most of the branches affected with this trouble are those hidden from the sun, which prevents the wood from ripening as thoroughly as those which are exposed to the sun.

For the last two or three years sooty mold on the pear has given rise to considerable trouble. This is caused by fungi which grow in the honey-dew secreted by psylla on the leaves and branches. As a consequence of this fungous growth, there results a clogging of the pores of the leaves, which renders them unhealthy, causing them to fall prematurely. The young twigs and branches become covered with a thick black growth, resembling soot, which interferes with their normal functions, thus checking their growth. A satisfactory way of ridding the branches of this sooty growth is not known to us at the present time, and from reports which we have received it would appear that the lime and sulfur treatment has no effect upon it. The best method of prevention is to kill the psylla, which can be effectively done by spraying.

Some incidental observations have been made during the year on diseases which are unusual, at least in this region; and these will be referred to briefly, since it is necessary that further studies of these be made before it can be ascertained whether they are likely to cause much trouble. Our attention has been called a few times to some greenhouse tomato troubles, one of which is probably the Fusarium wilt, or "sleeping disease," as it is termed, — a trouble which has been reported elsewhere.

Another tomato trouble which has been brought to our attention is probably identical with Œdema, and is caused by abnormal heat and moisture conditions. In another case a bacterial trouble of the tomato was observed which was undoubtedly brought about by the exceedingly poor management of the crop.

Two new or little-known asparagus troubles were noticed during the past season, one of which is undoubtedly a Rhizoctonia rot, which is mentioned as occurring on asparagus by Saccardo. We were not able to make an elaborate study of this asparagus infection, owing to the limited amount of material which was at hand. Most Rhizoctonia troubles are serious, and it remains to be seen whether this will prove to be so or not.

Bacterial Disease of Cucumbers.

The bacterial disease of cucumbers, termed by Dr. Erwin R. Smith "bacteriosis," has been seen here in summer for some years on out-door cucumber crops. My attention, however, has not been called to its appearance on greenhouse crops until this year; but if the reports and descriptions of this disease are correct, it has occurred in more than one greenhouse during the year.

In only one case have we had opportunity to examine an affected crop, and this was totally destroyed during October. This crop was started in August, and, like most crops of cucumbers started in midsummer, it was affected with downy mildew (*Plasmopara Cubensis,* B. & C., Humphrey). The soil in the house was of good texture for cucumbers, and well provided with horse manure and commercial fertilizers, as was evident from the vigorous growth of the plants. About the time the plants had reached a height of seven or eight feet and had set a large amount of fruit the leaves commenced to wilt, and in a few days most of the foliage collapsed, leaving only a few unaffected leaves at the top of the plant, which necessitated the removal of the entire crop. Adjacent to this greenhouse were other larger houses, which, however, were planted somewhat later, and the plants in these houses entirely escaped infection.

Bacteriosis of cucumbers has been rare, if it has occurred at all, under glass in this State. A few years ago we secured germs from an affected out-door crop of cucumbers, and inoculated the soil in our greenhouse in which cucumbers were growing, with the result that not the slightest infection occurred in any instance. The experiment was made during the fall and winter months, which may account in part for the failure of the germs to infect the plants.

There is always risk in planting a cucumber house in August, since the downy mildew previously mentioned, and Anthracnose (*Colletotrichum Lagenarium* (Pass.) Ell. & Hals.), are sure to be present during August in full force; and the same probably is true to a certain extent in regard to the germs of bacteriosis. At any rate, it is a significant fact that nearly every house planted late has none of these troubles to contend with.

In the case of the bacteriosis described above we are of the opinion that the method of growing the crop had something to do with its susceptibility to infection, since the plants were in our estimation somewhat too vigorous growers, and did not possess the best texture.

We have frequently advised growers of cucumbers not to plant in August, on account of mildews, etc. There is much less risk in planting in September, and scarcely any during any time in October. If a house of cucumbers is planted in August, it is necessary to ventilate freely, apply little or no water to the foliage, and keep down the moisture in the atmosphere to the lowest degree, in order to hold mildews and Anthracnose in check.

Bacterial Disease of Lettuce.

Our attention has been called at different times to an undescribed bacterial disease of lettuce, which is reported as causing considerable damage in some localities. This disease has been observed in our greenhouse for many years, and during the year 1901 Mr. Percival C. Brooks, then a member of the senior class in botany, investigated this problem. He succeeded in isolating an organism from a diseased lettuce plant, and obtained positive results from his inoculation experiments with healthy plants.

The disease in question has never been observed by us in this State except in our own house, notwithstanding the fact that we have for many years had occasion to carefully study the various lettuce crops in the State, and have constantly been on the lookout for it. Neither has careful inquiry brought to light any trace of a similar affection in lettuce houses in Massachusetts. Since the disease occurred in our lettuce house on crops which had been forced too rapidly, it was considered of little consequence and was given scarcely any attention, inasmuch as we thought the trouble arose from improper management of the crop. Our only purpose in calling attention to this disease at the present time is that it is reported as doing considerable damage elsewhere, particularly in the south, which makes it desirable that we should be on the lookout for it. The disease results in the appearance of numerous small brownish spots about the size of a pin-head on the young and tender light-colored leaves of the head. The spots are frequently quite numerous, and in some cases run together, causing a destruction of a portion of the leaves of the head. No attempt was made by Mr. Brooks to make any extensive study of the organisms causing the disease, since at that time it was believed to be of little consequence, and only an accompaniment of too rapid forcing. In some localities, particularly farther south, we hear different reports concerning its prevalence.

Bacteriosis of Geraniums.

In a previous publication of this station a short note was made of a bacterial disease of geraniums occurring in this State.[1] Since that time we have made yearly observations on the prevalence of this disease in various sections. It has appeared every year since it was first noted here in 1898, and has also been reported from various other sections of the United States within recent years.

Our observations have shown that it has frequently been abundant and generally distributed, so much so at times that gardeners have been more or less concerned about it. We have also noticed this disease in greenhouses each year, it having apparently been brought in with out-door stock, although it does not appear to be serious under glass. Our observations have shown that the trouble is more frequently found on plants exposed to bright sunshine than on those growing in shade, and is evidently more severe farther south, where the light is more intense than in Massachusetts. Geraniums require comparatively little light for their best development, and a strong light may favor the development of this disease.

The disease affects the leaves, causing spots to appear on them. The spots are often numerous and sometimes coalesce, which causes the diseased portions to dry up and turn brown. The spots are about one-eighth of an inch in diameter, and resemble blisters. No other portion of the plant is affected. Examination of a large number of diseased sections shows only a few bacteria present in the tissues except in those cells bordering on the outer portions of the spots.

The geranium is a very hardy plant, and one of the freest from disease. No attempt has been made to treat this disease, to our knowledge, and should it become more troublesome some remedy for it will have to be discovered.

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[1] Tenth annual report, Hatch Experiment Station, 1898, page 67.

Tobacco Troubles.

Some troubles, due to methods of handling the crop, occasionally occur on tobacco growing in the Connecticut valley. Instances have been known for years where the crops have been set back by the use of certain fertilizers and methods of applying them. Tobacco, corn and other crops, moreover, show a tendency to stand still or make little growth on soil in which there is an overabundance of moisture.

Our attention has been called to a tobacco trouble which appears to be caused by the use of fertilizer. In one particular field which we examined the roots of the plants had all the characteristic symptoms of fertilizer burning, and careful examination failed to reveal any fungi associated with this trouble. The tap roots of all the plants which we examined had been destroyed, and new secondary roots had developed freely on the injured end of the tap root. These were endeavoring to penetrate to the lower strata of the soil, and would in turn become burned on the tip before reaching any great distance.

The effect on the crop manifested itself in a stunted growth, the plants remaining in this condition for weeks. When plants affected with this trouble were removed to other soils they would in all cases make rapid growth. Even in the field where the trouble occurred they would reach a fair degree of maturity at the time of harvesting. There appears to be absolutely no connection between this trouble and the seed bed, since other fields close by were planted from this seed bed, and not the slightest evidence of the trouble was to be seen. Moreover, it occurs on new tobacco land as well as on old. It was as severe on land which had been planted this year for the first time as it was on old land.

The trouble apparently seems to have no inclination to spread, since a field only ten or twelve feet away from the infected one, planted with seedlings from the same seed bed, showed no trace of it. It is much more conspicuous in low places which receive drainage from the surrounding soil than on the drier knolls.

At present, at any rate, the trouble must be attributed to mistakes in fertilizing, since no fungi are associated with it; and the only difference between the cultivation of this particular crop in which the trouble occurred and other surrounding ones, some of which had been planted from the same seed beds, consisted in the methods of fertilizing.

Monilia on Peach Stem.

For a number of years we have received peach twigs in this department which have been conspicuously spotted. The spots appear on one-year-old wood, and are of an ash or greyish color in the center, with a more highly colored, generally purple margin. Examination of these spots has invariably revealed the presence of a species of Monilia which extends scarcely below the epidermis. Occasionally the spores of Cladosporium are to be found, but by no means frequently. Some years the spotting appears to be much more common than others, and there is generally little difficulty in finding it in orchards during such periods. Cultures from the spots have always produced Monilia. Mr. F. A. Bartlett, now of Hampton Institute, Hampton, Va., and formerly a senior in our laboratory, during the year 1905 made many isolations and cultures of this fungus. He was not able to complete his studies of the fungus, but from his observations it would appear that a species of Monilia was the sole cause of this spotting. Mr. Bartlett thus verified observations which had been previously made by my former assistant, Prof. R. E. Smith, and myself. From Mr. Bartlett's various cultures it would appear that the spores of Monilia causing this spotting to peach twigs are not the same as those occurring on the fruit (*Oidium fructigenum*)[1] but is a different species, possessing smaller spores, and otherwise differing from the species attacking the fruit of the peach, etc.

There are various Monilia and Cladosporium troubles which affect the peach described in experiment station publications and foreign pathological journals, all of which appear to differ from this one in its effect upon twigs.

We hope to make further investigations of this trouble, and in the meanwhile it may be mentioned that where the lime

[1] *Oidium fructigenum*, Kze. & Schm.

and sulfur treatment has been applied to peach trees for the San José scale not the slightest trace of this spotting can be found, showing that this mixture has a very repressive influence upon the fungus.

The Lime and Sulfur Mixture as a Fungicide.

The increased activity of the San José scale during the past two years has resulted in more attention being paid to the spraying of orchards. This has been the means of reducing very perceptibly many of the troubles to which orchards are subject. Our examinations of a number of orchards during the past summer which had been sprayed with the lime and sulfur mixture have convinced us that this mixture is one of the most reliable fungicides known for the suppression of certain fungous diseases. It is especially applicable for the control of such diseases as the peach leaf curl, as has been previously pointed out by many observers. It is equally valuable in the treatment of Monilia and Cladosporium, which occasionally attack the stem.

The large and exceedingly well-cared-for orchard of Mr. Elbert Bliss of Wilbraham offers one of the best examples of the efficiency of the San José mixture as a fungicide. His orchard, which covers many acres, was absolutely free from any blemish due to fungi, both as regards foliage and wood. The college orchard, which was sprayed for the San José scale with the lime and sulfur mixture, has been remarkably free from fungous troubles during the past season. Our observations of other orchards have seemed to indicate that spraying with the lime and sulfur mixture succeeds in controlling to some extent canker, pear blight, black knot and other diseases. We have frequently advocated early spring spraying of trees before the leaves appear, with a solution of copper sulfate at the rate of 1 pound to 50 gallons of water, as we maintain that many of the common blights are more successfully prevented by this spraying than by later ones. It has been shown that early spraying with copper sulfate has been successful in holding in check the black knot of the plum.

The San José scale may prove in more than one way a "blessing in disguise."

Potato Spraying Experiments.

A large field of potatoes on the college farm was used for experiments in spraying the past season. The field was located on the west slope near the farm barn, and included seven acres. The following varieties were planted: Early Harvest, Early Michigan, Carmen Number Three, Green Mountain and Delaware. These were planted in rows running lengthwise of the field. The experiment was carefully planned as regards varieties, conditions of the soil, etc., and running parallel to each of the various treated rows were left untreated ones for the purpose of comparison.

As there was some delay in obtaining the spraying mixtures, the whole field, including the checked plants, was sprayed once with Paris green for the potato beetle. In subsequent sprayings the following mixtures were used: wet Bordeaux containing Paris green, dry Bordeaux, copper phosphate and a mixture termed "1—2—3." The wet Bordeaux was made according to the standard formula (4—4—50). The other mixtures were proprietary substances, and were furnished by the Bowker Insecticide Company, which to our personal knowledge has always taken great pains to place on the market only the most reliable fungicides and insecticides. The "1—2—3" contained compounds of copper, arsenic and lime. The dates of the three applications were July 3, 7, and 12, no spraying being done after the latter date, on account of the luxuriant growth of the tops, which prevented access to the field without damage to the crop. The copper phosphate, dry Bordeaux and "1—2—3" are all dust sprays, and were applied early in the morning with a dust sprayer, when dew covered the foliage. The effects of spraying on this crop were carefully observed by various members of the station staff, together with Mr. Forristall, who supervised all the work, and made most careful observations as to the effects of the different sprays.

At the close of the experiments corresponding rows of the treated and untreated plants were dug, the potatoes carefully weighed by Mr. Forristall, and the results tabulated. The yields given by the various treatments are as follows: —

Average Yield of Sprayed Potatoes.

Treatment.	Average Yield (Pounds).
Wet Bordeaux,	55.98
Dry Bordeaux,	58.11
Copper phosphate,	52.34
"1—2—3,"	55.88
Untreated,	55.46

These results show no differences in the yield which can be ascribed to spraying. Observations on the condition of the crop during the summer did not show any material differences except in the case of the wet Bordeaux treatment, which was perceptibly superior in all respects to the others, at least during the greater part of the season. The plants treated with wet Bordeaux possessed the darkest-colored foliage, and were by far the most free from the flea beetle. The season was remarkably free from potato blights, the only thing occurring of any consequence being the flea beetle; and, with the exception of the wet Bordeaux, which contained Paris green, there appeared to be little or no difference between the treated rows and those untreated. At the time the potatoes were dug there was no perceptible difference to be observed between any of the rows. Owing to the season's comparative freedom from blight, little or no value can be placed upon these experiments.

The ease with which dust sprays can be applied makes the process of spraying less tedious, and a dust spray which possesses the merits of other reliable sprays on the market would be gladly received. However, careful tests of the relative merits of the wet and dry sprays indicate that the wet Bordeaux is superior in all cases to the dry.

Our potato growers should realize that the conditions in this State are entirely different from those in Vermont and Maine, and the spraying calendar recommended for those States is unsuited to our conditions, since their spraying is largely devoted to the control of the late blight, which is not generally severe here. On the other hand, it is the early blight, according to our experience, which does the most damage in Massachusetts; and in order to prevent attacks from this, farmers should commence to spray when the potatoes are not more than one-fourth grown, which would ordinarily be about the 20th of June. Much of the injury to potatoes is due to the flea beetle, which affects them in a manner similar to the early blight.

We believe that a first spraying of potatoes should be made with Bordeaux and "Disparene," instead of Paris green, since "Disparene" is a reliable insecticide, while Paris green is not, at the present time.

Copper Sulfate Treatment of Stagnant Water.

In a previous report we gave the results of a copper sulfate treatment of the college pond.[1] This pond is located on the college grounds, and contains about 8,000,000 gallons of water; it is quite shallow and has a muddy bottom. The amount of water which it receives during the summer months is not sufficient to cause a very constant overflow, and partly for this reason it occasionally becomes stagnant. There is also some pollution from cesspools which drain into it, and during freshets considerable amounts of fine sand, silt and clay are carried into the pond. Much of this silt, etc., remains in suspension for a long time, giving the water a yellowish tinge and roily appearance. Evaporation tests show that the water contains 45.6 parts sediment to 10,000 parts of water. During June the water usually has a disagreeable odor and becomes quite obnoxious. This odor is similar to that which rises from frog ponds where considerable decomposition takes place, and at other times it has the odor which is characterized as "fishy."

The pond has frequently been drained, which is responsible for stimulating growths of algæ, particularly Spirogyra, and for the past few years Anabæna has been present in greater or less amounts. It should be stated at the outset that our object in treating the pond was not to clear up points of controversy in connection with the copper sulfate method of treatment; it was done largely to obviate a nuisance.

That copper sulfate has an effect upon algæ has been known

[1] Eighteenth annual report, Hatch Experiment Station, 1906, pages 143–146.

to physiologists for many years; but the treatment of large volumes of water with this chemical is, so far as we know, comparatively recent. Those who wish to become familiar with the more technical features of this subject are referred to the older literature, much of which is in German, and to the more recent publications of the United States Department of Agriculture and our own State Board of Health.

The treatment given during 1906 was similar to that of 1905, and consisted in applying 1 part of copper sulfate to 4,000,000 of water. The copper sulfate was placed in a coarse bag attached to a canoe, which followed concentric circles over the pond until the copper sulfate was all dissolved. Samples of water were taken daily for bacterial examination a few days before treatment and each day after until July 19, when the experiment was discontinued. The usual bacterial methods were employed, with the following results: —

Table showing the Results of treating the College Pond with Copper Sulfate at the Rate of 1 Part of Copper Sulfate to 4,000,000 of Water. (Treated June 14, 1906.)

[Number of bacteria per c. c. of water.]

June 10,	7,005[1]	June 26,	846
11,	6,034[1]	27,	1,085
12,	5,757[1]	28,	1,231
13,	7,188[1]	29,	1,265
14,	7,158[1]	30,	1,006
14,	130[2]	July 1,	1,365
14,	56[3]	2,	1,231
15,	142[4]	3,	1,308
16,	156	4,	1,231
17,	156	5,	1,006
18,	341	7,	1,084
19,	554	9,	1,000
20,	769	11,	1,208
21,	1,000	13,	1,208
22,	1,000	15,	1,275
23,	756	17,	1,462
24,	768	19,	1,770
25,	927		

[1] Before treatment.
[2] One hour after treatment.
[3] Two hours after treatment.
[4] Twenty-four hours after treatment.

The number of bacteria per cubic centimeter showed a decided falling off after the treatment, but subsequently an increase was noticed, although the number did not equal that present before treatment. The first bacterial examination of the water occurred one and two hours respectively after treatment, at which time there was noted considerable decrease in the number of organisms. It seems hardly creditable, however, that the copper could have been sufficiently diffused in the pond to cause such a rapid decrease in the number of the bacteria in so short a time. Some Anabæna were present in the pond previous to treatment, but none was observed directly afterwards; neither were any Spirogyra noted either before or after treatment. On the other hand, there were various forms of life, such as Daphnia, etc., present, both before and after treatment. No chemical analyses of the water were attempted, since the ordinary methods of analysis are not especially valuable in detecting slight traces of copper in water. It would appear from the culture of seedlings in glass vessels containing water and sand in which copper is present, and from the results of chemical analyses of the mud in the bottom of the reservoir, that a large amount of copper is taken up by this mud. The results of copper treatment of the pond in 1905 and 1906 show that the bacteria never regained their former numbers.

In a pond like this one, which is more or less polluted from cesspools, one would naturally infer that bacteria would increase rapidly after a few days. During August the pond was in an even worse condition than in June, as a large number of dead fish, termed "suckers," which had died from some unknown cause, were floating on the surface. Again during October there was a fairly luxuriant growth of Anabæna present for a few days, but this disappeared quickly, presumably on account of the rather cold nights which occurred at that time.

At the time the treatment was under way, parallel laboratory tests were made. For this purpose we employed 18 liters of water from the college pond in two rectangular jars, there being 9 liters in each jar, one of which was treated with copper sulfate at the rate of 1 part of the sulfate to 4,000,000 of water, while the other jar was left untreated. The jars were placed side by side in the laboratory, and exposed to the organisms of the air. The water was taken from the pond previous to its being treated. The results of the experiments are shown in the following table: —

Table showing the Results of treating Pond Water with Copper Sulfate at the Rate of 1 Part of Copper Sulfate to 4,000,000 of Water. (Experiment made in Laboratory, in Glass Aquaria Jars.)

[Number of bacteria per c. c. of water.]

Date.	Pond Water untreated.	Pond Water treated.
June 14,	7,158	30[1]
15,	5,723	15
16,	4,849	38
17,	4,849	32
18,	4,444	24
19,	6,188	31
20,	7,927	43
21,	6,112	59
22,	4,772	101
23,	6,362	120
24,	5,313	54
25,	6,273	134
26,	7,004	126
27,	6,927	98
28,	8,282	170
29,	8,926	242
30,	6,419	310
July 1,	7,004	270
2,	7,409	298
3,	8,107	340
4,	6,792	930
5,	7,972	872
7,	10,168	800
9,	6,412	1,060
11,	6,989	1,000
13,	7,399	940
15,	6,034	946
17,	8,632	1,390
19,	10,656	1,240

[1] One hour after treatment.

The results shown in this experiment coincide in a general way with those of the previous one. They are, however, of more value, since they show the bacterial flora of the normal or untreated pond water.

It will be noted that the number of bacteria in the untreated pond water remained quite constant throughout the experiment, while the water treated with copper sulfate showed the same general decrease in the number of bacteria. The subsequent increase in the number of bacteria in the treated water in the laboratory experiment was smaller than that shown by the pond experiment. Furthermore, a comparison of the two jars in the laboratory experiments showed that the water in the treated jar was much clearer, owing to the fact that most of the forms of living matter had been killed and had settled to the bottom of the jar. This was proved by the much larger amount of sediment in the bottom of the treated jar than in the untreated.

Large bodies of water can be successfully treated with copper sulfate, and many undesirable forms of organisms eliminated. The copper sulfate treatment, moreover, appears to exert an influence upon the bacterial flora for quite a length of time; but after a certain period has elapsed a body of water may become as badly contaminated with various forms of living matter as before, or even worse.

The location of the college pond is such that no harm could result in any way from a treatment with copper sulfate, even though some of the copper escaped. Precautions, however, must be exercised in treating bodies of water; and the safest method to follow, in case such treatment is necessary, would be to consult our State Board of Health or others familiar with this subject.

Banding Substances for Trees.

In connection with the renewed warfare against the gypsy and brown-tail moths, a number of new banding substances, which are claimed to be effectual as insect barriers and harmless to trees, have been placed on the market within a year or so. These substances are sold under various names and at varying prices, and they are quite dissimilar in their chemical composition and in the effects produced on trees. Any substance which is likely to cause even the slightest injury when applied to trees should not be employed, and when such substances actually cause the death of trees, it becomes a gross offence to apply them to public shade trees.

At the request of William B. de las Casas, Esq., chairman of the Metropolitan Park Commission, the writer made an examination during the summer of 1905 of a large number of trees located in Middlesex Fells and other districts around Boston, with a view to determining the effects of the various so-called banding substances on trees.

In addition to our numerous examinations of the effects of these various substances on trees, we have tested a great many in a critical way on small plants. Our conclusions relating to the effects of the substances are based upon a larger number of observations, together with numerous tests on stems, leaves, etc., of a variety of herbaceous plants. Any substance which causes injury to herbaceous plants may also produce the same effect on trees, although the time necessary to produce injury to herbaceous plants is brief compared to that necessary to give rise to corresponding results in a tree.

A good banding substance should not cause the slightest injury to trees, or even to tender tissues. It should not harden at low temperature, neither should it melt at comparatively high temperature. It should be inconspicuous when applied to the tree, and easily put on and removed, and should remain sticky during the entire season.

Tanglefoot. — This material is now extensively used, and is a semi-transparent, sticky substance, not affected by low temperature (32° F.) or by temperatures under 125° or 130° F. Its principal bases are probably castor oil, resin and wax, which are substances harmless to vegetable tissue; and, whatever the other constituents of this banding substance may be, they do not render it harmful to trees. Tanglefoot applied to a large number of plants possessing a thin epidermis has never caused any injury. In short, this is the only substance which we have met which stands all the tests a perfectly harmless banding material should when applied directly to plant tissue.

Bodlime. — This is the proprietary name of a substance resembling Raupenleim, a European product, and both have been on the market for some years. Bodlime is an American preparation, and has been used extensively for some time. The directions which are furnished with Bodlime advise first putting a band of tarred or sheathing paper eight inches wide on young or thin-bark trees, and then applying Bodlime to the band. Over 90 per cent., however, of the trees examined by us last summer on which Bodlime had been applied were those of the smooth-bark type, ranging from two inches to two feet in diameter, and in no instances were tarred or sheathing paper bands applied. In practically all cases this substance had penetrated the bark and injured the cambium layer. This injury, however, is in all probability not sufficient to kill the trees in every case; but more or less prominent effects will be left on the trees for some years, as evidence of the injury due to Bodlime. Some specimens of trees six inches in diameter were pointed out which were killed with Bodlime; and practically all the Carolina poplars located on the Fellsway, Malden, which have been treated with this substance, showed much injury to the cambium layer, resulting in prominent swellings on the trees where this substance had been applied.

A number of small white maples (two or three inches in diameter), which had been treated with Bodlime, appeared in two or three weeks to have an abnormal cambium layer, due to the penetration of the substance to the vital tissue. In all these cases Bodlime was applied directly to the trees, without paper bands. It should be noted, however, *that the manufacturers never intended that it should be applied to small or smooth-bark trees without first banding with tarred or sheathing paper, and the directions specifically state this.* When this is applied to large trees, however, without paper banding, it generally causes some subsequent slight disfiguration of the tree. We believe, however, that Bodlime constitutes a reliable banding substance, and can be applied to trees if the directions of the manufacturers are followed, — to first put on a band of tarred or sheathing paper. It should by no means be considered a reflection on the manufacturers if people will persist in ignoring the proper directions for applying the substance, as there is scarcely a remedy on the market which will not produce injurious effects if used injudiciously.

Anti-Moth. — This substance was used considerably in the summer of 1905 as a tree-banding material. It is a dark-colored, pasty substance, suggestive of wheel grease, and is applied directly to the bark. There were many instances observed where it was causing injury by soaking through the large, thick, rough-bark trees, as well as small, thin-bark ones. The trees which came under our notice had been treated only a few weeks with this substance, but our observations were sufficient to show that this constitutes a dangerous substance to apply directly to the bark of trees. Various small herbaceous plants banded with Anti-Moth died in a few days.

Eureka Tree Paste. — This substance as a banding material is not so universally employed as those previously mentioned, therefore our observations were limited in regard to its effects on trees. Moreover, this material, at the time our observations were made, had been on trees for only a brief period of time, consequently, the ultimate effects on the trees have not been observed by us. This substance resembles Anti-Moth, and is applied in the same manner. From the nature of the material, and its effects upon the stems of herbaceous plants, it cannot be recommended as a safe banding substance. Our experiments on herbaceous plants show that it is equally as injurious as the substance previously mentioned.

Raupenleim and Dendrolene. — These have been used as banding materials, although we have seen no authentic instances where they have been applied to trees in the vicinity of Boston during the past year. Raupenleim is a well-known German banding material, and Bodlime is supposed to be in many respects similar to it. Both, as far as we can learn, have about the same effects on vegetable tissue; that is, they injure it. Raupenleim was previously used by the Gypsy Moth Commission in large quantities. Dendrolene is an American product, apparently similar to Raupenleim in every way, both being crude petroleum products.

Razzle Dazzle. — During the past year our attention has been called to the use of a banding substance termed Razzle Dazzle, which has been employed to some extent on trees. This substance was sent in to us from one of the towns in the vicinity of Boston, with the report that it was doing damage to trees. We made a test of the substance on various herbaceous plants, and found that it killed them in a very short time. The substance appears to be made of resin, castor oil and some other oil-like petroleum which is injurious to vegetable tissue. We found that Razzle Dazzle has altogether too low a melting point. It commenced to run at about 90° F., and flowed freely at 100° F.

Bug Stop. — This substance is apparently made out of resin, oil and some form of grease, which causes injury to vegetable tissue. We found on testing this that it was very similar in its effects on tissue to Razzle Dazzle, and has a melting point ranging from 79° to 94° F. Besides the injurious effects which it has on vegetable tissue, it has a melting point entirely too low to make it a desirable banding substance.

Printer's Ink and Tarred Paper. — Printer's ink applied to tarred paper has been used to some extent for many years as a banding substance, and no ill results arising from its use have met our observation. We find this substance used extensively in the city of Medford on General Lawrence's estate.

Other Injurious Substances. — In one of the cities in the neighborhood of Boston crude petroleum or gas oil, such as is used in the manufacture of water gas, has been extensively used in spraying the trunks of trees for the purpose of killing gypsy moth eggs. This substance penetrates the bark very readily, and kills the vital layer. There are numerous instances where trees have been completely girdled, and have died in a very short time from the use of this substance.

Gas oil and creosote are used extensively for treating gypsy moth nests, and when mixed with lampblack they appear to cause little or no injury. Both of these substances are capable of causing injury to plants, either when used alone or when mixed with lampblack. We have not discovered any injury to trees from the use of these substances, however, when mixed with lampblack and used as a paint for the treatment of gypsy moth egg clusters. In one instance, where creosote and naphtha were applied with an atomizer to the trunks of trees covered with gypsy caterpillars, at the rate of 1 part of creosote and 5 parts of naphtha, the bark was rendered brittle and lifeless. At the time our examinations were made on these trees no injury had occurred to the cambium layer, but we should suspect that injury would later follow this method of treatment.

Some injury to trees often occurs from the use of kerosene, or kerosene and water together, when applied to the bark of trees. Kerosene and water have occasionally been applied to tree trunks for various insect pests by the aid of a certain mechanical mixing device. It should be stated, however, that these mechanical mixers are unreliable, and it is never safe to apply kerosene to trees, not even when mixed with water. The use of a gasoline blower or torch for the purpose of killing caterpillars has been in vogue to some extent. This should be condemned, since some injury has resulted from this practice. Scraping the bark too closely previous to applying a banding substance should be guarded against.

In conclusion, it may be said that Tanglefoot appears to be the only banding substance which we have tested that does not in any way cause injury to plant tissue, and that can be safely applied directly to tree trunks. Since this substance has a tendency to run at about 125° to 130° F., a slightly higher melting point would improve it. The manufacturers test this substance at 126° F., on a smooth, vertical surface, claiming that it will not run below that temperature; also, that some of their samples will not run below 130° F. They state that it will stand a little higher temperature on the bark of trees before it begins to run. Unfortunately, much of the Tanglefoot sent out by the manufacturers last spring was made on a different formula, and the melting point was entirely too low. It was sent back to the manufacturers, and modified according to a previous formula.

Such material as printer's ink, Bodlime, etc., can be safely applied to tree trunks in connection with tarred paper; and the latter can also be applied to rough, thick-bark trees without killing them, although even when used in this manner it will

Showing effect of illuminating gas on elm tree, one and one-half years after leakage occurred. (From "Park and Cemetery.")

often produce some injury, which, however, may not prove fatal. We believe that it is essential, in applying any substance to a tree as a means of protecting it against insects, that one should be well within the limit of safety.

In this connection it should be noted that all of the manufacturers of these substances are, so far as we have learned, honorable business men, as is shown by their perfect frankness, and desire not to place any substance on the market which is not reliable. However, one should be cautious in purchasing newly advertised banding materials, since we have reason to believe that some of these new mixtures will not prove reliable. We have had opportunities to test a large number of new mixtures during the past two years, none of which, in our estimation, answers the requirements of a good, reliable banding substance.

Effects of Escaping Illuminating Gas on Trees.

Undoubtedly a larger number of trees suffer from the effects of escaping illuminating gas at the present time than in previous years. The increased death rate from this cause may be accounted for by the fact that gas is now more extensively used than formerly, and the larger pipes now in use, together with modifications in the methods of laying these pipes and calking, may be in part responsible for the increased leakage. At any rate, it would seem that where small pipes have been in the ground for many years with thread joint connections there is much less leakage than where larger pipes are used, and where the calking is done with Portland or Roman cement and oakum or lead.

There is a large amount of gas manufactured by companies which is unaccounted for. According to the twenty-first annual report of the Gas and Electric Light Commissioners of Massachusetts, the production of gas for the year 1905 in this State was 6,418,024,954 cubic feet. The amount unaccounted for during that year was 622,304,044 cubic feet; in other words, there was a loss of about 10 per cent. Probably this loss represents more than mere leakage, since part of it may be accounted for by differences in temperature which the gases are subjected to when measured. Nevertheless, there is a very large number of leaks in gas mains at the present time, and the number of cubic feet of gas which annually escape into the soil is quite large.

There are a great many joints in gas mains from which can be detected only slight leakage, — perhaps from two to three cubic feet a day; whereas there are others from which the leakage is very extensive, and from which thousands of cubic feet of gas escape into the soil in the course of a year. Even these smaller leaks, where the outflow is only from two to three cubic feet a day, are capable of injuring trees in the course of time, since the soil becomes charged with gas to quite an extent in a few years. Should the roots of trees happen to be near these leaks, the trees will become unhealthy, but perhaps will not die. There are hundreds of city trees affected in this manner, and gas is seldom suspected of causing their sickly condition. In the eastern States, at least, there are three kinds of gas used, — water gas, coal gas and oil gas. So far as the effects of these various gases on trees are concerned, there is apparently little or no difference, since they all contain similar elements which are poisonous to trees.

There are two classes of injury which may readily be distinguished as resulting from gas poisoning: first, incipient cases; and second, pronounced cases. In the first series we have those already alluded to as resulting from small leaks, and the ground in such cases never becomes fully charged for any considerable distance. They may not result in killing the tree directly, but cause it to be unhealthy, and there is likely to be a large amount of dead wood found on such trees annually. Occasionally a large tree may be located near a small leakage, and in such a case only a single root will be affected. Those portions of the trunk of the tree in direct connection with the leak will, however, show the effects of gas poisoning. Small leaks of this description often produce only local injury. Trees affected in this manner may suffer with what is termed "general debility," — a term often used to cover up a vast amount of ignorance concerning diseases in general. In severe cases of gas poisoning, such as take place where there is a large leak, the effects on a tree are very pronounced, and there is absolutely no hope of recovery for a

Large elms killed by escaping illuminating gas, one and one-half years after leakage occurred. (From "Park and Cemetery.")

tree which has once been severely injured by gas; in short, where a tree has been defoliated or even half defoliated from the effects of gas, there is no hope for it, although it might be possible, if one could dig up all the soil around it and expose it to the air, to eliminate much of the gas in the soil, in which case the tree might make some attempt to recover.

The characteristic symptoms of gas poisoning are quite marked to one familiar with them, and can generally be distinguished from other kinds of injury which are likely to affect a tree. It requires, however, pretty close observation and thorough understanding of conditions in order to distinguish gas poisoning from some other types of injury which may occur. For example, in the gypsy moth district about Boston the trunks of many trees have been treated with crude oil and various other substances which are exceedingly injurious to trees. Crude oil or kerosene, when sprayed on the bark of a tree, will penetrate the wood to some extent. Unless one is perfectly familiar with the characteristic symptoms of trees poisoned with gas, it would be a very easy matter to confound these two classes of injuries. In both cases the bark becomes loose and falls off the tree very quickly. From careful observations of the trunks of trees, however, the effects of crude oil can generally be distinguished from those caused by gas, by one who is familiar with these characteristic injuries.

In general, however, the symptoms shown by trees affected with illuminating gas are quite different from those arising from other causes which are likely to be active. Trees affected with gas are very susceptible to rapid disintegration. One of the first effects of poisoning in summer would be a yellowing and drying up of the foliage, and a greater or less defoliation of the tree, according to the degree of poisoning. The trunk of the tree is generally dark colored, indicating an absence of life; but this feature is not always present.

The occurrence of various species of fungi on trees affected by gas is rather conspicuous, since these fungi are often very numerous, and make their appearance soon after a tree has been injured; whereas on trees dying from other causes it is sometimes many years before the bark becomes covered with fungi. The sap wood is often found to be discolored, and it has peculiar, characteristic odors which assist in a diagnosis. Sometimes, however, especially when the tree is injured by gas in late summer, at which time the flow of sap is not so pronounced as in the spring, the odors of the wood are not so marked.

The writer has had many years' experience in examining trees injured by illuminating gas, and has had occasion to study a large number of them each year. In our diagnosis of such trees we make use of a small hatchet, which is employed to cut into the trunk of a tree for the purpose of examining the tissue. In most cases it is only necessary to insert the hatchet into the trunk and gradually pull the tissue back to see whether it is normal or abnormal. Little injury is done to the tree by this practice, as a mere slit in a healthy tree will heal over in a short time. In other cases it is necessary to take out a chip and examine the tissues under a microscope. An examination, by means of a hatchet, of the larger roots which extend above the surface of the soil, causes less disfigurement, and the source of leakage, if such is present, may be discovered. The escape of gas into the soil from a leak follows the line of least resistance. For this reason, if leakage occurs in the street in front of a house one can usually detect the odor of gas in the cellar, as the gas will follow the exterior of the pipe leading into the cellar.

There is considerable difference in the resistance of soils to gas. In gravelly soils we have known gas to travel 2,000 feet without any difficulty when the ground is frozen, and escape into the cellar of a house; whereas in heavier soils gas is more likely to be restricted to smaller areas.

The poisonous properties of gas undoubtedly consist in the coal tar products, which contain such compounds as sulfates, cyanides, etc. Gas escaping into the soil probably condenses fully as rapidly as in the pipe. The gas-drip which is taken out of a pipe is the condensed portion, and this in itself is very rank in odor and extremely injurious to plants, whether the volatile products are taken in through the leaves or the liquid through the roots. It is apparently these condensed products which are taken up by the roots and which poison the tree. About 1 or 2 per cent. of gas is absorbed by water, and the water in the soil becomes charged to a certain extent with gas. In the course of time, where the leakage is more or less extensive, the odor of the soil becomes extremely obnoxious. This odor disappears very quickly when the soil is aerated; in fact, when a gas leak is found it is an excellent idea to leave the ditch open for a few days, to get rid of the strong odors which are present in the soil. There is a certain capacity of adaptation of plants to poisons, and this probably exists to some extent in the case of trees; but this capacity is limited, and where the leakage of gas is continuous, the roots are sure to be poisoned in time. The writer has treated various small trees and plants with gas, and has grown plants in water charged with it. Gas, like many other poisons, acts as a stimulus to plants at first, but eventually kills them. It is possible, however, to keep roots alive in water charged with gas every twenty-four hours for a considerable length of time. Finally, however, after the plant has absorbed a certain amount the cambium layer is affected, and disintegration takes place rapidly. It requires a considerable amount of gas to kill a large tree, but it must be borne in mind that the conditions surrounding a tree are favorable for maintaining gas in the soil for a long time. Mr. H. A. Ballou, one of our former students, treated a large maple tree with 1,000 cubic feet of gas. This was done by digging a hole in the ground under the feeding roots to a depth of four feet or more, and the gas was allowed to escape into the soil at this point for a number of months. The result was that not the slightest injury was done to the tree. If, however, the same amount of gas had been allowed to escape near a tree located on a macadamized road, and the leakage had extended over a period of two years instead of three or four months, some injury would have been discernible.

Many gas companies now openly recognize the fact that a certain amount of gas leakage occurs continually, and that a certain number of trees are likely to be killed each year; therefore, they endeavor to settle all claims for damages to trees arising from gas out of the courts. In Massachusetts the court has decided in more than one instance that a good-sized, well-developed and sound tree in front of an estate is worth from $150 or $200 in the valuation of that property; and if such a tree is killed by gas, the abutter is entitled to damages. In most of the cases of gas poisoning the companies have settled with the abutters, allowing anywhere from $5 to $150 a tree. In other States courts have decided that an owner of land which abuts on a city street and which is planted with shade trees is entitled to have such trees protected against negligence or wilful destruction at the hands of a third party. A large, handsome tree taken from a well-kept avenue is a greater loss to the abutter's property than a similar tree on a poor, ill-kept street. Moreover, a tree half-killed by the teeth of horses is not worth as much as one in good condition. In some cities gas companies have settled with the city for the loss of trees.

According to tree laws in Massachusetts, gas companies are undoubtedly subject to a fine for injuring or causing the death of a tree, in addition to the damages for causing a deterioration of property owing to the loss of such trees, since the laws relating to injuries to shade trees are explicit. In some cases the abutter is satisfied if new trees are planted to replace the old ones.

Undoubtedly much of the loss arising from gas the past few years has been due to inferior work in laying pipes. In one small city, where four miles of pipe were laid, we were able to find one hundred trees which were injured beyond recovery from gas poisoning, two years after the gas mains were laid; and we venture to say that three or four hundred other trees in the same locality were more or less affected by gas, many of which will subsequently die a premature death.

Germination and Growth in Soils of Different Texture.

It requires only a casual glance at the flora of any region to note the fact that soil texture plays an important part in the distribution and adaptation of plants. Soil, however, is so intimately connected with and modified by other factors, such as organic matter, arrangement of the particles of the soil, chemical constituents, the presence of living organisms and differences in the amount of water, that it is a most difficult problem to determine accurately the role which texture alone plays in plant distribution and adaptation.

Humus is undoubtedly closely associated with certain ecological features connected with the life history of plants, since it furnishes an environment for various micro-organisms which in some instances amount to many millions per gram; and if the behavior of these organisms in culture media furnishes a criterion for their activity in soil, important chemical changes must take place.

In endeavoring to account for the distribution of any particular species of plant, one is confronted with a complex problem, since there are various influences responsible for distribution, and the elimination of these factors is beset with difficulties.

In some cases differences in the degree of adaptability of plants appear to exist corresponding with their stages of development; for example, a seedling will die in a soil of certain texture, when a more mature plant of the same species will succeed in thriving to a greater or less extent.

Soil texture exerts an influence upon the configuration of plants which may be seen even in restricted areas; for example, certain soils are especially adapted to the luxuriant development of elms, and such soils exert a marked influence not only upon the general type of tree, but the color, size and texture of the leaves, — a feature which may be seen to a similar degree in other native plants.

Among our well-known cultivated plants there are some which are influenced to quite an extent by soil texture, the best known among these being tobacco. Since the texture, aroma and color of the leaf is tested many thousand times daily by smokers, much knowledge has been gained regarding the influence of soil texture and other factors upon the growth of this crop. It is well known that the crops from some soils sell for two and three times as much as those grown on soils of a different texture. In the development of head lettuce soil texture also plays an important role. This type of lettuce is largely grown on the Atlantic coast soils, which predominate in the coarser grades of sand. When head lettuce is grown in finer-texture soils it does not head up well, and little or no attempt is made to grow this crop in soils of this nature. Lettuce seed sown in a soil of fine texture will not germinate nearly as well as in loose soil, and lettuce seedlings will reach a certain stage of development, remain stationary for weeks and eventually die. The reason why a fine-texture soil prevents seedlings from developing is lack of air. This may be illustrated by the more vigorous growth which lettuce seedlings make in such a soil near the edge of a flower pot than in the middle, and by various soil aeration experiments.

The compactness of a soil, as might be expected, exerts an influence upon germination and growth. The following table shows the effect of loose and tamped loam and subsoil upon the germination of seeds. In one case a good loam, containing about 8 per cent. of organic matter, was employed, one box being tamped very firmly with a heavy weight after the seeds were sown, and the other left very loose. In the other case two boxes of soil of fine texture (subsoil) were employed. This soil was very deficient in organic matter. These two boxes were treated in a similar way to those containing loam; that is, one was left very loose and the other tamped firmly after the seeds were sown. In all the boxes very little soil was placed over the seed.

Result of Seed Germination in Loose and Tamped Soils.

	Loam.		Subsoil.	
	Loose.	Tamped.	Loose.	Tamped.
Lettuce, 200 seeds,	75	–	51	–
Rattlebox, 200 seeds,	80	22	33	7[1]
White clover, 400 seeds,	146	7	45	–

[1] The seedlings came up in cracks in the soil.

No lettuce seed germinated in the tamped loam or subsoil, while white clover made its appearance in the tamped loam. Rattlebox, which with us is quite at home in fine-texture soil lacking organic matter, did better than the lettuce or white clover. None of the seed possessed a high percentage of germination, and some allowance must be made for this. All of the seed germinated better in the loose loam than in the loose subsoil, and the rattlebox and white clover showed greater capacity for adaptability to tamped soil than the lettuce.

Lettuce is remarkably susceptible to lack of soil aeration, as is shown by the many experiments we have made with this plant. The following table shows the effect of soil texture upon the germination and growth of lettuce. The boxes employed in this experiment were eight inches square, and each was nearly filled with carefully sifted coal ashes, containing particles corresponding to the sizes given in the table. Each box was weighed and watered daily, and the amount of water applied was such that the degree of saturation was equal to one-half the water-retaining capacity.

Influence of Soil Texture on the Germination of Lettuce Seeds and Growth of Seedlings.

	Size of Particles (Millimeters).	Per Cent. of Germination.	Average Weight of Seedlings (Milligrams).
Box 1, ...	2–1	54.2	40–60
Box 2, ...	1–.5	38.0	80–84
Box 3, ...	.5–.25	24.8	59.99
Box 4, ...	.25–.1	33.0	41.45
Box 5, ...	.1–.0001	14.2	19.25

The preceding table includes the results of three experiments, in which 3,000 seeds were employed. The highest percentage of germination is given by the seeds sown in ashes containing particles having a size of 2–1 millimeters; while the largest average weight of the seedlings is shown by those which were grown in ashes containing particles having a diameter of 1–.5 millimeters. In the case of some experiments in similar boxes with sand the highest percentage of germination took place in the particles ranging from .5 to .25 millimeters; and the largest average weight of seedlings was given by the particles ranging in size from 1 to .5 millimeters, or the same as in the experiment with ashes. It should be pointed out that important differences exist between coal ashes and sand in respect to absorption of moisture. This was quite noticeable in the experiments, inasmuch as the ashes act like a sponge and water is retained to quite an extent by them; while in the sand no such absorption takes place, as is readily shown by the top layers of the coarse sand becoming dry, — so much so at times that seed germination was seriously interrupted. For this reason it was impossible to maintain the same relative degree of moisture in the various strata in the sand boxes as in the ashes. Since ashes were more porous and spongy, the difference in the amount of moisture in the various strata was less marked, and there was no difficulty in maintaining enough moisture for germination in the coarse particles of coal ashes.

The influence of variation in the soil moisture cannot be eliminated in comparative experiments with soils of different texture, since the capillarity of the different grades of soils is by no means the same; neither is the amount of water which the seeds and seedlings received under these conditions identical.

Some parallel experiments were undertaken in shallow plates, containing about three-fourths inches of coal ashes, having the same range in the size of particles as in the previous experiment, with somewhat similar results. In the plate experiments the difference in the amount of moisture due to the difference in the capillarity was considerably modified, since the substratum was so shallow that the seedlings, after they had become mature to a certain degree, could obtain practically the same amount of water from each type of particles, providing evaporation was checked, thus preventing stimulation which would arise from the difference in the water supply, although the water in the plates containing the coarse particles would be more largely confined to the lower strata. Soil texture and water supply are intimately associated, and this has led some to believe that water constitutes the ruling element in the soil in crop production. Respiration is also an important function in plants, for which process oxygen is necessary. When plants are deprived of oxygen they cease to grow, and seeds will not germinate.

It is important that roots be supplied with air for respiration, as is shown by aeration experiments; and in the experiments with lettuce the difference in the percentage of germination and growth of seedlings in ashes was determined by differences in the air supply furnished by the various grades of particles employed.

Texture of Massachusetts Soils.

For some years this department has made mechanical analyses of soils in connection with the study of problems relating to greenhouse crops, and for various persons who desire to know the constituents of some particular soil. A list including some of the analyses is presented with this report, the soils being grouped in a general way under different headings.

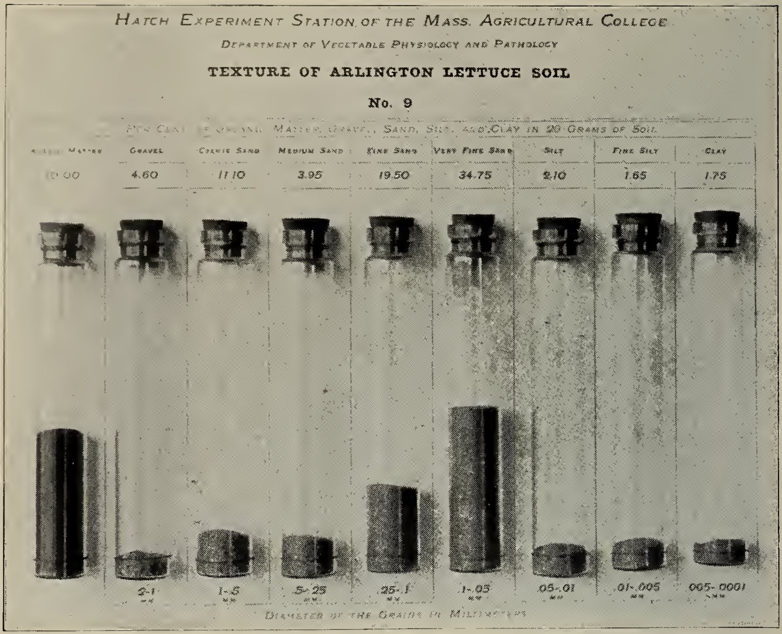
In the list of soils which follows, acknowledgment should be made to those who have taken part in this work, most of whom have been from time to time students and assistants in our laboratory. Some of these soils were analyzed by Mr. Asa S. Kinney, now director of the Botanical Gardens at Mount Holyoke College; others by Messrs. A. A. Harmon, A. C. Monahan, A. L. Dacy, E. H. Scott, L. K. Liang; and particularly Mr. N. F. Monahan, assistant in the laboratory, who has made by far the greatest number of these analyses.

The methods employed are those recommended by Dr. Milton Whitney. In some of the earlier samples the finer-grade material was separated by the gravity method, while all the later analyses have been made by the centrifugal method of separation. In all cases 20 grams of soil were used in each analysis.

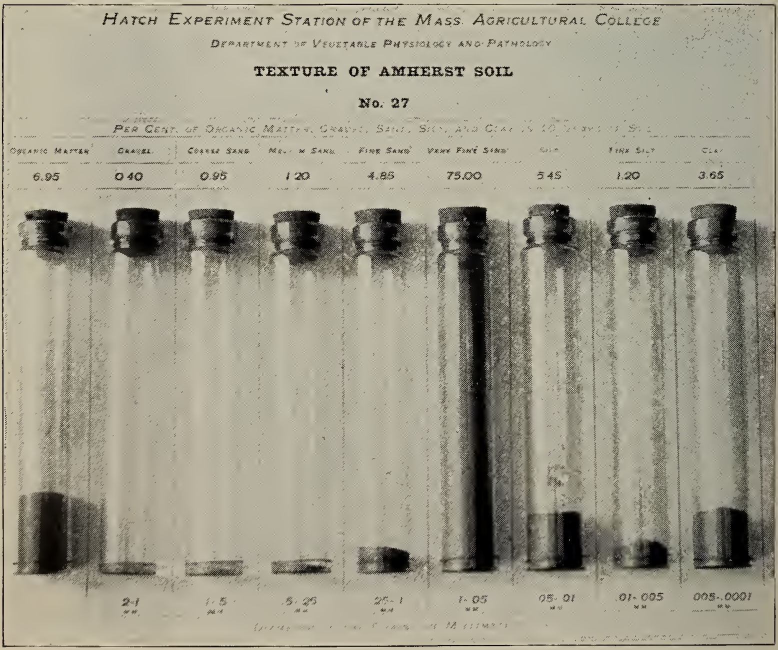
The soils best adapted to general market gardening are those which contain considerable proportions of coarse material, which render them loose and friable. Such soils predominate near the coast, and excellent types may be found in many of our river valleys. The soils about Boston, especially those in Arlington, Belmont, Newton, Bedford and Concord, are exceptionally well adapted to market-gardening purposes, and some of the best crops in the United States are raised in these towns. Market gardening has been carried on in the above-named localities for many years, and remarkable skill has been developed in handling certain crops. This statement holds true not only in general truck farming, which is followed to a large extent in these regions, but is especially applicable to the cultivation of head lettuce under glass, in which unique skill has been developed.

It is not unusual for market gardeners to put 40 cords of horse manure per acre on the land used for market-gardening purposes, and to a soil devoted to greenhouse lettuce even larger quantities of manure are applied. In general, the best market-gardening soils are those which contain a large amount of coarse material, which is well illustrated by the Belmont, Newton, Concord and Bedford soils. (*Cf.* Table I.)

In a similar class may be included Worcester soil No. 10, New Bedford, Swansea and Touisset. The Worcester soil No. 10 is from a river valley, and is well adapted to the growth of head lettuce. The Providence soil is quite similar to those of Cape Cod, and is somewhat coarser than the Arlington and Belmont types. When these coarser soils are well supplied with organic matter they are suitable for lettuce. The Worcester soils Nos. 13 and 20, together with the Amherst, Huntington and Pittsfield soils, are not desirable ones for head lettuce, since they are too compact. These soils, however, have been used for lettuce, and for this reason are included in this list.



An ideal market-garden soil.



Not well adapted to market gardening.

TABLE I. — *The Mechanical Analyses of Some Market-garden Soils.*

[Diameter of the grains in millimeters (1 millimeter equals about 1/25 of an inch); gravel, 2-1; coarse sand, 1-.5; medium sand, .5-.25; fine sand, .25-.1; very fine sand, .1-.05; silt, .05-.01; fine silt, .01-.005; clay, .005-.0001.]

Station Number.	LOCALITY.	Water-retaining Capacity.	Organic Matter.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt.	Fine Silt.	Clay.
6	Pittsfield,	50.00	11.50	5.35	5.00	4.80	14.00	37.00	7.05	1.20	6.95
9	Belmont,	51.30	10.00	4.60	11.10	3.95	19.50	34.75	2.10	1.65	1.75
14	Subsoil of No. 9,	29.30	1.80	2.85	8.25	14.30	32.20	32.05	2.30	1.30	2.35
10	Worcester,	46.20	9.01	7.17	15.40	10.10	15.30	29.54	9.85	2.87	2.07
13	Worcester subsoil,	41.00	9.60	1.40	2.00	3.95	20.70	43.45	7.20	3.05	3.60
15	Newton,	67.90	15.18	5.75	8.12	7.07	12.06	34.01	2.10	0.20	3.82
16	Spencer,	50.00	9.80	2.70	4.55	7.30	22.35	29.60	6.65	2.45	3.25
17	Providence, R. I.,	39.60	6.65	9.20	17.85	16.85	20.90	22.50	2.75	0.40	2.25
18	Pittsfield,	61.00	11.00	5.65	6.90	5.25	13.75	35.30	5.95	0.55	3.85
19	New Bedford,	40.00	7.60	4.10	5.45	6.45	12.00	39.45	6.95	5.50	5.55
20	Worcester,	45.10	9.40	1.65	2.80	4.25	19.85	42.95	4.50	2.95	2.75
21	Worcester subsoil,	36.50	2.80	1.00	1.20	1.10	8.30	66.45	7.35	2.10	5.35
22	Amherst,	40.50	6.00	2.60	5.90	7.90	15.40	40.75	9.25	2.60	4.65
44	Huntington,	43.20	8.00	0.36	0.90	1.32	10.09	29.40	27.38	6.35	7.93
47	Concord,	46.59	7.80	5.45	11.01	13.95	25.03	17.87	12.38	0.99	2.75
52	South Sudbury,	59.93	9.40	2.59	5.79	7.93	25.19	26.38	12.74	2.45	0.98
57	Bedford,	67.21	12.64	3.80	5.30	5.40	15.02	22.91	19.63	7.34	3.37
65	Waltham subsoil,	54.01	4.32	0.83	1.58	1.94	10.82	44.81	21.15	4.49	7.25
77	Belmont,	42.66	13.20	3.18	5.85	12.13	37.34	14.12	3.60	0.59	1.73
89	Swansea,	61.80	10.44	4.80	5.07	13.19	21.72	22.88	14.60	1.36	3.49
95	Touisset,	51.30	11.66	2.37	3.59	13.63	19.44	32.39	13.22	0.79	1.64
97	Belmont,	50.00	10.57	6.49	5.84	10.49	11.65	30.25	9.33	4.78	4.01

The greenhouse cucumber soils given in Table II. are from widely separated localities, and, with the exception of the organic matter which they contain, are no better adapted to the growth of cucumbers than soils which may be selected from other places. One special feature, however, in connection with these soils is the large amount of organic matter which they contain, which greatly modifies their texture. Most greenhouse soils are rich in organic matter, which is furnished by the extensive use of horse manure and decomposed sod. Cucumbers are not so susceptible to soil texture as lettuce, since almost any soil fairly well provided with organic matter is suitable for their growth; while in the cultivation of head lettuce it is necessary to have, in addition to a good supply of organic matter, a certain percentage of the coarser particles of soil.

The best method of preparing soil for cucumbers consists in mixing one-third horse manure, one-third loam and one-third sod. These constituents form a suitable basis for a good cucumber soil, and by the extensive use of horse manure each year it can be kept in good condition.

TABLE II. — *The Mechanical Analyses of Some Cucumber Soils.*

Station Number.	Locality.	Water-retaining Capacity.	Organic Matter.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt.	Fine Silt.	Clay.
34	East Brookfield, .	50.66	6.00	7.80	21.18	18.57	17.01	21.96	2.89	2.18	2.25
74	Athol, ...	57.30	22.46	8.71	12.80	7.33	12.39	8.85	13.21	2.59	1.39
75	Lincoln, . . .	57.00	11.00	2.36	6.18	7.87	24.66	29.89	13.33	0.83	3.14
76	Fitchburg, . . .	42.70	26.02	2.71	7.91	6.45	13.05	12.64	18.33	3.36	1.33
94	Beverly, . . .	66.40	12.13	6.21	6.94	12.26	10.97	29.48	15.32	1.55	1.39

Asparagus is usually grown on a coarse, sandy soil, generally deficient in organic matter, partly for the reason that such soils will not grow anything else satisfactorily. It by no means follows, however, that asparagus requires this type of soil, since, as a matter of fact, the best beds in the State are located on soil of finer texture than most of those shown in Table III.

Such soils as Nos. 33 and 73 possess finer textures than others, and they are excellent asparagus soils, besides having the advantage of growing crops which are not subject to the summer stage of the rust; whereas plants grown in coarse soils are often severely attacked by the rust, regardless of their location. The most important feature connected with asparagus soil in respect to texture is its ability to supply water during periods of excessive drought, which enables the plants to resist outbreaks of rust. In some cases asparagus beds will yield $1,000 per acre.

TABLE III. — *The Mechanical Analyses of Some Asparagus Soils.*

Station Number.	LOCALITY.	Water-retaining Capacity.	Organic Matter.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt.	Fine Silt.	Clay.
1	Eastham, . . .	38.99	2.00	9.38	27.91	25.09	21.43	8.70	1.40	0.77	1.44
7	Orleans, . . .	35.28	2.20	20.97	31.03	19.70	12.26	6.26	2.77	1.46	1.37
8	Concord, . . .	49.81	4.19	4.24	10.20	12.81	27.93	34.11	1.84	1.79	1.08
32	Subsoil of No. 8, .	33.66	1.77	9.69	12.75	11.80	19.23	24.30	14.70	2.24	0.78
30	Attleborough, . .	48.76	7.54	9.26	11.15	7.87	11.53	29.57	10.95	2.52	1.42
31	Montague, . . .	33.46	2.74	0.18	2.75	14.77	23.30	44.39	6.16	1.16	3.27
33	Montague, . . .	48.71	1.86	0.27	4.39	19.86	43.88	25.75	2.64	0.36	0.14
45	Concord, . . .	42.95	12.60	6.90	12.03	10.88	21.43	15.44	6.00	5.50	2.98
46	Concord, . . .	32.82	3.20	0.73	2.69	5.69	31.73	37.84	4.48	1.30	4.30
48	Longmeadow, . .	27.34	2.80	3.52	14.88	15.90	25.48	21.60	5.46	1.21	4.31
53	South Sudbury, .	33.64	3.38	0.65	3.22	9.18	40.27	30.29	2.47	1.75	1.99
55	South Berlin, . .	29.54	2.30	5.33	17.70	10.13	11.98	14.08	23.43	4.49	3.58
73	South Deerfield, .	34.00	1.68	1.33	6.76	22.68	31.12	18.41	6.89	1.53	3.49
2	Eastham, . . .	37.13	2.60	17.93	28.80	18.85	5.80	19.15	2.85	1.34	0.66

The soil of the Connecticut valley may be described as loam, predominating in fine sand and silt, and is quite different from soils found in other parts of the State. (*Cf.* Table IV.) It is remarkably free from stones, and well adapted to the growth of onions, tobacco, pickle cucumbers and various other crops. In some parts of the valley, where the soil is mixed with coarser material, good greenhouse lettuce is grown. The most important crops, however, are onions and tobacco, and the former crop is considered better than that raised in any other part of the State. Dr. Milton Whitney, chief of the Soil Bureau, who has investigated and mapped the Connecticut valley soils, implies that they are not so well suited to the growth of the best quality of tobacco as some of the types of Connecticut soil, but they yield heavily, which enables the tobacco grower to derive considerable income from this crop.

There is an opinion prevailing among farmers that some of the Connecticut valley soils are better adapted to the growth of onions than tobacco. The greater proportion of both crops is grown on what Dr. Whitney terms "Connecticut meadow" and "Podunk fine, sandy loam;" and we cannot say whether onions require, for their best development, soil differing very materially in texture from that required for tobacco.

TABLE IV. — *The Mechanical Analyses of Some Tobacco and Onion Soils.*

Station Number.	Locality.	Water-retaining Capacity.	Organic Matter.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt.	Fine Silt.	Clay.
11	Hatfield, . . .	33.33	3.78	0.05	0.13	0.30	3.38	60.35	26.29	0.71	4.34
12	Sunderland, . .	37.80	6.76	0.03	0.25	0.50	3.92	21.87	47.86	14.70	2.71
54	North Hatfield, . .	63.38	5.73	0.03	0.20	0.25	6.30	37.87	32.85	5.13	5.01
58	Sunderland, . .	32.38	4.72	0.13	3.32	0.43	5.83	52.18	23.40	2.12	1.54
59	Easthampton, . .	31.18	4.40	0.07	0.42	0.75	10.84	62.43	7.51	0.41	1.03
61	Hadley, . . .	38.78	5.32	0.05	0.28	0.33	1.08	51.46	24.01	7.75	7.00
62	Subsoil of No. 61, .	36.23	4.65	0.08	0.41	1.76	11.32	56.56	17.56	4.25	1.03
63	Double subsoil of No. 61.	34.77	2.40	0.56	0.33	4.98	2.33	50.68	18.80	11.33	6.36
70	Sunderland, . .	65.50	8.22	0.10	9.45	1.44	4.35	40.01	29.67	0.46	5.65
78	Whately, . . .	50.00	10.34	1.65	3.42	12.66	36.29	11.24	14.69	0.59	0.79
90	Whately, . . .	49.30	8.17	1.20	2.29	12.37	35.29	21.39	15.44	0.68	1.49

There is no greenhouse specialty which requires so much skill as the growing of roses, and the magnificent specimens which may be found in the markets at almost any season of the year surpass all other greenhouse products in beauty and perfection. There is no plant which requires so heavily manured a soil as the rose. The customary formula for mixing such a soil is one-third finely pulverized sod, one-third loam and one-third cow manure. In addition to this, some form of commercial fertilizer is occasionally applied. Watering the plants with a strong decoction of cow manure is frequently practised.

It is highly impracticable to use a soil of this nature for two consecutive seasons, since, owing to its high state of fertilization and the subsequent chemical changes which take place in the soil, a toxic effect is produced upon the plants. No class of greenhouse specialists is more particular about the texture of the soil employed than rose growers, especially when growing the American Beauty. American Beauties are more susceptible to differences in soil texture than other varieties of roses, and a perfectly satisfactory soil for their growth has not as yet been found in this State. They require soil of a different texture from Brides and Bridesmaids.

The rose soils in the list (*Cf.* Table V.) were obtained from various sources, some of which are noted for their production of excellent roses; while others are prospective rose soils, — that is, soils sent in by rose growers who wished to ascertain whether they were well adapted to the growth of roses. It will be noticed that most of these analyzed rather high in very fine sand and silt, while two of the samples contained nearly 10 per cent. of clay.

TABLE V. — *The Mechanical Analyses of Some Rose Soils.*

Station Number.	LOCALITY.	Water-retaining Capacity.	Organic Matter.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt.	Fine Silt.	Clay.
3	Natick, . . .	43.50	9.20	4.50	6.55	6.30	13.22	32.17	5.67	1.18	9.17
29	Madison, N. J., . .	52.10	9.96	3.87	7.10	8.10	13.77	26.77	8.85	1.20	9.40
35	Clifton, N. J., . .	64.30	7.90	3.60	13.50	18.77	17.83	23.30	8.59	1.66	3.53
43	Tarrytown, N. Y., .	54.06	8.10	.19	3.00	4.58	13.69	22.88	22.25	11.25	5.94
67	Amherst, . . .	56.50	8.96	3.51	3.25	3.87	9.75	45.42	14.49	.99	3.86
79	Westborough, . .	49.20	6.06	3.21	3.13	6.92	8.80	35.81	21.14	.99	4.31
81	Subsoil of No. 79, .	34.00	3.86	5.05	3.41	7.60	13.83	38.90	19.64	.73	3.77
82	Westborough, . .	60.24	6.99	3.07	3.23	7.77	9.25	47.81	16.28	.40	1.22
80	Subsoil of No. 82, .	36.00	3.88	5.52	4.61	9.29	13.36	26.12	26.25	.87	3.87
84	Westborough, . .	42.00	8.96	4.59	4.29	9.18	13.35	22.04	26.70	1.97	2.87
85	Natick, . . .	57.90	9.10	4.76	4.00	9.61	15.08	25.57	25.55	.90	1.48
86	Subsoil of No. 85, .	33.50	3.57	7.41	6.20	14.70	18.80	25.83	9.97	11.06	1.17
88	Natick, . . .	48.00	6.02	4.73	4.19	9.80	15.74	30.00	21.75	1.41	2.59
87	Subsoil of No. 88, .	60.25	4.71	4.35	3.58	8.36	11.25	33.77	26.47	1.04	4.01

Throughout Massachusetts there are many hills of an oval shape, whose long axes run in a northerly and southerly direction. These "clay hills" are designated "drumlins" by geologists, and in some parts of the State, notably on the ridge passing through Worcester county, they are abundant and symmetrical in outline, forming the most picturesque part of the landscape.

While these are commonly termed "clay hills," their surface soil cannot be classed as such, although it is a heavy, rather cold soil, especially adapted to the growth of some of the coarser grasses, like timothy. They make excellent pastures for cattle, and many of the best dairies in the State are located in regions where these hills prevail. (*Cf.* Table VI.)

Drumlins were formerly much valued by the Indians for agricultural purposes, since historical research reveals that many of them were cleared of forest growth at the time of the first English settlement in New England. They are well supplied with water, as is shown by the fact that crops grown on them seldom suffer from drought. They are largely cleared of forest growth to-day, because they are now, as in early times, highly valued for agricultural purposes. The original growth of trees consisted of chestnut, and where forests exist on these hills at the present time they consist mainly of this species.

TABLE VI. — *The Mechanical Analyses of Some Drumlin Soils.*

Station Number.	LOCALITY.	Water-retaining Capacity.	Organic Matter.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt.	Fine Silt.	Clay.
4	Spencer, . . .	40.70	8.50	5.32	6.80	8.88	21.96	32.51	8.07	2.02	3.05
49	Southbridge, . .	44.05	7.44	6.55	9.20	4.23	23.53	22.36	15.90	3.92	5.12
50	Subsoil of No. 49, .	33.30	3.20	5.98	8.18	6.07	15.78	16.84	19.60	13.05	6.23
51	Subsoil of No. 49, .	26.60	2.74	5.43	10.21	11.78	16.73	19.83	18.80	9.05	.39
83	East Brookfield, .	35.25	6.97	8.67	6.53	11.93	16.55	21.33	18.98	1.59	3.90

Of the remaining soils, a variety of types are represented. (*Cf.* Table VII.) A large number of these were taken from the experiment station grounds, and they predominate in very fine sand, which causes the soil to become quite compact when wet. They resemble the general type of Connecticut valley soils, and are not well adapted to the growth of greenhouse crops. The Oxford soil is from a river valley, and is suitable for truck farming. Soil No. 96 is from the Berkshire hills, and No. 56 from a Worcester county town, with an elevation of approximately 1,000 feet.

The analysis of earthworm castings is similar to that of the soil in which the earthworms live, with the exception of a small amount of organic matter.

TABLE VII. — *The Mechanical Analyses of Some Miscellaneous Soils.*

Station Number.	LOCATION.	Water-retaining Capacity.	Organic Matter.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt.	Fine Silt.	Clay.
5	Amherst experiment station.	68.45	7.32	.95	1.05	1.72	7.29	66.19	6.96	1.33	4.13
25	Amherst experiment station.	35.40	7.00	.25	.65	.90	4.45	74.15	5.01	.65	4.05
23	Amherst experiment station	42.50	8.60	2.80	1.80	3.05	10.70	50.95	6.70	2.35	6.50
24	Amherst subsoil, .	31.33	3.60	1.75	4.45	6.95	23.85	35.95	11.10	5.20	5.25
26	Amherst experiment station.	32.33	6.72	.35	.81	1.73	9.15	64.69	10.70	1.13	2.35
27	Amherst experiment station.	33.66	6.95	.40	.95	1.20	4.85	75.00	5.45	1.20	3.65
28	Amherst experiment station.	50.00	9.36	3.10	6.08	4.86	3.81	57.87	2.61	1.46	.73
36	Oxford, . . .	66.70	7.30	7.95	8.45	5.28	6.54	44.34	12.13	2.26	1.11
37	Amherst experiment station.	36.33	2.24	.34	4.03	5.03	6.64	74.42	1.98	.73	2.40
38	Earthworm castings.	67.76	9.60	2.10	7.51	7.45	13.40	39.26	12.13	3.21	1.79
39	Marshfield, salt marsh.	81.66	17.90	.00	.27	1.95	10.37	32.01	13.40	9.87	10.07
40	Marshfield, salt marsh.	81.33	17.50	.37	1.48	1.30	8.20	22.77	34.38	4.98	5.40
41	Wayland, fresh marsh.	142.50	77.39	.00	.30	.25	.50	2.10	.20	.45	13.05
42	Brick clay, . .	46.00	2.96	.00	.00	.00	.02	.16	15.18	15.83	64.15
56	Charlton, . .	65.13	11.10	3.07	5.62	6.41	9.28	22.51	17.97	3.84	3.57
60	Drift land, . .	25.16	.66	.13	1.08	7.85	61.06	25.82	.53	1.01	.51
64	Amherst subsoil, .	45.00	1.28	.82	2.27	2.26	13.35	29.53	14.40	14.42	12.55
66	Amherst experiment station.	59.01	9.80	.69	3.86	3.63	6.51	36.53	14.27	12.25	9.43
68	Amherst experiment station.	54.75	6.58	.99	1.48	1.53	12.51	28.02	14.51	14.11	10.41
69	Amherst experiment station.	65.25	18.21	1.45	4.40	3.85	12.93	38.13	1.50	.51	12.26
71	Amherst experiment station.	76.60	7.54	1.24	3.62	3.48	11.64	49.01	10.85	1.55	1.71
72	Amherst subsoil, .	86.10	.11	2.25	3.10	2.61	4.13	13.02	12.25	5.30	49.35
96	Franklin, . .	44.60	8.26	4.83	3.83	7.07	6.52	32.91	25.16	1.09	2.12
101	Belmont, . . .	39.33	8.42	8.90	5.59	18.64	26.19	18.48	3.40	2.60	1.63
104	Monson, . . .	37.50	8.98	3.54	2.99	9.16	17.45	19.36	27.94	2.75	3.36

REPORT OF THE ENTOMOLOGISTS.

C. H. FERNALD; H. T. FERNALD.

Outline of Work.

Four main lines of work have occupied the attention of the entomological division of the station during 1906: correspondence, experimental investigations, special research and the preparation of results for publication.

The correspondence during the year has been unusually large in amount, and has extended over a much longer period than is usual. The largest amount of this work generally comes between the first of May and the end of August, but this year it began in March and continued until into December. Of course during the remaining months numerous letters are received and answered, but the bulk of the correspondence has now not only increased beyond that of previous years, but has extended over a longer period.

No unusual devastation has been reported during the past year, but all of our injurious insects seem to have been abundant, and have caused their share of loss in one line or another.

Experimental investigations have been begun or continued from previous years along a number of lines. The prevalence of the white fly in greenhouses has caused much loss, and information as to the methods of controlling this insect has been in great demand. For this purpose fumigation with hydrocyanic acid gas appears to be the most successful if made at the proper intervals of time and in the proper way; but this gas is also injurious to plants, and how much these can stand under varying conditions of light, temperature, humidity, length of exposure to the fumes, etc., has not been determined for different kinds of plants at different ages. This has accordingly been made a subject of particular investigation during the past year.

Tomatoes were the first crop tested, the usual greenhouse varieties being selected; and the plants were fumigated at all stages of growth and under varying conditions, to determine in each case the maximum amount of gas which could be used without injury. These experiments have now been completed, and demonstrate that it is possible to fumigate tomatoes with a sufficient strength of cyanide to destroy the white fly without injuring the plants, provided certain conditions are carefully observed. The information thus obtained has already been supplied to a number of persons who have had trouble with the white fly in their greenhouses, and has been used successfully, and a bulletin on the subject is now being prepared. At the present time a similar series of experiments with cucumbers, another important forcing-house crop, and one also seriously injured by the white fly, is in progress.

The prevalence of root maggots of various kinds during the past few years has called attention to the need of a more thorough study of the methods for controlling these insects; and a series of tests of these methods was begun last spring, the intention being to try different treatments recommended, and obtain evidence as to their comparative value. For various reasons, however, it was impossible to complete these experiments during the season, and it is planned to repeat them on a larger scale next year.

The last two summers have been unusually favorable for the rapid increase and distribution of the San José scale. This pest has been in Massachusetts for about fifteen years, and in the localities where it was first introduced has spread in all directions for some distance. New centers of infestation, however, have been constantly established from the planting of infested stock of one kind or another; and while five years ago most of these centers were already in existence, the number of scales at each was so small that their presence was generally unsuspected. It would seem that during the first two or three years in any locality this scale spreads but little, as the plant it is on furnishes all the food supply needed; but as these plants become thoroughly covered with the scales, the young find it more difficult to obtain their food without wandering farther from where they were born, and apparently more of them under these conditions get upon the feet of birds or larger insects which alight where they are, and are thus carried away to infest other parts. The result of this is a general infestation of the region, following four or five years after the local infestation; and it is probable that this condition of affairs was reached generally in Massachusetts about 1904. Following this were two summers extremely favorable for a rapid increase of these pests; and we now find them in great abundance in many places where their presence has not before been suspected, and quite generally scattered through the State.

Whether this explanation, which naturally is more or less theoretical, be correct or not, the fact remains that the correspondence of this station shows that the San José scale was probably present in one or more somewhat restricted areas in nearly every town in Massachusetts east of the Connecticut River in 1904; while at the present time it would probably be easy to find it in a dozen places in each of these towns, and as frequently on large, old trees as on recently set ones.

Though this insect attacks a large number of kinds of plants, those of most importance to man are the fruit trees and certain ornamental trees and shrubs; and these, accordingly, are the ones which will receive attention in the way of treatment. A number of extensive studies in the treatment of the San José scale were begun at this station in 1902, at which time the conclusion was reached that the most successful treatment was obtained by the use of the lime and sulfur mixture. Farther experiments along this line have been made as opportunities offered, and the results reached still confirm that conclusion. Last spring over eight hundred trees belonging to the college were sprayed with a number of different preparations, and a study of the results was made during the entire summer and fall. The inconvenience in making the lime and sulfur mixture, resulting from the necessity of boiling the materials for from forty minutes to an hour, has led to an attempt to avoid this by adding materials which would continue the boiling begun by the slaking of the lime for a sufficient length of time to obtain the desired chemical combinations. Several of these "self-boiling mixtures" were tested last spring, but none of them gave as good results as the lime and sulfur mixture prepared in the usual way. Perhaps the best of these "self-boiling mixtures" was that obtained by a mixture of 20 pounds of lime, 14 pounds of sulfur and 10 pounds of sal-soda in 40 gallons of water. Similar combinations, substituting sodic sulfid or caustic soda for the sal-soda, were more expensive and gave less satisfactory results.

The Derror tree fluid was also tested in the course of these experiments, but so far as could be observed failed to be of the slightest benefit in any case.

The K. L. mixture, which has been recommended by the Delaware Experiment Station, also gave unsatisfactory results, besides being quite expensive.

The Rex lime-sulfur solution was applied in four different ways, in accordance with the suggestions of the manufacturers, but none of the four gave satisfactory results, although a small proportion of the scales was killed.

Scalecide, applied at the rate of 1 gallon to 22 gallons of water, proved to be something of an insecticide, killing many of the scales; but applied with the same apparatus, by the same men and on the same day, as the ordinary lime and sulfur mixture, it failed to give anything like as good results. From reports which have been received, however, from other places, it is probable that this material, used at greater strength, in two applications and under great pressure in the pump, may prove quite effective.

Observations for determining dates of appearance of the young of the oyster-shell and scurfy scale have been continued, and the same observations have been made for the white pine scale, as upon the time when the young appear entirely depends the time at which successful treatment can be given.

The raising of cranberries in Massachusetts is a very important industry, in which a large amount of capital is invested, and the annual value of the product is over a million dollars. The cranberry plant has a number of serious insect enemies, and fifteen years ago the subject of cranberry insects was given much attention at this station, and the results obtained at that time were published. Farther study on the subject has been greatly needed, but it was impossible to make these anywhere except on the bogs themselves, and until the present year arrangements for this could not be made. Last spring, however, it was found possible to again take up the study of cranberry insects under the local conditions found on the bogs, and an investigator spent five months in continuous study of these insects on the bogs around Wareham. Many of the problems connected with the control of cranberry pests have been solved, as a result of this investigation; but many new problems have appeared in the course of the work, which make it desirable to continue the study farther, and it is the present intention to have an investigator spend six months at least during the coming year in continuing the observations begun last summer. That the results thus far have been so satisfactory is due in a great measure to the hearty co-operation in the work given by the Cape Cod Cranberry Growers' Association, and of many individuals connected therewith.

During the latter part of last winter some very remarkable cocoons found in Dorchester were sent to this division by the Gypsy Moth Commission, and were found to be the cocoons of some foreign insect. Subsequently the moths which emerged from them were identified as being native in China and Japan, and concerning which very little appears to be known. The possibility that this insect may become a pest in this country is so great that it has seemed wise to thoroughly investigate its present distribution, abundance, probable means by which it reached this country, and all that is already known of it, and this work has taken much of the time during the last two months of this year. Apparently this insect, which may for convenience be designated the Oriental moth, has been in this country for six or seven years, and it is at least possible that it was introduced on nursery stock imported from Japan. It has now spread over a considerable territory in Dorchester, where it is quite abundant. The caterpillar feeds upon the leaves of a large number of our more common fruit and shade trees. While it is yet too soon to determine whether it will become a serious pest, the experience this State has had with the gypsy and brown-tail moths has been of such a nature that it is the part of wisdom to investigate all such importations as this, and be at least prepared for the worst. The insect has already shown that it can live in our climate, that it can become quite abundant, and that it has few if any enemies. At the present time in Asia it is present over twenty degrees of latitude, corresponding to the distance from Florida to Labrador in this country. A bulletin giving all the information thus far obtainable about this insect has already been issued, and further studies of it will be made the coming year.

The other subjects outlined in this report have taken so much time that little has been done along the line of special research, only one paper having been published, though several topics are now in hand, and the work on them occupies the few odd minutes not taken by other duties.

Insects of the Year.

The insects which have caused much loss in Massachusetts during 1906, as indicated by the correspondence of the station and also by personal observation, have been of many kinds. The condition of this State as regards the San José scale has already been described, and the correspondence about this pest has been very great in amount. In connection with this, the oyster-shell scale, the scurfy scale, the rose scale, the white pine scale and several kinds of Lecaniums have required a considerable amount of attention. Many letters with reference to the gypsy moth and brown-tail moth have also been received, and have either been answered from here, or the writers referred to the Gypsy Moth Commission, which now has charge of the work of controlling these insects. The elm-leaf beetle is gradually becoming more abundant, and has again reached the point where its numbers are sufficient to greatly injure the appearance of our elms. During the spring months an unusual abundance of the spiny elm caterpillars was noticed, and in some places they seriously injured the appearance of the trees. Plant lice of various kinds were also much in evidence; and many specimens of tussock moths, particularly the old tussock moth, were sent to the station for identification. Many inquiries about cutworms were received, but the correspondence on this topic was less than during the two years preceding; while inquiries about wire worms and the best treatment for them were more abundant than usual. In greenhouses the white fly is a serious pest, causing the loss of thousands of dollars, and much correspondence; while thrips, which was so much in evidence a few years ago, was inquired about but twice. The asparagus root miner, an insect not hitherto reported in this State, has made its appearance in several places in sufficient abundance to cause considerable injury. But little is known of the life history of this insect, and further investigations upon it are planned for the coming season.

As a whole, the important insects this year have been of so many different kinds that it has been impossible to give to most of them the uninterrupted attention which is needed, even for our most abundant forms, in order to test the best methods of control. There is no insect known about which more information would not be of assistance in leading to the discovery of better remedies than we now have; and it is most desirable that the insects causing the most loss in any year shall be carefully studied at the time, in the hope of finding better methods of control. Such conditions as have prevailed during the past season, therefore, where work of this kind has been almost impossible on account of so many calls for information in different directions, produce a year which must be considered as more or less unsatisfactory in the way of results; and this was certainly the case in 1906.

VETERINARY DEPARTMENT.

This newly organized department of the station has been in operation since July 1 of the present year. Previous to this the veterinary work in the station has been attended to by the veterinary department of the college.

Each year for the past fifteen years there has been an increasing demand from the stock owners of the State for information concerning veterinary subjects. This demand has come to the station in the form of requests for lectures and publications, and correspondence relative to animal diseases, or to the nature of material sent for examination. The specimens that have been received have come from various parts of the State, and have consisted of diseased tissues of the larger animals, or in some instances the cadavers of the smaller farm animals; and in some cases the products of the animals, such as milk, eggs, etc. This material has been subjected to a close examination, oftentimes a microscopical study and bacteriological examination, requiring a large amount of time and labor to complete it. Living animals sent for study and examination have been kept under observation in the hospital, where experiments have been conducted to obtain definite information regarding the nature of the particular affection, as regards cause, effects, contagiousness and other closely related matters. Upon the completion of the work written reports have been sent to those from whom the specimens have come, advising them of the nature, cause, treatment or prevention of the particular affection.

On several occasions visits have been made to farms in different parts of the State, to investigate outbreaks of disease of a character peculiar either on account of the circumstances under which the disease made its appearance, the form it assumed, or the peculiarity of the symptoms accompanying its development. Experiments conducted at the station, and on the farm in conjunction with the owners of the animals, have in several instances been fruitful of most favorable results, either in arresting the progress of the disease or in preventing its recurrence.

REPORT OF THE HORTICULTURIST.

F. A. WAUGH.

Outline of Work.

The work of the department of horticulture continues on the lines laid down several years ago, and set forth in previous reports of this station. The principal experiments undertaken deal with problems in the propagation of fruit trees, in pruning, and in the systematic study of varieties of fruits. These all require a considerable number of years to secure definite results, and no report on these experiments would be justified at this early date.

Incidental to other work, a few experiments of minor importance have been underway, such as cross-grafting herbaceous plants, test of varieties of strawberries, details of certain methods in market-garden practice, some study of thermo-physiological constants, the practical application of digesting fluids in the germination of seeds, the growing of mushrooms, etc. A short report on the experiment last mentioned is appended herewith.

Notes on Mushroom Culture.

Opportunity has offered during the last two years to make several practical experiments in mushroom culture. The principal matter at issue, aside from a demonstration of methods, was the comparative value of the new pure-culture spawn. Several commercial varieties of these so-called tissue or pure-culture spawn were tested and compared, and comparison was made with the common commercial English spawn and with the French spawn. The results are summarized below.

Mushrooms were grown under the ordinary conditions. No special houses were provided. For the most part, beds were made up under greenhouse benches in a house used for bedding out stock. In one instance beds were made in an unused cellar. This work was under the direct charge of Mr. Francis Canning, head gardener.

As has been said, the usual methods were followed. For instance, in the fall of 1904 a bed was made up, November 19. This was spawned November 30 with common English spawn and with a few varieties of pure-culture spawn. The first picking was made on January 6. The entire crop from a bed of 75 square feet was something over 50 pounds. This amount was sold for an average of 35 cents a pound, bringing a total of a trifle over $17.50. This gives an average return of approximately 24 cents per square foot. Part of this crop was sold locally in quart strawberry boxes, which will hold one pound of mushrooms when heaping full. A considerable amount of the crop was shipped to Boston, selling from 40 to 50 cents a pound, yielding a net average of 33 cents a pound.

In the fall of 1905 the experiment was renewed, greater care being taken to equalize all conditions, and to give a fair test on the comparative value of varieties used. Five pure-culture varieties were included in this planting, as follows: Alaska, Columbia, Bohemia, Galloway and Agaricus arvensis (this last is the variety now called Eureka). In separate sections of the same bed the common English and the French spawns were included. The following table shows the results of this experiment. The time of first picking is indicated, and of the last picking, thus showing the length of season. The total weight is given, and dates are added to indicate at what time of the season the beds were most productive. In the last column is shown the number of pounds produced by each bed during its most productive week.

Comparison of Varieties, 1905–06.

Variety.	Spawned.	First Picking.	Last Picking.	Total Weight.	Square Feet of Bed Surface.	Weight per Square Foot of Surface (Pounds).	Week most Productive.	Amount for Week (Pounds).
Alaska,	Oct. 26,	Dec. 11,	March 10,	7 lbs. 4 oz.,	9	.777	Dec. 11–18,	3.375
Galloway,	Oct. 26,	Dec. 16,	Jan. 25,	3 lbs. 8 oz.,	9	.388	Dec. 23–30,	2.000
Columbia,	Oct. 26,	Dec. 16,	March 10,	6 lbs. 4 oz.,	9	.666	Dec. 29–Jan. 9,	2.500
Bohemia,	Oct. 26,	Dec. 15,	March 10,	5 lbs. 14 oz.,	9	.555	Dec. 27–Jan. 2,	2.125
Arvensis,	Oct. 26,	Dec. 15,	March 10,	13 lbs. 14 oz.,	9	1.555	Dec. 23–30,	5.500
English,	Nov. 3,	Jan. 8,	March 10,	4 lbs. 12 oz.,	18	.222	Feb. 10–17,	1.500
French,	Nov. 3,	Feb. 24,	March 10,	8 oz.,	18	.027	March 10,	.375

It will be seen that the pure-culture varieties gave much larger yields than either the English or the French spawn. While this difference is very great in this experiment, indicating probably an inferior grade of English and French spawn, all our experiments have shown a similar advantage for the pure-culture varieties. Indeed, it seems to be one of the chief advantages of the new method of growing mushroom spawn from pure culture that it nearly always gives fresher and more vigorous spawn. The product is nearly always more uniform, and of higher quality; but, while this advantage is important, it is not so great as the one already mentioned.

A comparison of the different varieties shows that Eureka (Agaricus arvensis) leads all the others in productivity, Alaska coming second. This has been the result in all the experiments in which these varieties have been tested. Eureka is darker colored than any of the other varieties, and sometimes not quite so well shaped; nevertheless, it is solid and heavy, and of fairly good quality when cooked. Galloway is a white, small, delicate variety, the best of all for eating, but not sufficiently productive to pay the grower.

The following conclusions may fairly be drawn from the experiments: —

1. Pure-culture spawn is as a rule very much better than either English or French spawn.

2. There are important points of difference between the commercial pure-culture varieties; these differences consist in color, flavor, form, and above all else in productivity.

3. The most productive variety thus far tested is Eureka. Several other varieties are promising.

As a general result of our experience, it may be said that mushrooms can often be grown profitably as a catch-crop in cellars or under greenhouse benches where conditions are favorable. The most important favorable condition to be considered is a cheap and reliable supply of fresh horse manure. It is quite plain, however, from our experience, that the stories of sudden wealth accumulating from mushroom-growing are mostly fictitious.