State of New York — Department of Agriculture.

FOURTEENTH ANNUAL REPORT

OF THE

BOARD OF CONTROL

OF THE

NEW YORK
Agricultural Experiment Station,

(GENEVA, ONTARIO COUNTY.)

For the Year 1895,

With Reports of Director and Other Officers.

TRANSMITTED TO THE LEGISLATURE MARCH 13, 1896.

WYNKOOP HALLENBECK CRAWFORD CO.,
STATE PRINTERS,
ALBANY AND NEW YORK.
1896.

STATE OF NEW YORK.

No. 70.

IN ASSEMBLY,

MARCH 13, 1896.

FOURTEENTH ANNUAL REPORT

OF THE

Board of Control of the New York Agricultural Experiment Station.

STATE OF NEW YORK:

DEPARTMENT OF AGRICULTURE,
ALBANY, *March* 15, 1896.

To the Assembly of the State of New York:

I have the honor to herewith transmit the Fourteenth Annual Report of the Director and Board of Managers of the New York Agricultural Experiment Station at Geneva, N. Y., in pursuance of the provisions of the Agricultural Law, Chapter 338 of the Laws of 1893.

I am, respectfully yours,

FRED. C. SCHRAUB,

Commissioner of Agriculture.

ORGANIZATION OF THE STATION.

BOARD OF CONTROL.

GOVERNOR MORTON	Albany.
CHARLES JONES	Geneseo, Livingston County.
WILLIAM C. BARRY	Rochester, Monroe County.
PHILIP N. NICHOLAS	Geneva, Ontario County.
ADRIAN TUTTLE	Watkins, Schuyler County.
S. H. HAMMOND	Geneva, Ontario County.
WILLIAM D. BARNS	Middle Hope, Orange County.
MARTIN V. B. IVES	Potsdam, St. Lawrence County.
LUMAN D. OLNEY	Watertown, Jefferson County.
A. C. CHASE	Syracuse, Onondaga County.

OFFICERS OF THE BOARD.

MARTIN V. B. IVES	*President.*
W. O'HANLON	*Secretary and Treasurer.*
CHARLES JONES, PHILIP N. NICHOLAS, S. H. HAMMOND, L. D. OLNEY, W. C. BARRY, ADRIAN TUTTLE,	*Executive Committee.*

STATION STAFF.

Acting Director and Chemist	L. L. VANSLYKE, PH. D.
First Assistant	WILLIAM P. WHEELER.
Horticulturist	S. A. BEACH, M. S.
Assistant Horticulturist	WENDELL PADDOCK, B. S.
Entomologist	*F. A. SIRRINE, M. S.
Entomologist	*VICTOR H. LOWE, B. S.
Mycologist	*F. C. STEWART, M. S.
Assistant Chemist	C. G. JENTER, PH. C.
Assistant Chemist	A. L. KNISLEY, M. S.
Assistant Chemist	†A. D. COOK, PH. C.
Assistant Chemist	†H. H. SEELY, A. B.
Assistant Chemist	†W. H. ANDREWS, B. S.
Agriculturist	GEORGE W. CHURCHILL.
Clerk and Stenographer	FRANK E. NEWTON.

*Connected with Second Judicial District Branch Station.
†Connected with Fertilizer Control.

TABLE OF CONTENTS.

Fourteenth Annual Report

OF THE

Board of Control of the New York State Agricultural Experiment Station.

TREASURER'S REPORT.

Geneva, N. Y., *October* 1, 1895.

To the Board of Control of the New York Agricultural Experiment Station:

As treasurer of the Board of Control, I respectfully submit the following report for the fiscal year ending September 30, 1895:

Maintenance Account.

Receipts.

To balance on hand October 1, 1894	$680 73
To amount received from Comptroller	50,000 00
Total	$50,680 73

Expenditures.

By Board of Control	$631 67
By cartage and express	685 70
By farm implements and tools	481 58
By fuel	1,203 59
By gas	698 89
By general supplies	4,093 93
By labor	16,403 06
By library	260 23
By manure and fertilizer	303 15
By miscellaneous expenses	692 87
By printing	3,823 47

By repairs	$1,016 47
By salaries	14,249 44
By stationery	146 08
By telegraph and telephone	86 97
By traveling expenses	795 98
By water	456 00
By farm and grounds	615 01
By green houses	1,052 17
By scientific apparatus	263 83
By live stock	129 25
By furniture	11 50
Balance on hand October 1, 1895	2,579 89
Total	$50,680 73

Expense of Bulletins and Enforcing Provisions of Chapter 437 of the Laws of 1890.

RECEIPTS.

To balance on hand October 1, 1894	$97 20
To amount received from Comptroller	7,500 00
Total	$7,597 20

EXPENDITURES.

By chemicals	$323 99
By chemical apparatus	149 39
By gas	335 29
By miscellaneous expenses	16 50
By printing	700 67
By salaries	2,909 32
By stationery	185 90
By travel, securing samples	956 78
By water	114 00
By balance on hand October 1, 1895	1,905 36
Total	$7,597 20

Repairs to Farm Buildings.

RECEIPTS.

To balance on hand October 1, 1894	$869 83

EXPENDITURES.

By repairs	$869 83

Postage Account.

Balance on hand October 1, 1894	$842 00
EXPENDITURES.	
By postage	580 00
Balance on hand	$262 00

Under Chapter 675, Laws of 1894.

RECEIPTS.

To amount received from Comptroller	$9,097 05
EXPENDITURES.	
By vouchers approved by the special auditing committee of the Board and the Commissioner of Agriculture	9,051 17
Balance on hand	$45 88

I have returned to the Treasurer of the State of New York, 43 cents, the unexpended balance of appropriation to laboratory account; $68.62, unexpended balance of appropriation pursuant to chapter 356, Laws of 1892; $3.48, unexpended balance of appropriation made under chapter 356, Laws of 1892 (ice house).

I have on hand for surplus products sold, $884.77.

All expenditures are supported by vouchers approved by the auditing committee of the Board of Control and have been furnished the Comptroller of the State of New York.

United States Appropriation Under Act of Congress Approved March 2, 1887.

DR.

To receipts from Treasurer of the United States, as per appropriation for fiscal year ending January 30, 1895, as per act of Congress, approved March 2, 1887	$1,500 00

Cr.

By salaries	$1,189 98
By freight and express	37 10
By seeds, plants and sundry supplies	3 30
By fertilizers	8 50
By feeding stuffs	226 55
By traveling expenses	21 75
By balance	12 82
Total	$1,500 00

W. O'HANLON,
Treasurer.

REPORT OF THE ACTING DIRECTOR AND CHEMIST.

To the Board of Control of the New York Agricultural Experiment Station.

GENTLEMEN.—I submit herewith the fourteenth annual report of the New York Agricultural Experiment Station for the year ending December 1, 1895.

By action of your Board taken on June 7, 1895, I was requested to perform the work of Acting Director for three months, and in obedience to your later request I have continued to hold the position subject to your further order.

This report will be presented in the order of the following subjects:

I. Improvements and additions.
II. Outline of reports of different departments.
III. Bulletins published during the year.
IV. Tabulated summary of laboratory work.
V. Arrangement of chemical work.
VI. Addresses.
VII. Comparative profits derived from selling milk, butter and cheese.
VIII. Comparative field test of commercial fertilizers used in raising potatoes.
IX. Chemistry of plants, plant foods and soils.
X. Description of materials used as fertilizers.
XI. Purchase and use of fertilizers.
XII. Arithmetic of fertilizers.
XIII. Average composition and value of fertilizing materials and of farm crops.
XIV. The New York State fertilizer law and its meaning.
XV. Analysis of commercial fertilizers collected during the spring of 1895.

XVI. Analysis of commercial fertilizers collected during the fall of 1895.
XVII. Gifts to the Station.
XVIII. Newspapers and periodicals presented to the Station.
XIX. Rules of Station governing gratuitous chemical analysis for private parties.

I. Improvements and Additions.

The Legislature of 1895 appropriated $1,000 for a fruit house to be used for assorting and storing fruit, for exhibiting fruit and for experimenting as to the best methods of keeping different fruits. This will supply a long felt want. Such a building is an absolute necessity in order to enable us to make the best use of our extensive orchards, which are each year coming into more complete bearing. The building is located immediately west of the dairy building.

An additional appropriation was made of $7,500, for the construction of three dwellings to be used by officials of the staff. After careful consideration it was decided to build a triple house in order to utilize the appropriation in the most economical way possible. The building is located north and west across the road from the Director's residence. Ground was broken in August, and the building is to be completed in January, 1896. This building will add not a little to the appearance of the Station property, and will prove a great convenience for those members of the staff who have formerly been compelled to live at some distance from their work.

Arrangements have been made for extending the orchard, and an addition of about three acres will be made in the spring.

A hedge of Norway spruce has been set along the northwestern boundary of the Station property. This will add much to the appearance of this portion of the farm, and is designed in time to serve as a useful windbreak for the various buildings.

A new boiler and engine were placed in the dairy building last summer, furnished the Station at a special rate by D. H. Burrell & Co., of Little Falls, N. Y. This addition to the equipment of the dairy building had become an absolute necessity.

II. Outline of Reports of Different Departments.

1. *Report of the First Assistant.*—In his report Mr. Wheeler, the First Assistant, gives a brief general statement of the work of the past year. He reports briefly the method of cattle feeding for

the year, and makes mention of the rations fed during the different months. He also reports various feeding trials, ten in number, made during different seasons. The records are given for periods during which corn silage was fed, together with records for feeding periods immediately preceding or following. There are also in addition tables which give the average data in detail. He finds in general that there has been an increase in milk flow accompanying the use of corn silage in the rations, and at the same time there has been an increase in the total amount of fat in the milk, the per cent. of fat not diminishing. Using the valuations for food which are assumed in the report, milk has generally been produced at a lower cost when corn silage was fed than with the other foods used in these trials. Special attention is called in the report of each trial to the proportion of the cost of each ration represented by the grain food and by the silage or green fodder, and also the relative proportion of the total digestible nutrients in the ration supplied by these foods. The percentage of the nutriment supplied by the silage or green fodder has generally been much higher than the percentage of cost represented.

Under the subject of pig feeding Mr. Wheeler gives the records of feeding trials with several breeds and crosses. Some lots of pigs were fed only for a few months from birth until sold, or used in other experiments, but most of them were fed seven or eight months. Tabulated records are given for periods of feeding, showing the rate of growth, the amount of food and the cost of food given in gain in weight.

Attention is also called to the experiments under way with poultry. The report in full is given of a feeding experiment with laying hens of large and small breeds, in which are considered questions concerning the relative amounts of ground and whole grain that can be fed to best advantage. Rations containing ground and moistened grain and corresponding rations containing only whole grain were fed throughout the year. There are tables which give the average data for different periods of several weeks each. A general summary of the results is given.

2. *Report of Horticulturist.*—The horticultural investigations in 1895 were conducted chiefly in the following lines:

1. Testing fruits.
2. Origination of new fruits for the purpose of securing improved sorts.

3. Investigation of several subjects pertaining to forcing vegetables.
4. Comparison of different lines of treatment in combating some plant diseases of economic importance.

3. *Special Work in the Second Judicial Department.*—During the season of 1895 a series of twelve farmers' meetings was held. reaching localities in six counties. At these meetings addresses were given by members of the Station staff, assisted by specialists, Agricultural and horticultural topics of local interest were discussed. A stereopticon was employed in illustrating the different forms of insects and fungous diseases, spraying machinery, etc. These meetings were well attended, and were considered instructive and interesting. The impression made was so favorable that there was a very general impression that the meetings should be repeated another year. In addition to this series of meetings, numerous informal meetings were held in several localities during the summer, at which topics pertaining to injurious insects and plant diseases were discussed by members of the Station staff. Mr. V. H. Lowe and Mr. F. A. Sirrine, have carried on the entomological investigations, and Mr. F. C. Stewart has given his attention to the study of plant diseases and remedial treatment for the same. Detailed accounts of the work of these specialists are found in their annual reports, published in this volume. Mr. Paddock, Assistant Horticulturist, carried on experiments in treating leaf blight and fruit rot of cherries in Orange county. This is contained in the report of the horticulturist.

A co-operative field test of different brands of commercial fertilizers for potatoes was conducted in Suffolk county by the chemist of the Station, and the results of the test are published in his report. Two circulars designed to give information about destructive insects were issued so as to call attention to these pests just before they were expected to appear. Circular No. 1, by F. A. Sirrine, treated of the cabbage maggot, and No. 2, by V. H. Lowe, treated of the corn worm. Circular No. 3, issued May 15, 1895, gives a brief account of the progress of the work. Besides these circulars the following bulletins have been issued :

Bulletin No. 86, by S. A. Beach and W. Paddock, on treatment of injurious insects and fungous diseases.

Bulletin No. 87, by F. A. Sirrine, on the San Jose or pernicious scale.

Bulletin No. 93, by L. L. Van Slyke, on comparative field test of commercial fertilizers used in raising potatoes.

Bulletins Published During the Year 1895.

Bulletin No. 84, January, 36 pages.— Spraying pear and apple orchards in 1894, by S. A. Beach.

Bulletin No. 85, January, 28 pages.—Report of analysis of commercial fertilizers collected during the fall of 1894, by L. L. Van Slyke.

Bulletin No. 86, February, 56 pages.—Treatment of common diseases and insects injurious to fruits and vegetables, by S. A. Beach and W. Paddock.

Bulletin No. 87, March, 12 pages.—The San Jose or pernicious scale, by F. A. Sirrine.

Bulletin No. 88, March, 20 pages.—I. Forcing lettuce in pots. II. Mushrooms as a greenhouse crop, by S. A. Beach.

Bulletin No. 89, April, 15 pages.—Comparative profits derived from selling milk, butter, cream and cheese, by L. L. Van Slyke.

Bulletin No. 90, May, 20 pages.—Feeding experiments with laying hens and comparison of rations containing moistened ground grain with others containing dry whole grain, by W. P. Wheeler.

Bulletin No. 91, August, 21 pages.—A new strawberry, notes on strawberries, raspberries, blackberries and dewberries, by S. A. Beach and W. Paddock.

Bulletin No. 92, October, 56 pages.—Report of analysis of commercial fertilizers collected during the spring of 1895, by L. L. Van Slyke.

Bulletin No. 93, October, 15 pages.—Comparative field tests of commercial fertilizers used in raising potatoes, by L. L. Van Slyke.

Bulletin No. 94, October, 133 pages.—The composition and use of fertilizers; science applied to feeding plants, by L. L. Van Slyke.

Bulletin No. 95, November, 33 pages.—Currants, by S. A. Beach.

Bulletin No. 96, December, 48 pages.—Report of analysis of commercial fertilizers collected during the fall of 1895, by L. L. Van Slyke.

Bulletin No. 97, December, 50 pages.—Corn silage for milch cows, by W. P. Wheeler.

IV. TABULATED STATEMENT OF LABORATORY WORK FOR THE YEAR 1895.

	In milk.	In butter.	In cheese.	In whey.	In cattle foods.	In fertilizers.	In soils.	In chicken meat, bones, etc.	Total.
Determinations of nitrogen	7,158	5	79	48	285	1,475	8	184	9,242
Determinations of fat (Babcock test)	2,798	....	24	....	....	......	....	....	2,822
Determinations of fat (ether extract)	18	8	80	60	289	......	....	211	666
Determinations of water	1,458	12	59	32	297	......	2	....	1,860
Determinations of ash	1,455	2	2	32	186	......	....	215	1,889
Determinations of crude fibre	......	....	....	....	213	......	....	....	213
Determinations of sugar and starch	......	....	....	....	319	......	....	....	319
Determinations of phosphoric acid	......	....	....	....	....	2,940	....	....	2,940
Determinations of potash	......	....	....	....	....	1,052	....	....	1,052
Determinations of casein	2,847	....	....	....	....	......	....	....	2,847
Determinations of albumen	1,945	....	....	....	....	......	....	....	1,945
Miscroscopical examinations	......	....	....	....	....	......	....	....	217
Miscellaneous determinations	......	....	....	....	....	......	....	...	364
Grand total	......	....	....	....	....	......	....	....	26,376

V. Arrangement of Chemical Work.

The chemist gives such general and special supervision to all the different lines of work as they may require. The work done in the way of preparing bulletins and giving addresses is given under special heads.

The present arrangement of chemical work among the assistant chemists is as follows:

Mr. C. G. Jenter has special charge of the analysis of butter, of cattle foods and similar materials, of the determination of copper in plants, soils, etc., of miscellaneous analytical work, and of photographic work.

Mr. A. L. Knisely has special charge of the analysis of milk, whey and cheese and of the microscopical examination of milk. He has also done considerable work in relation to the availability of fertilizing materials.

Mr. J. A. Le Clerc has special charge of all nitrogen determinations, and also assists in analysis of dairy products.

Messrs. W. H. Andrews, A. D. Cook and H. H. Seely give their entire time to the analysis of commercial fertilizers and fertilizing materials.

Mr. A. H. Horton has charge of keeping the records connected with the investigation of dairy breeds of cattle, which require numerous and extended calculations.

VI. Addresses.

As chemist and acting director, I have delivered addresses on various agricultural topics at the following places: Richmondville, Guilford, Mount Upton, Seneca Falls, Penn Yan, Albion, Batavia, East Bloomfield, Avon, Dansville, Cohocton, Naples, Auburn, Oxford, Greene, Mattituck, Southold, Huntington, Port Jefferson, Mineola, Schenevus, Farmerville, Hayt's Corners, Aurora, Geneva, Ontario Beach and Syracuse.

VII. Comparative Profits Derived from Selling Milk, Butter Cream and Cheese.

A question of practical importance, now often asked by dairymen, relates to the form in which milk can be sold. From what form of product can the greatest profit be derived, from selling milk as milk or from selling it in the form of cream, butter or cheese? Several different factors enter into a complete answer of such a question. One of them may be cost of transportation to the best market. Another may be the greater relative market value of milk in the form of one product than in another. Thus, in the form of cream milk generally sells for more than in any other form, and occasionally cheese sells for a higher price relatively than butter, while the opposite may also be frequently true. In discussing this question, we must consider conditions which are normal or average rather than those which are exceptional. The data which we need to know are (1) the cost of production, and (2) the market value of the product. In regard to cost of production, we have already published data in Bulletins 77, 78 and 79, which can be utilized in considering the relative profits to be derived from selling milk in different forms. We have also fixed prices for milk and its different products, which represent average conditions and which are as nearly accurate, relative to one another, as we may easily approximate.

For the convenience of those who have not read the previous bulletins, we will give a brief statement here in regard to the basis upon which our calculations are made in ascertaining the profits derived from selling milk, cream, butter and cheese.

The food-cost of products alone is considered.

The value of the milk is based on the amount of total solids in milk allowing 9⅓ cents a pound for milk-solids, which is equivalent, on an average, to 2¾ cents a quart for milk or 1.28 cents a pound.

The value of the butter is placed at an average price of 25 cents a pound; the butter contains 85 per cent of fat.

The value of the cream is placed at 20 cents a quart; the cream contains 20 per cent of fat.

The value of the cheese is placed at 10 cents a pound for cheese about one month old, which would be equivalent to about 9⅔ cents a pound for green cheese.

In calculating the *amount of profit*, a deduction is made from the gross profit (the difference between the value of the product and its food-cost), amounting, on an average, to 12½ cents for each one hundred pounds of milk, representing the amount of feeding and tertilizing materials taken away from the farm in the case of selling milk and cheese. A smaller but proportionate reduction is made in fhe case of cream.

The foregoing prices placed on the different dairy products do not represent actual prices at this writing, but they represent fairly the average prices prevailing during a period of years previous to the present depression, and may be regarded as relatively accurate, whether absolutely so or not.

While the data contained in this bulletin are not intended to give in any respect a comparison of breeds or individuals, we state the names of the individual cows and also, in the first table, the breed to which each belongs, in order that any one interested in individual differences may make comparisons.

In the table following, we state under the column headed "Cost of one quart of milk" the food-cost of one quart of milk, giving the figures in order, commencing with the lowest. In the other columns, we indicate by figures in parentheses the order of each individual in different periods of lactation. There are 44 lactation periods included and so the numbers run from 1 to 44 inclusive. To illustrate the meaning of the arrangement of this table, Beauty Pledge, Holstein-Friesian, in her second period of lactation, produced a quart of milk at less cost than any other animal in any period of lactation and hence she ranks in this column first (1). Under the column headed "Cost of one pound of butter," this same animal ranked ninth (9); that is, in eight periods of lactation of other cows, butter was produced at less cost. In cost of cream production, she ranked sixth (6); and in cost of cheese production, ninth (9).

For the detailed data entering into the calculation of the results embodied in all the tables contained in this bulletin, the reader is referred to Bulletins 77, 78 and 79.

TABLE SHOWING COST OF PRODUCTION OF MILK AND ITS PRODUCTS.

NAME OF COW.	Breed.	Period of lactation.	Cost of one quart of milk.	Cost of one pound of butter.	Cost of one quart of cream.	Cost of one pound of cheese.
			Cents	Cents.	Cents.	Cents.
Beauty Pledge	Holstein-Friesian	Second	1.25 (1)	13.63 (9)	6.48 (6)	6.20 (9)
Junietta Peerless	Ayrshire	Third	1.27 (2)	15.33 (16)	7.27 (15)	6.15 (23)
Netherland Constance	Holstein-Friesian	First	1.30 (3)	18.65 (33)	8.76 (34)	6.80 (18)
Nora	American-Holderness	First	1.32 (4)	14.62 (13)	6.94 (11)	6.07 (7)
Manton Belle	Ayrshire	Fourth	1.33 (5)	16.00 (18)	7.55 (16)	6.65 (17)
Manton Belle	Ayrshire	First	1.45 (6)	17.95 (30)	8.49 (30)	7.33 (24)
Queen Duchess	Ayrshire	Second	1.45 (7)	16.40 (22)	7.80 (22)	6.51 (25)
Ruth	Holstein-Friesian	First	1.46 (8)	21.26 (44)	9.98 (42)	8.10 (39)
Betsy 10th	Short-Horn	Second	1.47 (9)	13.20 (6)	6.33 (5)	5.54 (2)
Junietta Peerless	Ayrshire	Second	1.50 (10)	19.50 (37)	9.20 (37)	7.80 (34)
Queen Duchess	Ayrshire	First	1.51 (11)	16.04 (19)	7.64 (18)	6.52 (16)
Manton Belle	Ayrshire	Third	1.54 (12)	17.80 (29)	8.44 (29)	7.15 (23)
Esel 2d	Holstein-Friesian	First	1.55 (13)	16.58 (24)	7.89 (23)	6.26 (12)
Oriole	Guernsey	First	1.58 (14)	12.84 (4)	6.26 (4)	5.92 (4)
Gilderbloom	Jersey	Third	1.65 (15)	12.33 (2)	7.79 (19)	5.80 (3)
Maggie 6th	American-Holderness	Secon d	1.66 (16)	18.44 (32)	8.76 (34)	7.57 (28)
Miss Flow 5th	Ayrshire	Third	1.66 (17)	19.32 (35)	9.17 (36)	7.72 (31)
Barbara Allen	Jersey	Third	1.68 (18)	12.66 (3)	6.12 (2)	5.98 (6)
Countess Flavia	Jersey	Fourth	1.69 (19)	11.30 (1)	5.49 (1)	5.26 (1)
Miss Flow 5th	Ayrshire	Second	1.70 (20)	20.48 (41)	9.70 (41)	8.15 (40)
Oriole	Guernsey	Second	1.72 (21)	12.90 (5)	6.20 (3)	5.97 (5)
Manton Belle	Ayrshire	Second	1.73 (22)	19.53 (39)	9.26 (39)	8.00 (37)
Maggie 6th	American-Holderness	Third	1.74 (23)	19.50 (38)	8.69 (32)	7.51 (27)
Maggie 6th	American-Holderness	First	1.78 (24)	21.12 (43)	10.00 (43)	8.65 (43)

Artalia	Devon	First	1.79 (25)	17.00 (26)	8.12 (26)	6.80 (19)
Rosette Ford	Guernsey	First	1.80 (26)	14.85 (15)	7.13 (13)	6.90 (21)
Miss Flow 5th	Ayrshire	Fourth	1.82 (27)	19.36 (36)	9.22 (38)	7.75 (32)
Betsy 10th	Short-Horn	First	1.89 (28)	18.08 (31)	8.65 (31)	7.57 (29)
Countess Flavia	Jersey	Second	1.90 (29)	13.50 (8)	6.52 (8)	6.23 (11)
Stella Select	Guernsey	First	1.91 (30)	17.36 (27)	8.31 (27)	8.30 (42)
Rosette Ford	Guernsey	Second	1.93 (31)	13.73 (10)	6.62 (9)	6.42 (14)
Ione	Devon	First	1.98 (32)	18.92 (34)	9.05 (35)	8.24 (41)
Barbara Allen	Jersey	Second	2.00 (33)	16.50 (23)	7.93 (24)	7.76 (33)
Countess Flavia	Jersey	Third	2.01 (34)	13.42 (7)	6.49 (7)	6.20 (10)
Genevies Gift	Devon	First	2.02 (35)	17.42 (28)	8.36 (28)	7.90 (35)
Miss Flow 5th	Ayrshire	First	2.03 (36)	19.70 (40)	9.43 (40)	7.92 (36)
Barbara Allen	Jersey	First	2.05 (37)	15.75 (17)	7.60 (17)	7.44 (26)
Genevies Gift	Devon	Second	2.08 (38)	16.18 (21)	7.79 (20)	7.35 (25)
Albert's Carol	Jersey	Second	2.09 (39)	14.54 (12)	7.00 (12)	7.00 (22)
Albert's Carol	Jersey	First	2.10 (40)	16.62 (25)	8.00 (25)	8.00 (38)
Countess Flavia	Jersey	First	2.10 (41)	14.84 (14)	7.17 (14)	6.86 (20)
Madame Select	Guernsey	Second	2.13 (42)	14.15 (11)	6.84 (10)	6.37 (13)
Gilderbloom	Jersey	First	2.24 (43)	16.14 (20)	7.79 (21)	7.58 (30)
Ione	Devon	Second	2.29 (44)	21.00 (42)	10.13 (44)	9.12 (44)

We will treat the subject under consideration under the following heads:

1. Comparative profits derived from milk and butter.
2. Comparative profits derived from milk and cream.
3. Comparative profits derived from milk and cheese.
4. Comparative profits derived from butter and cream.
5. Comparative profits derived from butter and cheese.
6. Comparative profits derived from cream and cheese.

1 COMPARATIVE PROFITS DERIVED FROM MILK AND CHEESE.

NAME OF COW.	Period of lactation.	Profit derived from selling milk.	Profit derived from selling butter.	Amount of profit from selling milk over selling butter.	Amount of profit from selling butter over selling milk.
Junietta Peerless	Third	$36 19	$33 05	$3 14	....
Betsey 10th	Second	35 23	43 30	....	$8 07
Queen Duchess	Second	30 69	25 85	4 84	....
Countess Flavia	Fourth	29 81	54 61	....	24 80
Netherland Constance	First	29 62	19 55	10 07	....
Barbara Allen	Third	29 04	48 93	....	19 89
Manton Belle	Fourth	28 89	26 93	1 96	....
Queen Duchess	First	27 53	27 38	0 15	....
Gilderbloom	Third	26 55	44 50	....	17 95
Beauty Pledge	Second	26 31	41 33	....	15 02
Oriole	Second	26 25	45 05	....	18 80
Nora	First	25 63	26 82	....	1 19
Esel 2d	First	25 62	26 73	....	1 11
Manton Belle	Third	25 00	23 68	1 32	....
Rosette Ford	Second	24 47	45 13	....	20 66
Oriole	First	24 02	36 18	....	12 16
Countess Flava	Second	23 97	38 43	....	14 46
Junietta Peerless	Second	23 11	14 35	8 76	....
Manton Belle	First	20 29	16 63	3 66	....
Miss Flow 5th	Third	20 07	14 78	5 29	....
Countess Flavia	Third	19 64	37 85	....	18 21
Artalia	First	18 66	19 70	....	1 04
Manton Belle	Second	17 92	14 25	3 67	....
Rosette Ford	First	17 89	27 95	....	10 06
Madame Select	Second	17 87	36 35	....	8 48
Maggie 6th	Second	17 70	16 80	0 90	....
Barbara Allen	Second	16 85	24 85	....	8 00
Countess Flavia	First	16 50	34 25	....	17 75
Betsey 10th	First	15 78	16 83	....	1 05
Maggie 6th	Third	15 36	17 55	....	2 19
Stella Select	First	15 34	20 86	....	5 52
Albert's Carol	Second	14 80	30 64	....	15 84
Ruth	First	14 06	7 53	6 53	....
Miss Flow 5th	Second	13 96	8 95	5 01	....
Miss Flow 5th	Fourth	13 55	15 03	....	1 48
Albert's Carol	First	13 23	23 33	....	10 10
Barbara Allen	First	13 23	25 90	....	12 67
Genevie's Gift	Second	10 71	21 00	....	10 29
Ione	First	9 61	11 70	....	2 09
Gilderbloom	First	9 26	22 90	....	13 64
Miss Flow 5th	First	9 22	13 00	....	3 78
Maggie 6th	First	8 85	7 15	1 70	....
Genevie's Gift	First	8 10	12 48	....	4 38
Ione	Second	4 78	8 00	....	3 22

We call attention to the following points of interest:

1. In 14 periods of lactation, representing 7 different individuals of 3 different breeds, the profit derived from selling milk was greater than that derived from selling butter. The amount of excess varied from $0.15 to $10.07 and averaged $4.07.

2. In 30 periods of lactation, representing 15 different individuals of 7 different breeds, the profit derived from selling butter was greater than that derived from selling milk. The amount of excess varied from $1.04 to $24.80 and averaged $10.13.

3. If we average all the results, we find that the amount of profit from selling milk averaged $19.80 for each lactation period of each individual, while the profit from selling butter averaged $25.64; that is, an amount equal to $5.84 more was realized from butter than from milk for each cow. Stated in another form, for every dollar of profit derived from selling milk, the sum of $1.30 was derived from selling butter.

2. COMPARATIVE PROFITS DERIVED FROM MILK AND CREAM.

NAME OF COW.	Period of lactation.	Profit derived from selling milk.	Profit derived from selling cream.	Amount of profit from selling milk over selling cream.	Amount of profit from selling cream over selling milk.
Junietta Peerless	Third	$36 19	$90 33	....	$54 14
Betsey 10th	Second.	35 23	103 15	....	67 92
Queen Duchess	Second.	30 69	75 76	....	45 07
Countess Flavia	Fourth.	29 81	118 03	....	88 22
Netherland Constance	First	29 62	72 44	....	42 82
Barbara Allen	Third	29 04	112 63	....	83 59
Manton Belle	Fourth.	28 80	77 24	....	48 35
Queen Duchess	First	27 53	77 99	....	50 46
Gilderbloom	Third	26 55	101 04	....	74 49
Beauty Pledge	Second.	26 31	101 84	....	75 53
Oriole	Second.	26 25	104 91	....	78 66
Nora	First	25 63	68 68	....	43 05
Esel 2d	First	25 62	78 39	....	52 77
Manton Belle	Third	25 00	78 78	....	53 78
Rosette Ford	Second.	24 47	109 15	....	84 68
Oriole	First	24 02	84 37	....	60 35
Countess Flavia	Second.	23 97	91 92	....	67 95
Junietta Peerless	Second.	23 11	58 55	....	35 44
Manton Belle	First	20 29	56 31	....	36 02
Miss Flow 5th	Third.	20 07	58 20	....	38 13
Countess Flavia	Third.	19 64	89 94	....	70 30
Artalia	First	18 66	60 01	....	41 35
Mantou Belle	Second.	17 92	57 90	....	39 98
Rosette Ford	First	17 89	72 53	....	54 64
Madame Select	Second.	17 87	89 72	....	71 85
Maggie 6th	Second.	17 70	59 36	....	41 66
Barbara Allen	Second.	16 85	72 22	....	55 37

3. COMPARATIVE PROFITS DERIVED FROM MILK AND CREAM.—(*Continued.*)

NAME OF COW.	Period of lactation.	Profit derived from selling milk.	Profit derived from selling cream.	Amount of profit from selling milk over selling cream.	Amount of profit from selling cream over selling milk.
Countess Flavia	First	$16 50	$88 05	....	$71 55
Betsey 10th	First	15 78	56 68	....	40 90
Maggie 6th	Third	15 36	60 82	....	45 46
Stella Select	First	15 34	65 48	....	50 14
Albert's Carol	Second	14 80	77 63	....	62 83
Ruth	First	14 06	42 50	....	28 44
Miss Flow 5th	Second	13 96	42 14	....	28 18
Miss Flow 5th	Fourth	13 55	59 22	....	45 67
Albert's Carol	First	13 23	68 22	....	54 99
Barbara Allen	First	13 23	70 93	....	57 70
Genevie's Gift	Second	10 71	59 63	....	48 92
Ione	First	9 11	43 23	....	34 12
Gilderbloom	First	9 26	64 33	....	55 07
Miss Flow 5th	First	9 22	53 39	....	44 17
Maggie 6th	First	8 85	38 06	....	29 21
Genevie's Gift	First	8 10	39 30	....	31 20
Ione	Second	4 78	40 07	....	35 29

A study of the foregoing table brings out the following points:

1. In no case was the profit derived from selling milk equal to that derived from selling cream.

2. While the average profit derived from selling milk for each period of lactation averaged $19.80, that derived from selling cream averaged $72.52. Hence, for each period of lactation and for each animal, the selling of cream yielded a profit of $52.72 more than the selling of milk. For each dollar of profit derived from selling milk, the sum of $3.66 was derived from selling cream.

The question may suggest itself to many, as to why cream should sell for so much more than the milk from which it is produced. The explanation lies mainly in the fact that the consumption of cream is comparatively small, consumers regarding it as a great luxury. Consumers are not aware of the fact that it would often be more economical to purchase milk and raise their own cream. It is also probably true that competition in the sale of cream will ultimately lower its price to one more nearly corresponding to that of milk. The figures given above represent approximately the conditions prevailing in the market at present.

3. COMPARATIVE PROFITS DERIVED FROM MILK AND CHEESE.

NAME OF COW.	Period of lactation.	Profit derived from selling milk.	Profit derived from selling cheese.	Amount of profit from selling milk over selling cheese.	Amount of profit from selling cheese over selling milk.
Junietta Peerless	Third	$36 19	$18 24	$17 95	....
Betsey 10th	Second.	35 23	25 69	9 34	....
Queen Duchess	Second.	30 69	11 49	19 20	....
Countess Flavia	Fourth.	29 81	29 45	0 36	....
Netherland Constance	First	29 62	12 36	17 26	....
Barbara Allen	Third	29 04	21 79	7 25	....
Manton Belle	Fourth.	28 89	11 54	17 35	....
Queen Duchess	First	27 53	13 62	13 91	....
Gilderbloom	Third	26 55	21 07	5 48	....
Beauty Pledge	Second.	26 31	16 84	9 47	....
Oriole	Second.	26 25	21 21	5 04	....
Nora	First	25 63	14 15	11 48	....
Esel 2d	First	25 62	18 55	7 07	....
Manton Belle	Third	25 00	9 48	15 52	....
Rosette Ford	Second.	24 47	18 73	5 74	....
Oriole	First	24 02	16 75	7 27	....
Countess Flavia	Second.	23 97	16 66	7 31	....
Junietta Peerless	Second	23 11	2 06	21 05	....
Manton Belle	First	20 29	4 91	15 38	....
Miss Flow 5th	Third	20 07	3 20	16 87	....
Countess Flavia	Third	19 64	17 38	2 26	....
Artalia	First	18 66	9 82	8 84	....
Manton Bell	Second.	17 92	1 45	16 47	....
Rosette Ford	First	17 89	9 30	8 59	....
Madame Select	Second.	17 87	17 17	70	....
Maggie 6th	Second.	17 70	4 54	13 16	....
Barbara Allen	Second.	16 85	3 78	13 07	....
Countess Flavia	First	16 50	12 82	3 68	....
Betsey 10th	First	15 78	4 42	11 36	....
Maggie 6th	Third	15 36	5 55	9 81	....
Stella Select	First	15 34	....	15 34	....
Albert's Carol	Second.	14 80	9 85	4 95	....
Ruth	First	14 06	45	13 61	....
Miss Flow 5th	Second.	13 96	13	13 83	....
Miss Flow 5th	Fourth.	13 55	4 37	9 18	....
Albert's Carol	First	13 23	2 70	10 53	....
Barbara Allen	First	13 23	6 50	6 73	....
Genevie's Gift	Second.	10 71	6 39	4 32	....
Ione	First	9 11	51	8 60	....
Gilderbloom	First	9 26	5 66	4 60	....
Miss Flow 5th	First	9 22	3 37	5 85	....
Maggie 6th	First	8 85	*1 75	10 60	....
Genevie's Gift	First	8 10	1 93	6 17	....
Ione	Second.	4 78	*3 42	8 20	....

*Loss.

An examination of the preceding table calls attention to the following points of interest:

1. In no case was the profit derived from selling cheese equal to that derived from selling milk.

2. While the profit derived from selling milk for each period of lactation averaged $19.80, the selling of cheese resulted in an average profit of $9.79. Hence, the sale of milk yielded $10 more profit for each period of lactation than did the sale of cheese. For every dollar of profit derived from selling cheese, the sum of $2.02 was derived from selling milk.

4. COMPARATIVE PROFITS DERIVED FROM BUTTER AND CREAM.

NAME OF COW.	Period of lactation.	Profit derived from selling butter.	Profit derived from selling cream.	Amount of profit from selling cream over selling butter.	Amount of profit from selling butter over selling cream.
Junietta Peerless	Third	$33 05	$90 33	$57 28	....
Betsey 10th	Second.	43 30	103 15	59 85	....
Queen Duchess	Second.	25 85	75 76	49 91	....
Countess Flavia	Fourth.	54 61	118 03	63 42	....
Netherland Constance	First	19 55	72 44	52 89	....
Barbara Allen	Third	48 93	112 63	63 70	....
Manton Belle	Fourth	26 93	77 24	50 31	....
Queen Duchess	First	27 38	77 99	50 61	....
Gilderbloom	Third	44 50	101 04	56 54	....
Beauty Pledge	Second.	41 33	101 84	60 51	....
Oriole	Second.	45 05	104 91	59 86	....
Nora	First	26 82	68 68	41 86	....
Esel 2nd	First	26 73	78 39	51 66	....
Manton Belle	Third	23 68	78 78	55 10	....
Rosette Ford	Second.	45 13	109 15	64 02	....
Oriole	First	36 18	84 37	48 19	....
Countess Flavia	Second.	38 43	91 92	53 49	....
Junietta Peerless	Second.	14 35	58 55	44 20	....
Manton Belle	First	16 63	56 31	39 68	....
Miss Flow 5th	Third	14 78	58 20	43 42	....
Countess Flavia	Third	37 85	89 94	52 09	....
Artalia	First	19 70	60 01	40 31	....
Manton Belle	Second.	14 25	57 90	43 65	....
Rosette Ford	First	27 95	72 53	44 58	....
Madame Select	Second.	36 35	89 72	53 37	....
Maggie 6th	Second.	16 80	59 36	42 56	....
Barbara Allen	Second.	24 85	72 22	47 37	....
Countess Flavia	First	34 25	88 05	53 80	....
Betsey 10th	First	16 83	56 68	39 85	....
Maggie 6th	Third	17 55	60 82	42 27	....
Stella Select	First	20 86	65 48	64 62	....
Albert's Carol	Second.	30 64	77 63	46 99	....
Ruth	First	7 53	42 50	34 97	....
Miss Flow 5th	Second.	8 95	42 14	33 19	....
Miss Flow 5th	Fourth.	15 03	59 22	44 19	....
Albert's Carol	First	23 33	68 22	44 89	....
Barbara Allen	First	25 90	70 93	45 03	....
Genevie's Gift	Second.	21 00	59 63	38 63	....
Ione	First	11 70	43 23	31 53	....
Gilderbloom	First	22 90	64 33	41 43	....
Miss Flow 5th	First	13 00	53 39	40 39	....
Maggie 6th	First	7 15	38 06	30 91	....
Genevie's Gift	First	12 48	39 30	26 82	....
Ione	Second.	8 00	40 07	32 07	....

We call attention to the following facts, in connection with the foregoing table:

1. In no case was the profit derived from selling butter equal to that derived from selling cream.

2. While the average profit derived from selling butter for each period of lactation amounted to $25.64, the profit from selling cream amounted to $72.52. Hence the sale of cream yielded $46.88 more profit for each period of lactation than did the sale of butter. For every dollar of profit derived from the sale of butter, the sum of $2.83 in profit was derived from the sale of cream.

5. COMPARATIVE PROFITS DERIVED FROM BUTTER AND CHEESE.

NAME OF COW.	Period of lactaon.	Profit derived from selling butter.	Profit derived from selling cheese.	Amount of profit from selling butter over selling cheese.	Amount of profit from selling cheese over selling butter.
Junietta Peerless	Third	$33 05	$18 24	$14 81	....
Betsy 10th	Second.	43 30	25 69	17 61	....
Queen Duchess	Second.	25 85	11 49	14 36	....
Countess Flavia	Fourth.	54 61	29 45	25 16	....
Netherland Constance	Third	19 55	12 36	7 19	....
Barbara Allen	Third	48 93	21 79	27 14	....
Manton Belle	Fourth.	26 93	11 54	15 39	....
Queen Duchess	First	27 38	13 62	13 76	....
Gilderbloom	Third	44 50	21 07	23 43	....
Beauty Pledge	Second.	41 33	16 84	24 49	....
Oriole	Second.	45 05	21 21	23 84	....
Nora	First	26 82	14 15	12 67	....
Esel 2d	First	26 73	18 55	8 18	....
Manton Belle	Third	23 68	9 48	14 20	....
Rosette Ford	Second	45 13	18 73	26 40	....
Oriole	First	36 18	16 75	19 43	....
Countess Flavia	Second.	38 43	16 66	21 77	....
Junietta Peerless	Second.	14 35	2 06	12 29	....
Manton Belle	First	16 63	4 91	11 72	....
Miss Flow 5th	Third	14 78	3 20	11 58	....
Countess Flavia	Third	37 85	17 38	20 47	....
Artalia	First	19 70	9 82	9 88	....
Manton Belle	Second.	14 25	1 45	12 80	....
Rosette Ford	First	27 95	9 30	18 65	....
Madame Select	Second.	36 35	17 17	19 18	....
Maggie 6th	Second.	16 80	4 54	12 26	....
Barbara Allen	Second.	24 85	3 78	21 07	....
Countess Flavia	First	34 25	12 82	21 43	....
Betsy 10th	First	16 83	4 42	12 41	....
Maggie 6th	Third	17 55	5 55	12 00	....
Stella Select	First	20 86	....	20 86	....
Albert's Carol	Second.	30 64	9 85	20 79	....
Ruth	First	7 53	45	7 08	....
Miss Flow 5th	Second.	8 95	13	8 82	....
Miss Flow 5th	Fourth.	15 03	4 37	10 66	....
Albert's Carol	First	23 33	2 70	20 63	....
Barbara Allen	First	25 90	6 50	19 40	....
Genevie's Gift	Second.	21 00	6 39	14 61	....

5. COMPARATIVE PROFITS DERIVED FROM BUTTER AND CHEESE.—(*Continued.*)

NAME OF COW.	Period of lactation.	Profit derived from selling butter.	Profit derived from selling cheese.	Amount of profit from selling butter over selling cheese.	Amount of profit from selling cheese over selling butter.
Ione	First	$11 70	$0 51	$11 19	....
Gilderbloom	First	22 90	5 66	17 24	....
Miss Flow 5th	First	13 00	3 37	9 63	....
Maggie 6th	First	7 15	*1 75	8 90	....
Genevie's Gift	First	12 48	2 93	10 55	....
Ione	Second.	8 00	*3 42	11 42	....

*Loss.

An examination of the preceding table brings out the following facts:

1. In no case did the profit from selling cheese equal that gained from selling butter.

2. The excess of profit from butter over that from cheese varied from $7.08 to $27.14. While the average profit derived from selling cheese from each period of lactation amounted to $9.79, that from selling butter averaged $25.64. Hence the sale of butter gave $15.85 more on the average than did the sale of cheese. For each dollar of profit derived from the sale of cheese, the sum of $2.62 in profit was derived from the sale of butter.

6. COMPARATIVE PROFITS DERIVED FROM THE SALE OF CREAM AND CHEESE.

NAME OF COW.	Period of lactation.	Profit derived from selling cream.	Profit derived from selling cheese	Amount of profit from selling cream over selling cheese.	Amount of profit from selling cheese over selling cream.
Junietta Peerless	Third	$90 33	$18 24	$72 09	....
Betsey 10th	Second.	103 15	25 69	77 46	....
Queen Duchess	Second.	75 76	11 49	64 27	....
Countess Flavia	Fourth.	118 03	29 45	88 58	....
Netherland Constance	Third	72 44	12 36	60 08	....
Barbara Allen	Third	112 63	21 79	90 84	....
Manton Belle	Fourth.	77 24	11 54	65 70	....
Queen Duchess	First	77 99	13 62	64 37	....
Gilderbloom	Third	101 04	21 07	99 97	....
Beauty Pledge	Second.	101 84	16 84	85 00	....
Oriole	Second.	104 91	21 21	83 70	....
Nora	First	68 68	14 15	54 53	....
Esel 2d	First	78 39	18 55	59 84	....
Manton Belle	Third	78 78	9 48	69 30	....

COMPARATIVE PROFITS DERIVED FROM THE SALE OF CREAM.—(*Continued.*)

NAME OF COW.	Period of lactation.	Profit derived from selling cream.	Profit derived from selling cheese.	Amount of profit from selling cream over selling cheese.	Amount of profit from selling cheese over selling cream.
Rosette Ford	Second.	$109 15	$18 73	$100 42	....
Oriole	First ..	84 37	16 75	67 62	....
Countess Flavia	Second.	91 92	16 66	75 26	....
Junietta Peerless	Second.	58 55	2 06	56 49	....
Manton Belle	First ..	56 31	4 91	51 40	....
Miss Flow 5th	Third..	58 20	3 20	55 00	....
Countess Flavia	Third..	89 94	17 38	72 56	....
Artalia	First ..	60 01	9 82	50 19	....
Manton Belle	Second.	57 90	1 45	56 45	....
Rosette Ford	First ..	72 53	9 30	63 23	....
Madame Select	Second.	89 72	17 17	72 55	....
Maggie 6th	Second.	59 36	4 54	54 82	....
Barbara Allen	Second.	72 22	3 78	68 44	....
Countess Flavia	First ..	88 05	12 86	75 23	....
Betsey 10th	First ..	56 68	4 42	52 26	....
Maggie 6th	Third..	60 82	5 55	55 27	....
Stella Select	First ..	65 48	....	65 48	....
Albert's Carol	Second.	77 63	9 85	67 78	....
Ruth	First ..	42 50	45	42 05	....
Miss Flow 5th	Second.	42 14	13	42 01	....
Miss Flow 5th	Fourth.	59 22	4 37	54 85	....
Albert's Carol	First ..	68 22	2 70	65 52	....
Barbara Allen	First ..	70 93	6 50	64 43	....
Genevie's Gift	Second.	59 63	6 39	53 24	....
Ione	First ..	43 23	51	42 72	....
Gilderbloom	First ..	64 33	5 66	58 67	....
Miss Flow 5th	First ..	53 39	3 37	50 02	....
Maggie 6th	First ..	38 06	1 75*	39 81	....
Genevie's Gift	First ..	39 30	1 93	37 37	....
Ione	Second.	40 07	3 42*	43 49	....

* Loss.

The following statements summarize the data presented in the foregoing table:

1. In no case did the profit from selling cheese equal that gained from selling cream.

2. The excess of profit from cream over that from cheese varied from $37.37 to $100.42. The profit derived from selling cheese averaged $9.79, while that from cream averaged $72.52 for each period of lactation. Hence the sale of cream gave $62.73 more on an average than did the sale of cheese. For each dollar of profit derived from the sale of cheese, the sum of $7.40 in profit was derived from the sale of cream.

SUMMARY.

1. Basis of Calculations.

(*a*) *Cost.*—The food-cost of products alone is considered.

(*b*) *Value of Milk.*—The value of the milk is based on the amount of total solids in milk, allowing $9\frac{1}{3}$ cents a pound for milk-solids, which is equivalent, on an average, to $2\frac{3}{4}$ cents a quart for milk or 1.28 cents a pound.

(*c*) *Value of Butter.*—The butter is calculated to contain 85 per cent. of fat and an average price of 25 cents a pound is placed on it.

(*d*) *Value of Cream.*—The cream is calculated to contain 20 per cent. of fat and an allowance of 20 cents a quart is made for it.

(*e*) *Value of Cheese.*—The price for cheese is placed at 10 cents a pound for cheese about one month old.

(*f*) *Method of Calculating Profit.*—A deduction is made from the gross profit (the difference between the value of the product and its food-cost), amounting to $12\frac{1}{2}$ cents for each 100 pounds of milk, representing the amount of feeding and fertilizing materials taken away from the farm in the case of selling milk and cheese. A smaller but proportionate reduction is made in the case of cream.

2. Average Profits Derived from Selling Milk and its Products for one Period of Lactation.

(*a*) *From Cheese,* $9.79.
(*b*) *From Milk,* 19.80.
(*c*) *From Butter,* 25.64.
(*d*) *From Cream,* 72.52.

3. The Amount of Profit Gained in Selling Milk and its Products in one Form over other Forms.

(*a*) Butter over milk, $5.84 profit.
(*b*) Milk over cheese, 10.00 profit.
(*c*) Butter over cheese, 15.85 profit.
(*d*) Cream over butter, 46.88 profit.
(*e*) Cream over milk, 52.72 profit.
(*f*) Cream over cheese, 62.73 profit.

4. Comparative Statement of Profits Derived from Selling Milk and its Products.

(*a*) Ratio of profit of milk to butter, 1 : 1.30.
(*b*) Ratio of profit of cheese to milk, 1 : 2.02.

(*c*) Ratio of profit of cheese to butter, 1 : 2.62.
(*d*) Ratio of profit of butter to cream, 1 : 2.83.
(*e*) Ratio of profit of milk to cream, 1 : 3.66.
(*f*) Ratio of profit of cheese to cream, 1 : 7.40.

VIII. Comparative Field-tests of Commercial Fertilizers Used in Raising Potatoes.

SUMMARY.

I. *Object and Plan of Investigation.*— The object of the work was to compare ten different brands of commercial fertilizers used in raising potatoes. Potatoes were planted in 26 plots containing about one-eighth of an acre each. In the use of one brand, the fertilizer was put on in quantities equivalent to 1,000, 1,500 and 2,000 pounds an acre, being applied both broadcast and in the row. In all other cases, the fertilizer was applied in the row in quantities equivalent to 1,000 and 2,000 pounds an acre.

II. *Soil.*— The soil was a sandy loam underlaid with sand and gravel. For five years previous it had been used in raising clover and timothy without application of fertilizers.

III. *Composition of Fertilizers Used.*— In the fertilizers used, the nitrogen varied from 3.27 to 4.50 per cent.; the available phosphoric acid, from 5.85 to 8.37 per cent.; and the potash, from 6.15 to 11.55 per cent.

IV. *Amount of Fertilizing Constituents Applied on One Acre.*— Nitrogen was applied in quantities varying from 32.7 to 90 pounds an acre; available phosphoric acid, from 58.5 to 167.4 pounds; and potash from 61.5 to 231 pounds.

V. *Yield of Potatoes.*— (a) In every instance, the use of fertilizers increased the yield of potatoes, the increase varying from 5.4 to over 81 bushels an acre. (b) The use of 2,000 pounds of ferilizer an acre did not always increase the yield over that produced by the use of 1,000 pounds. (c) The increased application of fertilizer usually increased the proportion of marketable potatoes.

VI. *Relation of Yield of Potatoes to Cost of Fertilizer Used.*— (a) The value of the crop at 50 cents a bushel varied on the different plots from $75.30 to $116.55. (b) Each bushel of potatoes due to increased yield from use of fertilizer cost from 26.2 cents to $4.35. (c) In the most favorable case, the extra yield of potatoes, due to the use of fertilizer, was worth enough to pay for the fertilizer and leave $13.34 in addition. In the most unfavorable case, the increased yield was insufficient by $29.05 to pay for the fertilizer used. (d) In no case did an application of 2,000 pounds of fertilizer an acre produce as economical results as did the use of 1,000 pounds; and, in most cases, the use of the higher quantity was attended with loss of money.

VII. *Comparison of Applying Fertilizers Broadcast and in Row.*— Better results were obtained by applying the fertilizer in the row, when smaller amounts of fertilizer were used. When 2,000 pounds of fertilizer an acre were used, better results came from applying broadcast.

INTRODUCTION.

The growing of potatoes forms a very extensive and important part of the agriculture of Long Island. There are connected with this industry several conditions which are peculiar to the locality. The soil is more or less light in character, and fertilizers tend to leach easily. Hence, to grow this crop successfully requires annual applications of fertilizers in fairly large quantities. The conditions present offer several questions of interest for study. Among such questions, the following may be suggested:

What amount of fertilizing material in the form of commercial fertilizers can be used most economically?

What method of applying a fertilizer is attended with the best results?

Will the effects of the application of fertilizers continue through only one season or through more?

Can any system of cultivation be introduced which will enable the farmer to raise potatoes more profitably with smaller applications of fertilizers?

A satisfactory investigation must involve a study of these and similar questions and must therefore be broad in its scope. The work undertaken during the past season is to be regarded only as a preliminary introduction to carrying out a more extended and complete series of experimental studies in the future.

The investigation was undertaken in response to an urgent expression on the part of many representative farmers of Long Island. It was not possible to prepare plans early enough to make the experiments of this season hardly more than preliminary to more extended work during the coming seasons.

The work of the season of 1895 has had for its object a comparative field-test of ten different brands of potato-fertilizers which are in common use on Long Island. Incidentally, a simple comparison was made between applying a fertilizer broadcast and in the row.

The co-operation of Mr. Z. Hallock of Jamestown, L. I., was secured in carrying on the work. Mr. Hallock's long, practical experience as a successful potato grower was an assurance that the work would be skillfully and conscientiously done.

The detailed plans were made by the writer with the help of suggestions from Mr. Hallock and others. The work has been superintended on the part of the Station by Messrs. Lowe, Stewart and Sirrine. All details of labor have been performed by Mr. Hallock or under his immediate supervision and direction.

CHARACTER AND PREVIOUS HISTORY OF SOIL.

The field used for the experiments is located on the farm of Mr. Hallock, near Jamesport. The soil is a light loam from two to three feet deep. This is underlaid by sand and gravel which extend down more than fifty feet.

In regard to its previous history, the field was last planted with potatoes in 1890, after which it was sowed with rye and seeded with timothy and clover. There was an excellent crop of clover in 1892 and the field was mowed each season following. No commercial fertilizers were applied while the field was in grass.

PREPARATION OF SOIL FOR PLANTING.

The field was plowed about April 1, 1895, and then lay until May 1. The soil was then thoroughly worked each way with a Mason's spading harrow and then with a smoothing harrow. It was then marked off with a sled marker in rows three feet apart. The field was divided into plots of three rows each, one row being left vacant between the adjacent plots. Each plot thus consisted of three rows thirty-three rods long. There were in all twenty-six plots. These were carefully staked off and numbered.

KINDS OF FERTILIZERS USED.

Ten different brands of fertilizers used were as follows:

1. "Riverhead Town Agricultural Society fertilizer," manufactured by Frederick Ludlam.

2. "Special," manufactured by Ellsworth Tuthill & Co.

3. "Potato fertilizer," manufactured by Lister's Agricultural and Chemical Works.

4. "Potato fertilizer," manufactured by George B. Forrester.

5. "No. 1 fertilizer," manufactured by Hallock & Duryee Fertilizer Co.

6. "Potato fertilizer," manufactured by Acme Fertilizer Co.

7. "Complete manure for potatoes and vegetables," manufactured by Bradley Fertilizer Co.

8. "Wells & Hudson fertilizer," manufactured by Bowker Fertilizer Co.

9. "Red Brand," manufactured by E. Frank Coe.

10. "Champion No. 1," manufactured by Moller & Co.

APPLICATION OF FERTILIZERS.

Plots No. 1 and No. 26 were not fertilized at all. On plots 2 to 7, the Riverhead Town Agricultural Society fertilizer was used in quantities which were equivalent to 1,000 pounds, 1,500 pounds, and 2,000 pounds an acre. On plots 2, 3 and 4, the fertilizer was applied broadcast, while on 5, 6 and 7, it was applied in the row. With each of the other fertilizers, amounts were applied which were equivalent to 1,000 and 2,000 pounds an acre, and the application was made only in the row.

PLANTING, CULTIVATION, ETC.

The potatoes were planted on May 3 and 4 with the Aspinwall potato-planter. On May 16 they were harrowed and again also on May 25. On June 1 the potatoes were grown enough to enable one to follow the rows and were cultivated with a Hudson's Bicycle Cultivator. On June 6 and 7 they were cultivated again and hoed; as also on June 12. On June 14 Paris green was applied. On June 18 the ground was cultivated lightly on the surface, not over two inches deep.

At this time the crop presented a good appearance. The plots with the smaller amounts of fertilizer looked better in most cases than did those with the larger amounts. Those plots in which the fertilizers were applied broadcast appeared better than those where the fertilizer was applied in the row.

June 21 and 22 Paris green was applied again and the crop was hoed.

On June 29 the crop was cultivated again, using a one-horse iron cultivator in place of the Hudson's cultivator previously used. At this time the vines almost completely covered the ground, except where no fertilizer was used.

On July 19 the late blight began to make its appearance, owing to the prevalence of extremely wet and warm weather. On July 22 Mr. Stewart sprayed the potato-tops thoroughly with Bordeaux mixture. They were cultivated again at this time. On August 1, they were again sprayed.

On August 20 and 21, the field was cultivated again and the weeds were hoed out. At this time the vines were mostly dead. Where they had not been sprayed, they were completely dried up.

On September 3, the digging of the potatoes commenced. The potatoes were carefully sorted and weighed under the supervision of one of the representatives of the Station. The machine used for sorting the potatoes separated those less than 1½ inches in diameter from the marketable ones.

We will now consider in order —

1. The composition of the fertilizers used.

2. The amount of nitrogen, potash, and phosphoric acid used on different plots.

3. The relation of the constituents of potato fertilizers to the amount of fertilizing materials removed by the potato crop.

4. The yield of potatoes.

5. Relation of yield of potatoes to cost of fertilizers used.

6. Comparison of results in applying fertilizers broadcast and in the row.

1. THE COMPOSITION OF THE FERTILIZERS USED.

In the table below we state the composition of the different fertilizers used, giving the manufacturer's guarantee and the results of the Station's analysis. We designate the different fertilizer simply by the name of the manufacturer.

TABLE SHOWING COMPOSITION OF FERTILIZERS.

FERTILIZER MANUFACTURED BY.	Per cent. of nitrogen.	Per cent. of available phosphoric acid.	Per cent. of actual potash.	
Frederick Ludlam	4.1	8.	10.	Guaranteed.
	4.	8.37	10.54	Found.
Ellsworth Tuthill & Co.	4.1	8.	10.	Guaranteed.
	4.50	6.21	11.55	Found.
Lister Bros.	3.70	7.5	7.	Guaranteed.
	3.55	7.75	7.50	Found.
Geo. B. Forrester	3.70	5.50	10.	Guaranteed.
	3.95	7.92	10.75	Found.
Hallock & Duryee	3.30	7.	9.	Guaranteed.
	3.87	8.06	11.	Found.
Acme Fertilizer Co	3.30	7.	9.	Guaranteed.
	3.31	5.85	8.12	Found.
Bradley Fertilizer Co	3.70	8.50	10.	Guaranteed.
	3.67	7.92	9.67	Found.
Bowker Fertilizer Co	3.29	9.	7.	Guaranteed.
	2.61	9.78	7.12	Found.
E. Frank Coe	3.30	9.	6.	Guaranteed.
	3.29	8.35	6.15	Found.
Moller & Co	3.40	7.	6.	Guaranteed.
	3.27	6.04	6.71	Found.

The nitrogen varied from 3.27 to 4.50 per cent.; the phosphoric acid from 5.85 to 8.37 per cent.; the potash from 6.15 to 11.55 per cent.

2. THE AMOUNT OF FERTILIZING CONSTITUENTS USED ON DIFFERENT PLOTS.

The amount of mixed fertilizer used on an acre is only a partial ecord of facts. In comparing different fertilizers, it is a matter of interest and importance to know how many pounds of nitrogen, phosphoric acid and potash were applied. In the table below we give this information in regard to each plot, basing the figures on one acre.

TABLE SHOWING AMOUNT OF FERTILIZING CONSTITUTENTS USED.

NUMBER OF PLOT.	Pounds of nitrogen per acre in fertilizer.	Pounds of available phosphoric acid per acre in fertilizer.	Pounds of potash per acre in fertilizer.
1	....	....	....
2	40	83.7	105.4
3	60	125.5	158
4	80	167.4	210.8
5	40	83.7	105.4
6	60	125.5	158
7	80	167.4	210.8
8	45	62.1	115.5
9	90	124.2	231
10	35.5	77.5	75
11	71	155	150
12	39.5	79.2	107.5
13	79	158.4	215
14	38.7	80.6	110
15	77.4	161.2	220
16	33.1	58.5	81.2
17	66.2	117	162.4
18	36.7	79.2	96.7
19	73.4	158.4	193.4
20	26.1	97.8	71.2
21	52.2	195.6	142.4
22	32.9	83.5	61.5
23	65.8	167	123
24	32.7	60.4	67.1
25	65.4	120.8	134.2
26	....	....	....

An examination of the foregoing data shows:

1. That the amount of nitrogen in 1,000 pounds of different fertilizers varied from 26.1 to 45 pounds.

2. That the amount of available phosphoric acid varied from 58.5 to 97.8 pounds in 1,000 pounds of different fertilizers.

3. That the amount of potash varied from 61.5 to 115.5 pounds in 1,000 pounds of different fertilizers.

The fertilizers used are all supposed to be specially adapted for potatoes, but we see considerable variation in composition. They vary the least in nitrogen between the highest and lowest amounts of this kind of plant-food contained in them. They vary a little more in the amount of available phosphoric acid contained in in them; while, in potash, the highest one contains nearly twice as much as the one containing the lowest amount of potash. These rather wide variations in the amount of plant-food supplied by different "specials" suggest that manufacturers are still quite far from agreeing upon an ideal formula for potatoes, if, indeed, such an ideal formula is possible.

3. THE RELATION OF THE CONSTITUENTS OF POTATO-FERTILIZERS TO THE AMOUNT OF MATERIALS REMOVED BY THE POTATO CROP.

How many pounds of nitrogen, phosphoric acid, and potash are removed from one acre by a crop of potatoes yielding 200 bushels? According to calculations based on the most available data at hand, a crop of 200 bushels of potatoes would take from one acre of soil from 30 to 35 pounds of nitrogen, from 20 to 25 pounds of phosphoric acid, and from 60 to 65 pounds of potash.

Comparing these figures with the amounts of fertilizing constituents contained in 1,000 pounds of the various fertilizers used, we find that the nitrogen in no cases runs below the amount required for the crop, while in some cases it is somewhat in excess. These fairly large quantities are justified, if we assume that the soil itself furnishes little nitrogen or that all of the nitrogen applied is not completely taken up by the crop.

In the case of phosphoric acid, we find that the amount supplied in 1,000 pounds of the mixed fertilizers used was in every case more than twice as much as that consumed by the crop and in some cases was more than three times as much. While it may be well to apply phosphoric acid considerably in excess of the amount used by the crop, it would appear that too great an excess for economy is often used. This, however, is a question which may well be studied in our future investigations.

In the case of potash, the amount used by the crop was considerably less than that supplied, but the difference was not nearly so great as in the case of phosphoric acid.

It will thus be seen that when we use as much as 1,000 pounds of a good potato-fertilizer we are supplying plant-food rather more than sufficient to meet the demands of the crop. And it would follow, on theoretical grounds, that amounts applied in excess of this, even on poor soils, would not meet with profitable returns.

4. THE YIELD OF POTATOES.

We will next consider the yield of potatoes in reference to the amount of fertilizers used, and also the proportion of culls and marketable potatoes.

No. of plat.	KIND OF FERTILIZER USED.	Amount of fertilizer used per acre.	Yield of potatoes per acre.	Pounds of marketable potatoes for 100 pounds of unsorted potatoes.	Pounds of culls for 100 pounds of unsorted potatoes.
		Pounds.	Bushels		
1	None	None.	150.6	83.8	16.2
2	Frederick Ludlam	1,000	197.3	88.4	11.6
3	Frederick Ludlam	1,500	188.4	91.0	9.0
4	Frederick Ludlam	2,000	216.3	91.6	8.4
5	Frederick Ludlam	1,000	207.5	91.0	9.0
6	Frederick Ludlam	1,500	197.1	91.6	8.4
7	Frederick Ludlam	2,000	199.8	92.3	7.7
8	Ellsworth Tuthill & Co.	1,000	180	88.9	11.1
9	Ellsworth Tuthill & Co.	2,000	183.3	92.6	7.4
10	Lister Bros.	1,000	193.4	89.2	10.8
11	Lister Bros.	2,000	219.2	92.6	7.4
12	Forrester	1,000	204	92.0	8.0
13	Forrester	2,000	169.4	92.3	7.7
14	Hallock & Duryee	1,000	194.5	91.5	8.5
15	Hallock & Duryee	2,000	187.5	90.5	9.5
16	Acme Fertilizer Co.	1,000	189.8	90.6	9.4
17	Acme Fertilizer Co.	2,000	196.3	92.0	8.0
18	Bradley	1,000	193.7	90.5	9.5
19	Bradley	2,000	191.4	91.7	8.3
20	Bowker	1,000	156.9	89.5	10.5
21	Bowker	2,000	158.4	91.9	8.1
22	E. Frank Coe	1,000	200.5	91.5	8.5
23	E. Frank Coe	2,000	233.1	92.0	8.0
24	Moller & Co.	1,000	201.8	93.0	7.0
25	Moller & Co	2,000	187.9	91.5	8.5
26	None	None.	152.5	89.9	10.1

The data embodied in the foregoing table appear to justify the following statement of results:

1. In every instance the use of a fertilizer increased the yield of potatoes. This increase varied from 5.4 to over 81 bushels per acre.

2. The use of 2,000 pounds of fertilizer an acre produced a larger crop in some instances and a smaller one in others than did the use of 1,000 pounds an acre. The largest increase of yield in any one case was 33 bushels more (plot 23) by the use of 2,000 pounds than by the use of 1,000 pounds. In one case the larger application gave 35 bushels less (plot 13). It was noticed that on the plots where the larger amounts of fertilizer were used, the potatoes came up unevenly and in some cases not at all. This was undoubtedly due to the fact that the seed-potatoes were injured by contact with the fertilizer.

3. The increased application of fertilizer generally produced a larger proportion of marketable potatoes. The proportion of marketable potatoes varied from 83.5 to 93 per cent. of the entire

yield. The proportion of culls was largest on plot 1, where no fertilizer was used; though on plot 26, where no fertilizer was used, the proportion of marketable potatoes was larger than on plot 1. In most cases the fertilizer increased the marketable quality of potatoes even when it did not affect the yield in bushels.

5. RELATION OF YIELD OF POTATOES TO COST OF FERTILIZERS USED.

The essential point to be considered is the cost of production. The increase of yield may be misleading. We must know how much it costs us to increase our production before we can determine whether the increase is made at a profit or loss.

In the following table, we give the cost of fertilizer used for each bushel of potatoes produced and also the cost for each bushel produced as compared with the plots on which no fertilizer was used. We call the average yield of plots 1 and 26, 151½ bushels, this being the yield where no fertilizer was used.

No. of plot.	Cost of fertilizer used on one acre.	Cost of fertilizer for each bushel of potatoes produced.	Increased number of bushels of potatoes resulting from use of fertilizer.	Cost of each bushel of potatoes resulting from use of fertilizer.	Value of crop at 50 cents a bushel.	Gain or loss from use of fertilizer.
		Cents.	Bushels.	Cents.		
1	....	....	....	....	$75 30	....
2	$14 66	8.31	45.8	32.0	98 65	$8 29
3	21 99	13.09	36.9	59.6	94 20	*3 54
4	29 32	15.27	64.8	45.2	108 15	3 08
5	14 66	7.96	56.0	26.2	103 75	13 34
6	21 99	12.55	45.6	48.2	98 55	81
7	29 32	16.50	48.3	60.7	99 90	*5 17
8	14 25	8.72	28.5	50.0	90 00	....
9	28 50	16.82	31.8	89.6	91 65	*12 60
10	17 00	9.88	41.9	40.6	96 70	3 95
11	34 00	19.85	67.7	50.2	109 60	*15
12	19 00	10.48	52.5	36.2	102 00	5 25
13	38 00	24.35	17.9	212.9	84 70	*29 05
14	16 50	9.08	43.0	38.4	97 25	5 00
15	33 00	19.80	36.0	91.7	93 75	*15 00
16	17 50	10.41	38.3	45.7	94 90	1 65
17	35 00	20.00	44.8	78.1	98 15	*12 60
18	17 50	13.35	42.2	41.5	96 85	3 60
19	35 00	20.58	39.9	87.7	95 70	*15 05
20	15 00	10.80	5.4	277.7	78 45	*12 30
21	30 00	21.30	6.9	435.0	79 20	*26 55
22	18 00	10.00	49.0	37.0	100 25	6 50
23	36 00	17.37	81.6	44.1	116 55	4 80
24	16 00	8.92	50.3	31.8	100 90	9 15
25	32 00	19.13	36.4	87.9	93 95	*13 80
26	....	....	....	....	76 25	....

* Loss.

From the foregoing table we can make the following summarized statement:

1. The cost of fertilizer for each bushel of potatoes produced varied from 7.96 cents on plot 5 to 24.35 cents on plot 13. In no case was the increase of yield proportionate to the amount of fertilizer used when more than 1,000 pounds an acre was applied.

2. There was in every case an increased yield due to the application of fertilizer. This increase varied from 5.4 bushels on plot 20 to 81.6 on plot 23 over the yield on the unfertilized plots.

3. The cost of the increased yield due to the use of fertilizers varied from 26.2 cents (on plot 5) to $4.35 (on plot 21) for each bushel of potatoes produced in excess of the yield of the unfertilized plots.

4. The money value of the crop at 50 cents a bushel varied from $75.30 on plot 1 to $116.55 on plot 23.

5. If we calculate the amount of money received for extra yield of potatoes due to the use of fertilizers and compare this amount with the money expended for the fertilizers used, we find that on plot 5 there was the greatest gain, amounting to $13.34 in yield over the cost of fertilizer used. In other words, the extra yield was enough to pay for the fertilizer and $13.34 more. From this amount there was a variation down to an actual loss of $29.05 (on plot 13); that is, on this plot the extra yield of potatoes due to the use of fertilizer was insufficient by $29.05 to pay for the fertilizer used. In no case did an application of 2,000 pounds of fertilizer produce as economical yields as did the application of 1,000 pounds. In every case except two (plats 4 and 23), the use of 2,000 pounds was attended by actual loss.

6. COMPARISON OF RESULTS IN APPLYING FERTILIZERS BROADCAST AND IN THE ROW.

On plots 2, 3 and 4 the fertilizer was applied broadcast, while on plots 5, 6 and 7 the applications were made in the row. The amounts of fertilizer applied are given below.

TABLE SHOWING COMPARISON OF DIFFERENT METHODS OF APPLYING FERTILIZERS.

NUMBER OF PLOT.	Pounds of fertilizer applied on one acre.	Method of application.	Bushels of potatoes produced on one acre.
2	1,000	Broadcast	197.3
5	1,000	In row	207.5
3	1,500	Broadcast	188.4
6	1,500	In row	197.1
4	2,000	Broadcast	216.3
7	2,000	In row	199.8

From a comparison of the foregoing data, it is seen that better results were obtained with the smaller amounts of fertilizer when the fertilizer was applied in the row. On the other hand, when 2,000 pounds of fertilizer were used, better results were obtained from applying it broadcast. This is undoubtedly due to the fact that a large amount of fertilizer applied in the row comes more or less into contact with the seed-potatoes and injures their germinating power. It was apparent on most of the plots where the larger amounts were applied that the potatoes came up more or less uneven and some failed altogether to come up.

It remains for us to ascertain in the future to what extent the fertilizers used in excess remain available in the soil. It also remains for us to try similar experiments upon lighter soil. There is some reason for believing that there is too much neglect in keeping abundance of humus in the soil, especially where the soils are of the character common on Long Island. It is quite probable that fertilizers can be used most economically in smaller quantities than half a ton an acre, provided the soil is kept supplied with humus. These points, however, can be definitely settled only by our future work.

In, conclusion, it is suggested by way of precaution that these results of our preliminary experiments must not be regarded as conclusive upon any of the points tested. Different results might have been obtained on a soil differing in character and history from the one used. The present results are rather to be regarded as helpful suggestions for future lines of investigation.

IX. The Chemistry of Plants, Plant-foods and Soils.

I. THE CONSTITUENTS OF PLANTS.

Chemical Elements.—All matter is composed of about seventy different chemical elements. *A chemical element is any substance which cannot, by any known means, be separated into two or more different kinds of matter.* For example, gold is an element, because, in whatever manner it may be treated, we cannot get anything out of it but gold; pure gold contains nothing but gold. So nitrogen is an element, because, as far as we able to find out, it contains only one thing, that is, nitrogen. Similarly, carbon, sulphur, potassium, oxygen and iron are elements.

Just as the twenty-six letters of our alphabet are combined in various ways to form the words of a whole language, so these seventy elements or simple substances, constituting nature's alphabet of matter, are capable of being united to produce all the different chemical compounds that go to make up the countless forms of matter. The number of different combinations possible between these seventy elements is practically infinite.

Elementary Composition of Plants.—When we state what elements any substance contains, we give its *elementary composition.* For example, sugar contains the elements, carbon, hydrogen, and oxygen; this is a statement of the *elementary composition* of sugar. So, when we state what elements a plant contains, we give its elementary composition or analysis. The term *ultimate composition* means the same as elementary composition. We will now consider the elementary composition of plants.

The exact number of different kinds of plants growing on the earth has never been definitely ascertained; but the number probably exceeds 200,000. Of this large nnmber, only a few have been subjected to careful chemical analysis, and yet so uniform in all its great variety are nature's methods of working and building, that we can quite safely say that, so far as the elementary composition of plants is concerned, little remains to be learned. Chemical analysis shows that, *of the seventy elements known to exist, only fourteen are essential to produce all the different forms of vegetable life.*

While all plants contain certain chemical compounds in common, such as cellulose, albuminoids, etc., it may be that each plant contains in some one or all of its parts one or more chemical compounds peculiar to itself, so that there may be as many distinct chemical compounds in the vegetable kingdom as there are different species of plants. This, of course, can not be known absolutely until all plants in existence have been carefully analyzed; but, whether the number of different chemical compounds in the vegetable kingdom be a few thousand or a few hundred thousand, we know that they are almost entirely made up of fourteen elements, and these, therefore, form the chemical alphabet of the vegetable kingdom, all the different vegetable compounds, like words from letters, being formed by the union of two or more of these elements.

The fourteen elements which are regarded as being necessary to the perfect growth and development of every plant are the following: Carbon, Hydrogen, Nitrogen, Oxygen, Phosphorus, Sulphur, Chlorine, Silicon, Calcium, Iron, Magnesium, Manganese, Potassium, and Sodium. The element fluorine is of frequent occurrence in very small quantities; and the following elements are of rare or doubtful occurrence: Aluminum, barium, bromine, cobalt, copper, iodine, lead, lithium, nickel, rubidium, tin, titanium, and zinc; but their occurrence is a matter of curiosity rather than of practical importance, for, unlike the fourteen named above, they seem in no way to be necessary to plant life.

To chemical analysis we owe all that we know about what plants contain or are made of. Eighty years ago not a single vegetable substance had been accurately analyzed; and, although, in the thirty years following, much was learned about the different elements contained in plants, it was not until after the investigations of Liebig that our knowledge of the chemistry of plants progressed with any satisfactory degree of rapidity

Classification into Air-Derived and Soil-Derived Elements.— The elements that are necessary to the growth of plants may be divided into two quite distinct classes, which have important and marked differences. These two classes are: (a) Air-derived or organic elements. (b) Soil-derived or inorganic elements.

(*a*) *Air-Derived Elements.*	(*b*) *Soil-Derived Elements.*
Carbon.	Phosphorus.
Hydrogen.	Sulphur.
Oxygen.	Chlorine.
Nitrogen.	Silicon.
	Calcium.
	Iron.
	Potassium.
	Sodium.
	Magnesium.
	Manganese.

It is usual among writers on agricultural chemistry to call these classes organic and inorganic elements, but this use of these words is extremely inaccurate; for any element may be either organic or inorganic, according as it is or is not a part or product of an organized body. Oxygen, as it exists in the air, is inorganic matter; but when, through vital processes, it becomes part of an animal or plant, it is organic.

These two classes of elements differ in three important particulars, as follows:

First. The elements of the first class are derived exclusively from the air, either directly or indirectly; while those of the second class come exclusively from the soil.

Second. Air-derived elements disappear, for the most part, in the form of gases, when a plant is burned; while the soil-derived elements, usually the smaller part, are left in the form of a residue or ash, upon which further heating will not have any effect. Some carbon and oxygen and nitrogen are always found in the ash, while slight quantities of chlorine, sulphur and phosphorus are apt to be driven off by heating. The two classes of elements are, therefore, not so sharply defined in this regard as they are in respect to the sources from which they come.

Third. These two classes differ very noticeably in regard to the quantities in which they are present in plants. Thus, *the air-derived elements constitute, at least, ninety-five per cent of the whole vegetable kingdom,* while the soil-derived elements occur in small quantities, varying from a fraction of one per cent up to ten per cent., or even more in some cases. Because the soil-derived elements occur in small quantities, it does not follow that their presence is of less importance; in their absence, vegetation would disappear.

We will now consider each of these elements in order, and mention briefly some of the more important characteristics of each; but before doing this, it is desirable to explain the meaning of two or three chemical terms which we shall have occasion to use.

Classification into Acid-forming Elements and Metals.—Of the fourteen elements which are found in plants, some are spoken of as *non-metallic* elements or *acid-forming* elements, because, in certain combinations, these elements form well-known acids. The other elements are known as *metallic elements or metals.*

(*a*) *Acid-forming Elements.*	(*b*) *Metals.*
Carbon.	Calcium.
Hydrogen.	Potassium.
Oxygen.	Sodium.
Nitrogen.	Iron.
Phosphorus.	Magnesium.
Sulphur.	Manganese.
Chlorine.	
Silicon.	

Acids and Salts.—(*a*) *An acid is a compound containing an acid-forming element combined with hydrogen and oxygen*, or in some cases, with hydrogen alone. The following examples will serve to illustrate:

Nitrogen with *oxygen* and *hydrogen* forms *nitric acid* (aquafortis).

Phosphorus with *oxygen* and *hydrogen* forms *phosphoric acid.*

Sulphur with *oxygen* and *hydrogen* forms *sulphuric acid* (oil of vitrol).

Chlorine and hydrogen form hydrochloric acid (muriatic acid).

(*b*) *A Salt is a compound formed by putting a metal in the place of the hydrogen of an acid;* that is, an acid differs from a salt simply in having a metal where the acid has hydrogen. Every acid has a salt corresponding to it. For example, as stated above, *nitric acid* consists of *nitrogen* and *oxygen* and *hydrogen.* Now, if we put the metal *potassium in the place of hydrogen* we have a compound containing

Nitrogen and *oxygen* and *potassium* (in place of hydrogen). This compound is the *potassium salt of nitric acid* and is called *potassium nitrate* or nitrate of potash. Again, *Phosphoric acid* consists of *phosphorus* and *oxygen* and *hydrogen;* in place of *hydrogen* put one of the metals, as *calcium*, and we have a compound containing

Phosphorus and *oxygen* and *calcium* (in place of hydrogen), which is the *calcium salt of phosphoric acid* and is called *calcium phosphate* or phosphate of lime.

Similarly, if a metal, as magnesium, is put in the place of the hydrogen of sulphuric acid, we have the *magnesium salt of sulphuric acid* or *magnesium sulphate*, familiar to us as Epsom salt. If in hydrochloric (muriatic) acid, we put some metal as sodium in place of the hydrogen, we have a compound consisting of sodium and chlorine, which is the *sodium salt of hydrochloric acid* and is called *sodium chloride*, sometimes muriate of soda, familiar to us as common salt.

The word "salt" as used in chemistry applies to a great number of compounds, and many of the substances we have to deal with in speaking of fertilizers are *chemical salts;* that is, *substances formed by putting some metal in place of the hydrogen of some acid.*

Carbon.—(*a*) *Importance.*—The element carbon may be called the central element of all animal and vegetable substances; for there is not a living thing, from the smallest cell to the giant tree, which does not contain carbon as a necessary constituent. That all vegetable and animal substances contain carbon can easily be shown by simply heating them sufficiently, and thus causing them to *blacken* or *char*. When, for example, wood is heated, the different elements of which it is composed are driven off in one form or another, but the carbon is the last to go, and remains behind as a black substance or charcoal, unless heated higher, when it disappears or burns up.

(*b*) *Occurrence.*—Carbon usually occurs in nature united in compounds with other elements. Thus, most products of plant life contain carbon combined with the elements hydrogen and oxygen; such are starch, sugar, and cellulose or woody fibre. Carbon combined with oxygen occurs in the air in the form of carbon dioxide, commonly called carbonic acid gas. Carbon, when combined with ogygen and some element such as calcium, occurs in the form of carbonates; for example, marble, limestone, and chalk are chemically known as calcium carbonate or carbonate of lime.

Carbon by itself or in the free condition, that is, not united with any other elements, is familiar to us in several different forms; the most common of these are (1) diamonds; (2) graphite, which is used in the manufacture of lead-pencils; (3) ordinary wood-charcoal; (4) lamp black; (5) animal charcoal; (6) mineral coal. Excepting diamond these forms of carbon are more or less impure, containing some other things mixed with the carbon.

Hydrogen.—(*a*) *Occurrence.*—The element hydrogen is nearly always found combined with other elements. It combines with oxygen to form water. Hydrogen also occurs in most animal and vegetable substances, such as various kinds of wood, fruits, etc., in which it is combined with the elements, carbon and oxygen. Hydrogen is always present in all kinds of acids.

(*b*) *Description.*—Hydrogen, in the uncombined form, is a gas that resembles air in that it has neither color, smell, nor taste.

Oxygen.—(*a*) *Occurrence.*—Oxygen is the most abundant of all the elements. The compounds which contain no oxygen are few in number. Oxygen forms nearly one-half of the crust of the earth; eight-ninths of water; about one-fifth of air; and one-third of all animal and vegetable matter.

Oxygen occurs in the air uncombined with other elements. Oxygen, combined with the elements carbon and hydrogen, or with carbon, hydrogen and nitrogen, is found in substances which go to make up animals and vegetables.

(*b*) *Description.*—As might be inferred from knowing that oxygen in the uncombined state forms part of the air, oxygen is a gas having no color, taste or smell.

Oxygen is a very active substance from a chemical point of view. It tends to unite with nearly all of the elements. In all forms of burning, the oxygen of the air is simply uniting with other elements. Thus, in a coal fire the oxygen unites with the carbon of the coal. The heat is produced by the union of the two elements.

Nitrogen.—(*a*) *Occurrence.*—Nitrogen occurs in nature in the following forms:

(1) As a constituent of *air*.
(2) In the form of *ammonia*.
(3) In the form of nitric acid and *nitrates*.
(4) In various other forms in plants and animals.

(1) NITROGEN IN AIR.—Nitrogen, uncombined with other elements, forms about four-fifths of the air. Since the nitrogen in the air is not combined, we can perceive its properties for ourselves, and our obser vation shows us that it is a gas, which has neither color, taste nor smell.

(2) NITROGEN IN AMMONIA.—Nitrogen combined with the element hydrogen forms ammonia. Ammonia is present in the air in very small quantities. Ammonia is formed when vegetable and animal substances containing nitrogen decompose.

Ammonia is a colorless gas, and it is this gas dissolved in water which is familiar to us as ammonia water or "Spirits of Hartshorn," and which causes the peculiar odor of "hartshorn."

Ammonia unites with different acids and forms salts somewhat as metals do; these salts we call *ammonium salts*, compounds which do not generally have any odor like ammonia. Thus, ammonia combined with sulphuric acid forms *ammonium sulphate*, commonly called sulphate of ammonia; ammonia, combined with hydrochloric acid, forms *ammonium chloride*, sometimes called muriate of ammonia, also known as *sal ammoniac*.

(3) NITROGEN IN NITRATES.—Nitrogen, combined with hydrogen and oxygen, forms *nitric acid or aqua fortis*. If in nitric acid a metal as sodium, for example, takes the place of hydrogen, we have formed a sodium salt of nitric acid or a *nitrate*, called sodium nitrate, or nitrate of soda.

When animal and vegetable substances decompose in rather warm, moist places, the nitrogen is changed into nitrates. This change of the nitrogen of organic matter into nitrates is caused by germs called *bacteria*, which are very small living vegetable organisms, and which exists everywhere in enormous numbers. The process is known as "*nitrification*."

(4) NITROGEN IN ANIMALS AND PLANTS OR ORGANIC NITROGEN.—Nitrogen, combined with the elements, hydrogen, carbon and oxygen occurs in plants and in animals. Such substances for example are the casein or curd of milk, the gluten or gummy portion of wheat, the fibrin of blood, the white of egg, etc. When such compounds decompose, the nitrogen is first changed into ammonia, and then, under proper conditions of warmth, moisture and access of air, into nitric acid or nitrates. The nitrogen existing in animals and plants is generally called *organic nitrogen*.

(*b*) *In what Forms Nitrogen is Useful to Plants.*—Plants can use nitrogen in three different forms, viz.:

(1) As nitrogen gas or uncombined nitrogen.
(2) In the form of ammonia.
(3) In the form of nitrates.

All plants can not use nitrogen in any of these three forms equally well, but each form is found specially suited to certain kinds of plants as will be noticed.

(1) NITROGEN GAS USED BY PLANTS.—Although we have nitrogen gas or uncombined nitrogen existing in the air in enormous quantities, still the number and kinds of plants which can use the nitrogen of the air is not large. In general, those plants which are called *leguminous*, such as the bean, pea, clover, alfalfa, etc., can take uncombined nitrogen from the air. Upon the roots of such crops are found certain lumps or warts or tubercles. These tubercles contain large numbers of micro-organisms derived from the soil and these micro-organisms have the power of bringing the nitrogen of the air into such combinations as the plant can use.

(2) NITROGEN OF AMMONIA USED BY PLANTS.—The leaves of some plants have the power of absorbing ammonia directly from the air and obtain nitrogen in this way, but only in very small quantities. Some plants obtain nitrogen from ammonium salts through the soil, but in general, the compounds of ammonia are changed into nitrates in the soil before being used by plants.

(3) NITROGEN OF NITRATES USED BY PLANTS.—The largest part of the nitrogen obtained by most plants is taken up by their roots from the soil *in the form of nitrates*; that is, nitric acid combined with some metal, as sodium or potassium. As already stated, most of the nitrates used by plants are formed by changing into nitrates ammonia compounds and organic substances in the soil by the process called *nitrification*. Hence, *nitrogen, in the form of nitrates*, is the most *available* form for most plants; that is, it can be most readily taken up and used by plants.

Phosphorus.— (*a*) *Description.*— Phosphorus, when uncombined with other elements, is a yellowish, waxy-looking, solid substance. It is soft and can be cut as easily as ordinary beeswax. It is very poisonous. It takes fire very easily and, therefore, has to be kept under water. When phosphorus burns, it simply unites with the oxygen of the air, forming a compound which contains oxygen and phosphorus; this compound of oxygen and phosphorus is commonly called phosphoric acid.

(*b*) *Occurrence.*— Phosphorus is always found in nature combined with other elements. It occurs combined with oxygen and calcium (or lime) and this compound is called *calcium phosphate or phosphate of lime*. It also occurs in soils as phosphate of magnesia, phosphate of alumina and iron. Calcium phosphate or phosphate of lime is found in some minerals and in the bones of animals.

(*c*) *Importance of Phosphorus Compounds.*— The phosphates, like the nitrates, are found everywhere in the soil and are of great value in their relations to plants. The phosphates found in the bones are taken into the animal body in the food. All plants used as food contain small quantities of phosphorus compounds which they get from the soil. The phosphates taken into the body are partly given off in the excrement and urine.

Sulphur.—(*a*) *Occurrence.*— Sulphur uncombined with other elements, is found near volcanoes. Combined with other elements, sulphur is found in a great many minerals. Sulphur is also found in vegetable and animal products, combined with the elements carbon, hydrogen and nitrogen. The properties of the element sulphur are too well known to need any description.

(*b*) *Compounds.*— When *sulphur* is combined with *hydrogen* and *oxygen* in certain proportions it makes *sulphuric acid*, commonly called *oil of vitrol.* When the hydrogen of sulphuric acid has its place taken by any metal, a sulphate is formed. For example, when the metal potassium takes the place of the hydrogen of the sulphuric acid, a salt is formed known as *potasium sulphate*, commonly called *sulphate of potash;* from sulphuric acid and the metal calcium is formed the salt *calcium sulphate*, commonly known as *sulphate of lime.*

Chlorine. — (*a*) *Description.* — Chlorine, when not combined with other elements, is a greenish-yellow gas, having a very suffocating odor. The gas is very poisonous and has very active chemical power.

(*b*) *Occurrence.*—Uncombined chlorine is never found in nature. We commonly know chlorine only in its compounds. Chlorine combined with hydrogen forms hydrochloric or muriatic acid. Chlorine combined with any metal forms *chlorides* commonly known also as *muriates.* For example, *chlorine* combined with the metal *sodium* forms a compound which is called *sodium chloride* or chloride of sodium, or muriate of soda ; and this sodium chloride is the common salt familiar to us in every-day experience. *Chlorine* combined with the metal *potassium* forms *potassium chloride* commonly called *muriate* of *potash.*

Silicon.—*Occurrence.*—Silicon, next to oxygen, is the most abundant element in nature. It does not occur uncombined with other elements. Silicon combined with oxygen forms a compound commonly called *silica.* Quartz and sand are nearly pure silica.

Silicon combined with oxygen and several of the metallic elements, such as sodium, potassium, calcium, etc., forms compounds which are called *silicates.* The feldspars are silicates; clay is a silicate. Ordinary glass consists of a mixture of silicates.

Calcium.—*Occurence.*—The metal calcium is always found in nature combined with other elements. The compounds of calcium are ordinarily known as lime compounds, because calcium, when combined with oxygen to form a compound known as calcium oxide, was called lime, and this calcium oxide or lime was supposed to be present in calcium compounds.

Calcium combined with oxygen and carbon forms a compound which is known as *calcium carbonate or carbonate of lime.* Limestone, marble, chalk, eggshells and coral consist of calcium carbonate or carbonate of lime. Calcium and sulphuric acid form a compound known as *calcium sulphate or sulphate of lime;* gypsum and plaster of Paris are familiar forms of calcium sulphate; it is often called simply "*plaster.*"

Calcium combined with oxygen, as already noted, forms calcium oxide, which is commonly known as *lime or quicklime.* This is made by burning some form of calcium carbonate, as limestone, oyster shells, coral rock, etc.; the carbon dioxide (carbonic acid) is driven off by the heat, and calcium oxide or quicklime remains.

When quicklime is exposed to the air, it slowly absorbs moisture and carbon dioxide and is changed back into calcium carbonate. When quicklime is changed into calcium carbonate (carbonate of lime), the lime is said to be *air-slacked.*

Potassium.—*Occurrence.*—The metal potassium is never found uncombined in nature. It is a constituent of many minerals. The decomposition of these minerals give rise to the presence of potassium compounds everywhere in the soil. It is taken up by plants; and when vegetable material is burned, the potassium remains behind, chiefly as potassium carbonate. When wood-ash is treated with water, or "leached," the potassium carbonate is dissolved out, forming "lye," and this, evaporated to dryness, leaves impure potassium carbonate, which is commercially known as *potash.*

In using the term *potash* in connection with fertilizers, potassium oxide is always meant. The compounds of potassium are commonly called *potash compounds*, because it was formerly supposed that potassium oxide or potash was present in all of them.

Potassium combined with chloride forms potassium chloride or chloride of potash or *muriate of potash*, etc. Potassium and sulphuric acid form potassium sulphate or *sulphate of potash*. Potassium and nitric acid form potassium nitrate, also called *nitrate of potash* and *saltpeter*.

Sodium.—*Occurrence.*—Sodium occurs in nature mostly in combination with the element chlorine in the form of *sodium cholride* or *common salt*. It is found everywhere in the soil, but usually in small quantities. Sodium and nitric acid form *sodium nitrate or nitrate of sodă*, commonly known as Chili saltpeter.

Magnesium, Iron and Manganese.—These elements, especially magnesium and iron, are present as essential constituents of plants. They exist in various forms of combination with other elements.

2. CLASSIFICATION AND DEFINITION OF TERMS USED IN CONNECTION WITH FERTILIZERS.

A Fertilizer *may be defined as any substance which, by its addition to the soil, is intended to produce a better growth of plants.*

The materials which come under the head of fertilizers are numerous in kind, and different both in form and the manner in which they act.

The following tabulated classification, while not strictly accurate in every respect, will serve to give a good general idea of the number and relations of the terms used in speaking of fertilizers:

- FERTILIZERS
  - I. DIRECT OR NUTRITIVE.
    - 1. *Natural*..
      - Stable manure.
      - Refuse vegetable matter.
      - Green crops for plowing under.
      - Cotton-seed.
      - Muck, marls, etc.
    - 2. *Artificial*.. Commercial, Chemical, or Prepared.
      - *a.* Complete or general.
      - *b.* Incomplete or special.
  - II. INDIRECT OR STIMULANT.
    - Lime.
    - Gypsum.
    - Salt, etc.

These terms are, in general, loosely and indiscriminately used, as their meaning is often misunderstood; and so an attempt will be made here to define them in accordance with the best usage of the terms.

A Direct Fertilizer *is one that contains elements of plant-food, which are available at once*, that is, which can be taken up and used immediately by plants.

The term **Available** is applied to plant-food which is *soluble*, that is, in such a condition that the roots of the plant can take it up readily in solution.

Plant-food is **Unavailable**, when it is in an *insoluble* form, so that the roots of the plant fail to take up any part of it. A large proportion of plant-food present in the soil is unavailable, but by the action of air, water, carbonic acid, etc., it is gradually changed to soluble or available forms, which the plant can take up and use. As will be noticed later, phosphoric acid in the form of *insoluble* calcium phosphate or phosphate of lime is unavailable as plant-food, but when converted into a superphosphate or *soluble* calcium phosphate, it becomes available. Unavailable plant-food is *potential* food or food in reserve.

An Indirect Fertilizer *is one which does not furnish to the soil any needed plant-food and which may not be plant-food at all, but which is characterized by the way in which it acts on the matter already in the soil, changing more or less of it from unavailable plant-food to an available form.* For example, lime, gypsum, salt, etc., are indirect fertilizers, as they are generally used by farmers. Later some attention will be given to the action of some of the most familiar indirect fertilizers. They are commonly used by farmers, not because the elements they furnish are lacking in the soil, but because they can act upon unavailable plant-food and render it available, or because they may have some beneficial influence upon the mechanical condition of the soil.

Natural Fertilizers include the solid and liquid excrement of animals, all kinds of vegetable refuse, green crops for plowing under, cotton-seed, mucks, marls, etc.

Artificial Fertilizers are also known by such names as *commercial fertilizers, chemical fertilizers, etc.*, and are artificial preparations or mixtures of fertilizing materials sold under trade names. The fertilizing materials used in making these mixtures include the substances found in natural deposits and by-products of numerous industries, which are obtainable by farmers only through the channels of trade. Some substances which might be classed as natural fertilizers, such as cotton-seed meal and tobacco stems, are also included among the materials of artificial fertilizers.

Complete Fertilizers, known also as *general fertilizers*, are those which contain nitrogen, phosphoric acid and potash.

Incomplete Fertilizers, also called *special fertilizers*, are those which contain only one or two of the three constituents, nitrogen, phosphoric acid and potash.

There is a common practice among farmers and dealers of calling all commercial fertilizers "phosphates," regardless of whether they contain any phosphates at all or not. The practice is clearly objectionable, because a phosphate is not the only fertilizing constituent presented in commercial fertilizers,— in some cases it may be entirely absent. The term "superphosphates" applies truthfully to many commercial fertilizers, but even these can not be correctly spoken of as simply "phosphates." This common usage of the term "phosphate" for any form of fertilizer emphasizes the fact that there has been a tendency to overestimate the value and importance of this constituent, resulting in large applications of it without regard to the needs of soil or crop.

3. THE RELATIONS OF THE DIFFERENT ELEMENTS OF PLANTS TO FERTILIZERS.

Carbon.—We know that carbon must be an important element in plant-food, since it forms nearly one-half of the solid portions of plants. Notwithstanding the fact that carbon forms so large a portion of plants, it has no importance as an *active* food constituent of *direct* fertilizers. This statement may appear strange and the question may be asked, "Why is not carbon to be regarded as an essential constituent of direct fertilizers?" The answer is that the carbon of plants comes from the carbon dioxide (carbonic acid gas) of the air, and the air furnishes an inexhaustible and available supply of this substance. We do not, therefore, need to add carbon to the soil in order to supply the needs of plants. However, some forms of carbon possess value as *indirect* fertilizers. When vegetable or animal matter undergoes decomposition in the soil more or less carbon dioxide is formed. This is taken up by the soil-water and acts as a solvent, changing unavailable into available forms of plant-food.

Hydrogen and Oxygen.—As already stated, water is formed by the union of two gases, hydrogen and oxygen. These elements are supplied to plants in the form of water. Growing plants contain a larger amount of water than of any other constituent. More or less of the oxygen and hydrogen of the water is separated in the plant, and in this way plants secure the hydrogen and oxygen which they need to build up their tissues. In this manner water acts as a *direct fertilizer*. The water is supplied to the soil by rains; from the soil it is taken into the plant through the roots. In regions adapted to agriculture, plants receive all the hydrogen and oxygen needed, and usually much more, from the rains. Therefore, these elements are not regarded as important parts of fertilizers.

When water is supplied to plants by irrigation, it can very properly be called a fertilizer, and an extremely important one.

Nitrogen.— Experiments have shown that nitrogen is essential to the growth of plants; that the quantities of nitrogen available as plant-food are very small; that nitrogen is one of the first elements in the soil to be used up; that, of all fertilizing elements, nitrogen is and always has been the most expensive.

Phosphorus.— The fact that phosphorous compounds are absolutely necessary for the maturity of plants indicates that phosphates are essential to complete fertilizers. Soils become deficient in available phosphates quite rapidly, especially in grain-growing regions.

Sulphur.— Sulphur is known to be an essential constituent of plant-food.

So far as known, plants take it up and use it in the form of sulphates. As a rule, there appear to be in all soils amounts of sulphates sufficient to supply indefinitely all the demands of crops. As the quantity of sulphur used by plants is very small, soils do not readily become exhausted of this element. Therefore, we do not need, in general, to add sulphur compounds to the soil. Calcium sulphate (sulphate of lime) and potassium sulphate (sulphate of potash) are often present in commercial fertilizers, but they are generally used not on account of the sulphur they contain. Some forms of sulphur compounds render a soil barren, when present in any considerable quantity.

Chlorine.— While chlorine is known to be an essential constituent of plant-food, the circumstances which require its addition to the soil appear extremely rare, except in some cases where it may be used for an indirect benefit. It is added to fertilizers in considerable quantities in the form of potassium chloride (muriate of potash) but this is largely because this happens to be the cheapest form in which potash can usually be obtained. It is the effect of the potash, not of the chlorine, that is desired. An excess of compounds of chlorine in soils renders them barren.

Silicon, in the form of silica and silicates, is abundant in all soils, and does need special attention in connection with fertilizers.

Calcium.—All plants require calcium or, as it is more commonly called, lime. Most soils appear to contain an inexhaustible supply of this element, and only in exceptional cases does it need special attention in connection with furnishing a supply of plant-food. Calcium is not, therefore, regarded as an essential constituent of a direct fertilizer, but some of its compounds are known to be valuable under certain conditions as indirect fertilizers.

Potassium.— Experiments show that when potassium (or potash) compounds are lacking in the soil, the plant suffers greatly, though it does not necessarily die. The development of the woody parts of plants and the fleshy portions of fruits seems to be largely dependent on the influence of potassium compounds. As potash is taken up by vegetation, most soils under constant cultivation sooner or later become deficient in potash, and this loss must be supplied by means of fertilizers. Therefore, potassium (potash) compounds are regarded as essential constituents of direct fertilizers.

Sodium in the form of sodium chloride (common salt) is found in small quantities in all soils. While it appears as a regular, though small, constituent of plants, it is generally held that it is not a necessary constituent of plant-food, and that the requirements of plants do not call for the addition of sodium compounds to fertilizers. In the case of nitrate of soda, it is not the sodium, but the nitrogen in the form of nitrate, which gives the compound its value as plant-food. It merely happens that the nitrate can be furnished most cheaply in this form. The application of sodium chloride as an indirect fertilizer has been found, under some conditions, to be attended with beneficial results.

Magnesium is a necessary constituent of plants, but, so far as known, it rarely needs to be added to a soil. There are some magnesium compounds existing as impurities in the German potash salts, and when these latter are used, some magnesium is added to the soil incidentally.

Iron, though used by plants in very small quantities, is an essential constituent of plant-food. It is rarely, if ever, absent from cultivable soils, and hence does not need to be considered in connection with commercial fertilizers.

4. THE SPECIFIC ACTION OF DIFFERENT ELEMENTS OF PLANT-FOOD UPON PLANTS.

The question is often asked in connection with the different constituents of plant-food regarding the function each performs in plant growth. It is well known that each element contributes to the building of definite compounds contained in the plant, and that each has one or more special offices to fulfill. While the specific action and functions of the different elements are not clearly understood in all details, much is known, and we now present a brief outline of the facts relating to this subject, so far as known.

Carbon is a constituent of nearly all the compounds, except water, found in plants, such as starch, fibre, sugar, fat or oil, albuminoids, acids, etc. Hence, its function is to supply its necessary part of the material found in such compounds. The carbon dioxide is taken into the leaves of plants, and in the presence of sunshine is decomposed, its carbon uniting with other elements to form various compounds, its oxygen being largely returned to the air.

Oxygen, next to carbon, is the most abundant element found in plants, and there are very few compounds occurring in plants which do not contain more or less oxygen. The chief function of oxygen is to supply the various compounds of plants with the needed portion of this material. Plants require oxygen about as much as do animals. Green plants can not flourish without a supply of oxygen. The absence of oxygen prevents the germination of seeds. Considerable quantities of oxygen are absorbed from the air by the opening buds of trees. More or less oxygen in the soil is necessary for the active life of roots. In the act of flowering, the absorption and chemical action of oxygen in the blossom is so marked, in some cases, as to develop sufficient heat to be measured by a thermometer.

Water (Hydrogen and Oxygen).— In the combination of oxygen with hydrogen in the form of water, these two elements perform important functions. In the first place, nearly all the hydrogen found in the different compounds of plants comes from water. More or less of the oxygen is also supplied this way. In addition to furnishing materials with which to build other compounds, water acts as a carrier within the plant in transferring from one part of the plant to another, as needed, the various products contained in the plant, just as the blood in the animal body carries to every portion the nutriment adapted to each organ and part.

Nitrogen.—The influence of nitrogen in its various forms upon plant growth is shown by at least three striking effects.

First. The growth of stems and leaves is greatly promoted, while that of buds and flowers is retarded. Ordinarily, most plants, at a certain period of growth, cease to produce new branches and foliage, or to increase those already formed, and commence to produce flowers and fruits, whereby the species may be perpetuated. If a plant is provided with as much available nitrogen as it can use just at the time it begins to flower, the formation of flowers may be checked while the activity of growth is transferred back to and renewed in stems and leaves, which take on a new vigor and multiply with remarkable luxuriance. Should flowers be produced under these circumstances, they are sterile and produce no seed.

Second. The next effect of nitrogen upon plants is to deepen the color of the foliage, which is a sign of increased vegetative activity and health.

Third. Another effect of nitrogen is to increase in a very marked degree the relative proportion of nitrogen in the plant.

Phosphorus.—Experiments have shown that plants will die before reaching maturity, unless they have phosphoric acid compounds to feed upon. Phosphates appear to perform three distinct functions in plants.

First. They aid in the nutrition of the plant by furnishing the needed quantities of phosphorus.

Second. They aid the plant, in some way not well understood, to make use of or assimilate other ingredients. Phosphorus is found in the seeds of plants, and, as already stated, a plant does not come to maturity and so does not produce seeds, unless phosphates are present in the soil for the plants to feed upon. The liberal application of available phosphate compounds appears to hasten the maturity of plants.

Third. Certain forms of phosphates render the albuminoids sufficiently soluble to enable them to be carried from the growing parts of plants to the seeds, in which they accumulate in quantity.

Sulphur is required by plants in order to produce the albuminoids and many of the vegetable oils, such as those contained in horseradish, mustard, turnips, onions, etc. Otherwise, it is not clearly known what functions sulphur may perform in plant development.

Chlorine.—The function of chlorine in connection with the development of plants is not satisfactorily settled. There are some reasons for believing that some of the compounds of chlorine, especially the potassium chloride (muriate of potash), are instrumental in transferring starch from the leaves, where it is formed, to the flower and fruit.

Silicon.— It is an unsettled question as to what silicon does in plant growth. Some have thought that its functions might be to give stiffness to slender stems in the case of such plants as grasses, sedges, etc., but there are some serious objections which interfere with the complete acceptance of such a proposition.

Calcium forms a part of several compounds found in plants. Its chief function appears to be that of strengthening cell-walls. It is often found united with different acids forming calcium (or lime) salts. Thus, in beet leaves, we find the salt calcium oxalate. In what specific way it otherwise affects the growth of plants, we do not yet know definitely.

Potassium compounds are essential to the formation and transference of starch in plants. Starch is known to be first formed in the leaves of plants, after which in some way it becomes soluble enough within the plant-cells to enable it to pass through the cell-walls gradually and later to be carried into the fruit, where it accumulates and changes back to its insoluble form. It is well established that potassium compounds are intimately connected with the formation of starch in the leaves and with its transference to the fruit. No other element can take the place of potassium in performing this work. For the carrying of starch a minute amount of calcium (lime) and chlorine appears to be needed in addition to the potassium. Potassium compounds are important on account of their influence upon the development of the woody parts of stems and the fleshy portions of fruit. Again, potassium compounds are present in those plant juices, which are rather sour; in these cases, the potassium is combined as an acid salt with such acids as citric, malic, tartaric, oxalic and other acids.

Iron is essential to the formation of the green-coloring-matter of plants called chlorophyl. In the absence of iron, leaves lose their green color and become pale or white and no starch is formed.

Magnesium closely resembles calcium in many ways, but can not replace it in plants. Magnesium appears to be associated with nitrogen in the formation of protoplasm; it also appears to have some effect upon the formation of the green coloring-matter or chlorophyl of plants.

5 THE RELATIONS OF THE DIFFERENT ELEMENTS OF PLANT-FOOD TO SOILS.

General Composition and Origin of Soils.—Of the fourteen elements necessary to perfect plant growth, ten come exclusively from the soil, as previously indicated. These have already been described, and we do not need to give further attention to them in this place. The soil-derived elements, though forming on an average only about five per cent. of the whole vegetable kingdom, are of the utmost interest and importance to the farmer; for, while the atmosphere is in itself entirely beyond his control, he can, through the medium of the soil, influence the amount of air-derived constituents taken up by plants.

Soils consist of decomposed rocks mixed in varying proportions with organic matter called humus, formed by the decay of animal and vegetable substances. The principal part of the soil was once solid rock, and the first step toward the formation of soil was the powdering of the rock. The conversion of rocks into soil has been accomplished by means of various agencies, such as heat and frost, moving water and ice, chemical action of air and water, and the influence of animal and vegetable life. The value of a soil for agricultural purposes depends largely upon the original material from which it was made, and upon the state of fineness to which it has been reduced.

Food Constituents and Mechanical Constituents of Soils.—The constituents of soils can be divided into two general classes, which we will call (*a*) *food constituents and* (*b*) *mechanical constituents.*

(*a*) *Food constituents* include the ten soil-derived elements which are essential to the development of plants. They may be divided into two kinds, *available* and *unavailable* food constituents.

The food constituents of the soil are *available* when they are soluble; that is, when they are in such forms as the plant can take in and use. They are *unavailable* when they are in an insoluble condition and can not be used at once by the plant.

(*b*) The *mechanical constituents* of the soil include (1) *clay*, (2) *sand*, and (3) *humus*. These act as a mechanical support to plants and as indirect fertilizers.

(1) *Clay* has the power of absorbing and retaining a large amount of water, thus preserving a sufficient amount of moisture in the soil. Clay has the power also of holding ammonia and some mineral salts and again giving them up to plants. Clay, therefore, acts on the available elements of the soil as a sort of regulating material, retaining or yielding them by turns as the earth passes from a state of drought to one of excessive moisture.

(2) *Sand* serves, when mixed with clay, to diminish its compactness and makes it more porous and permeable to the air.

(3) *Humus* is the organic matter in the soil formed by the decay of animal and vegetable matter. It is brown or black in appearance; leaf-mold, swamp-muck and peat are varieties of humus, differing in appearance according to the condition of their origin and formation. The decay of roots, the plowing under of sod and stubble, and the application of manure cause the formation of humus in the depths of the soil. The composition of humus is somewhat doubtful. It is probably a variable mixture of several substances. Humus is extremely valuable as an indirect fertilizer, for the following reasons:

First. Humus absorbs water much more extensively than any other ingredient of the soil, and thus promotes moisture of the soil.

Second. Humus aids in the decomposition of the mineral matters of the soil, changing unavailable into available plant-food.

Third. Humus fixes ammonia in the soil, so as to prevent it from being carried off by the rains; it afterwards gives up this ammonia to plants. Humus is, therefore, a very desirable constituent of the soil, and the beneficial effects of stable-manure and green manure are often doubtless due, in no small degree, to the abundance of humus which they furnish to the soil.

Fourth. Humus improves the mechanical condition of heavy soils by making them lighter, more porous and less adhesive. It also is helpful on sandy soils, serving to bind together the loose particles of soil, enabling it to retain moisture and preventing excessive leaching of plant-food.

Amount of Plant-food in Soil.—The proportion of plant-food even in a fertile soil is comparatively small. One thousand pounds of a good soil may contain:

Phosphoric Acid, 1½ lbs.
Nitrogen, 1½ lbs.
Potash, 2 lbs.

Some soils may contain larger quantities than these. But when we consider the total amount of plant-food in one acre of soil, the amounts appear large.

While the weight of soil in an acre of different kinds of land varies, we may take the average weight of dry soil in one acre to the depth of nine inches as approximating about 3,000,000 to 3,500,000 pounds. One acre of soil containing the proportions of plant-food given above would, therefore, contain the following aggregate amounts:

Nitrogen, 4,500 lbs.
Phosphoric Acid, 4,500 lbs.
Potash, 6,000 lbs.

A large portion of the plant-food in the soil is not available. The character of the soil affects very considerably the available condition of the plant-food. For example, a sandy soil is rendered fertile by a smaller amount of plant-food than is a clay soil, owing, in part to the greater development of roots in a sandy soil, and, in part, to the different condition in which the mineral food exists in the sandy soil. The insoluble condition of plant-food in the soil prevents its rapid loss by leaching.

Loss of Fertilizing Constituents from the Soil. — Without going into a detailed explanation in regard to the causes, we will consider briefly the extent to which the three chief forms of plant-food are liable to be lost from soils.

(*a*) *Phosphoric Acid in Phosphates.*— The ordinary form of calcium phosphate being insoluble in water, is not, to any appreciable extent, removed from the soil by the drainage water. The soluable form of calcium phosphate would probably be lost to some extent in drainage water, were it not for the fact that it is quickly changed in the soil to the "reverted" or less soluble form and, in this "reverted" condition, the phosphate is not apt to be carried away in drainage water.

(*b*) *Nitrogen Compounds.*— Since ammonia compounds and nitrates dissolve easily in water, is there not danger of their being carried away in drainage water from the upper soil out of reach of the plants? Experiments have been made to settle the question, and results indicate that *ammonia* compounds are largely retained in the soil. *Nitrates are apt to be washed out and lost in the case of bare fallow land;* but, when the soil is covered with vegetation, there is little or no loss, for the reason that the roots of growing plants absorb nitrogen very readily. Some nitrogen may be lost also by organic matter in the process of decay, escaping into the air as free nitrogen.

(*c*) *Potash in Potassium Compounds* is not apt to be lost to any extent in drainage waters, since most soils have the power of changing soluble forms of potash into forms less soluble, which are gradually redissolved and given up for the use of plants.

In addition to the preceding statements, it may be said, in general, that loss of plant-food is greatest in sandy soils; the coarser the sand, the greater the loss, other conditions being the same. Clay and humus have very marked power in retaining plant-food.

Relations of Plants and Soils.— We have seen that a very small part of the soil furnishes the most important constituents of plant-food. The soil also performs other functions than furnishing plant-food. We can summarize as follows the general offices which the soil fulfills in its relation to plants:

First. The soil acts as a mechanical support for plants; the roots of the plants penetrate the soil downwards and sideways, and brace the plant firmly to its upright position.

Second. The soil furnishes directly all the soil-derived elements used by the plant, and is thus immediately connected with the nutrition of plants. In addition, the soil serves as a medium for conveying to the plant a considerable portion of the air-derived elements.

Third. The soil contributes to the development of plants by modifying and storing the heat of the sun, by regulating supplies of food, and, in various ways, by securing those conditions which must be present and unite to produce the fully developed plant.

Fourth. The soil acts like a sponge to hold water for the use of plants.

Analysis of Soils.—It is ordinarily supposed that a chemist has only to make an analysis of a soil in order to tell just what the soil needs and what elements should be added to it to make it most productive. What chemical analysis does actually tell is what elements are present in the soil and in what quantities they are present; it does *not* tell whether the elements are available as plant-food, and it is just this point which one should know in order to supply to a soil what is needed. Few agricultural chemists to-day place unlimited confidence in the chemical analysis of a soil to find out its needs in the line of plant-food.

X. Description of Materials Used as Fertilizers.

1. FORMS OF PLANT-FOOD ESSENTIAL TO FERTILIZERS.

In the absence of iron in the soil, plants turn yellow and cease to grow; other elements, as chlorine, sulphur, etc., are essential to the complete development of a plant. But these elements are used by plants in very small quantities, and, moreover, they occur abundantly everywhere in soils, as already indicated. Therefore, it is unnecessary to supply these elements artificially to soils, and we do not need to consider them in connection with fertilizers. The elements of plant-food which experience most often shows to be lacking in soils are these three:

Nitrogen, *Potassium* (contained in potash compounds) and *Phosphorus* (contained in phosphoric acid compounds or phosphates).

2. STIMULANT OR INDIRECT FERTILIZERS.

A Stimulant or Indirect Fertilizer is one which does not in itself furnish directly to the soil any needed plant-food, but whose chief value depends upon the power it possesses of changing unavailable into available forms of plant-food. The stimulant or indirect fertilizers which have been most commonly employed are lime, gypsum and common salt.

Gypsum or Land Plaster, known also as calcium sulphate or sulphate of lime, has been much used in fertilizing crops. Its value is due to its action as an *indirect* fertilizer. There has been much difference of opinion as to the manner in which gypsum acts. Probably it acts in at least three different ways, as follows:

First. It has the power to form compounds with ammonia, in which the ammonia is no longer in danger of loss by evaporation. This power of fixing ammonia is probably of little value when plaster is applied to the surface of the soil, but it may be of much value when scattered over a heap of fermenting manure, and moistened with water, when it will retain the ammonia which would otherwise escape. For the same reason, plaster is useful to distribute about stables, so that it may mix with the manure.

Second. It has been shown recently that gypsum in some manner aids the process of nitrification, by which ammonia and the nitrogen of organic matter are converted into nitric acid and nitrates.

Third. Gypsum acts upon the insoluble forms of potash and some other elements of plant-food, converting them into soluble and available forms which plants can readily take up and use. This is probably the most important effect of plaster as an indirect fertilizer.

In whatever way gypsum may act, it is well established that it is of value when applied on certain soils to certain crops, such as clover, peas, lucern and similar plants. All forms of superphosphate contain more or less gypsum, as will be explained later.

Quicklime.—Quicklime or burnt lime or calcium oxide, commonly called lime, is known to be valuable as an indirect fertilizer. It produces changes in both the physical and the chemical character of soils. It changes the mechanical condition of soils by loosening heavy clay soils and also by holding together and giving body to light sandy soils. Freshly burned lime acts chemically upon soils by decomposing vegetable and mineral matter already present in the soil and changing them into forms which are available as food for the plant. Thus, lime acts upon insoluble mineral substances containing potash, soda, etc., and converts them into soluble forms which plants can use. Lime aids in the decomposition of animal and vegetable matter, such as vegetable mold, stable manure, etc., and tends to convert them into available plant-food. In this change from insoluble to soluble forms, any food not taken up by plants during the season may be washed away before another season and thus lost. In using lime, care should be taken not to use too large quantities, and ordinarily it is best to use it in connection with liberal applications of nutritive fertilizing substances. Lime can be used to advantage on freshly drained swamp lands and also on lands newly cleared.

Common Salt has an indirect fertilizing value which is mainly due to the fact that it has the power of changing unavailable forms of plant-food, especially potash, into available forms.

Danger in using Stimulant Fertilizers.— It should be kept in mind that these stimulant fertilizers are not used for the plant-food contained in them; hence, as used, they do not furnish needed plant-food. The chief value of their use lies in the fact that they can change unavailable into available forms of plant-food. It can readily be seen that, when stimulant fertilizers are used exclusively for a term of years, the soil each year loses nitrogen, potassium and phosphorus compounds, which are not replaced. The inevitable result of such treatment is the exhaustion of these important food constituents from the soil. This affords an explanation of the question often raised now as to why the application of land-plaster does not give such results in crop yields at present as in former days. When land-plaster was the only fertilizing material added to soils for years in succession, it was possible to produce increased crops, so long as there were in the soil enough compounds of nitrogen, potassium and phosphorus to be rendered available by the action of the land-plaster. When, therefore, these forms of plant-food were largely removed, there was nothing for the land-plaster to act upon, in order to increase the supply of available food material. The land-plaster furnished no needed food but simply helped the crops to use up more rapidly the store of plant food present in the soil.

3. NUTRITIVE OR DIRECT FERTILIZING MATERIALS.

Nutritive or Direct Fertilizers contain forms of plant-food, which contribute directly to the growth and substance of plants. Such materials may contain either nitrogen or potash or phosphoric acid compounds, or any two, or all three of these forms of nutriment. We shall consider these various materials under the following heads:

(a) Commercial fertilizing materials containing nitrogen compounds.

(b) Commercial fertilizing materials containing phosphoric acid compounds.

(c) Commercial fertilizing materials containing potash compounds.

(d) Farm-produced fertilizing materials.

This division is not sharply defined, since one material may contain more than one form of nutriment; however, in most cases, each kind of material contains some one of the three forms of plant-food in much larger proportions than any other form. Owing to the value of farm-produced manures and to the importance of calling special attention to their value, we treat this subject under a separate head in connection with the forms of materials used in commercial fertilizers.

(*a*) *Fertilizing Materials Containing Nitrogen Compounds.*

The various materials which are used to furnish nitrogen in commercial fertilizers are derived from three general sources, which we can indicate as follows:

(1) Mineral nitrogen compounds.

(2) Vegetable nitrogen compounds.
(3) Animal nitrogen compounds.

(1) *Commercial Fertilizing Materials containing Mineral Nitrogen Compounds.*

The forms of mineral compounds containing nitrogen, most commonly found in the market, are *nitrate of soda* and *sulphate of ammonia.* Much less common are nitrate of potash and muriate (chloride) of ammonia.

Nitrate of Soda, known also as "Chili saltpeter," is found in large deposits which have been formed in the rainless regions of Chili and Peru. As it is mined, the nitrate of soda is quite impure, the chief impurity being common salt. Before being sent to market, it is purified, and the form in which farmers purchase it generally contains from 95 to 96 per cent. of real nitrate of soda. Stated in another way, 100 pounds of good commercial nitrate of soda contain from 15½ to 16 pounds of nitrogen.

Sulphate of Ammonia is formed from waste materials produced in the manufacture of illuminating gas. This is the most highly concentrated form of nitrogen commonly found in the market. One hundred pounds of sulphate of ammonia contain about 25 pounds of ammonia, which is equivalent to about 20½ pounds of nitrogen.

(2) *Commercial Fertilizing Materials Containing Vegetable Nitrogen Compounds.*

While nitrogen may be supplied by many forms of vegetable matter, only a few substances of this kind are used in commercial fertilizers, chief of which are *cottonseed-meal, castor-bean pomace and tobacco stems.*

Cottonseed-Meal is the product formed by removing the oil from the seed by pressure, after which the material is dried and ground. It has been used at the South mainly for fertilizing purposes. One ton of cottonseed-meal contains about 140 pounds of nitrogen, 60 pounds of phosphoric acid and 40 pounds of potash. It is valued highly as a food for cattle, and, when thus fed, practically all of the fertilizing value is recovered in the manure. When it can be purchased at a moderate price, it makes a valuable fertilizer to be applied directly to the soil. The hulls of the cottonseed also possess considerable fertilizing value.

Castor-Bean Pomace is a by-product of castor-oil factories; it is made by about the same process as that used in producing cottonseed-meal. As a rule, it has less fertilizing value than cottonseed-meal, one ton containing about 110 pounds of nitrogen, 40 pounds of phosphoric acid and 20 pounds of potash.

(3) *Commercial Fertilizing Materials Containing Animal Nitrogen Compounds.*

Probably the larger proportion of the nitrogen occurring in commercial fertilizers is furnished by animal matter in one form or another. This material comes mainly from slaughter houses, rendering works and fish-oil factories. The following list contains most of the substances of animal origin commonly used: *Azotin or ammonite, dried blood, dried fish, fish-scraps, ground fish, hair, hoof-meal, horn-dust, leather-scraps, nitrogenous guanos, tankage, wool-waste, etc.*

Azotin or Ammonite consists of dried and ground meat, tendons, membranes, etc., from which fat has been extracted. It usually contains over 10 per cent. of nitrogen along with 3 or 4 per cent. of phosphoric acid.

Dried Blood consists of blood obtained from slaughtering animals; it is prepared for market by evaporating, drying and grinding. The color varies with the degree of heat employed in drying, ranging from red to black. That from hogs is usually more red than that from cattle. One hundred pounds of dried blood contain from 10 to 15 pounds of nitrogen.

Dried Fish, Fish-Scraps, and Ground Fish consist of refuse from fish-oil works; it is dried and ground for market. It is more valuable according as it is finer and drier. Dried ground fish, of good quality, contains from 7 to 8 per cent. of nitrogen, together with as much or more phosphoric acid.

Hair is obtained from slaughter-houses; it is often mixed with dried blood and other forms of animal matter. It contains about 15 per cent. of nitrogen.

Hoof-Meal and Horn-Dust are by-products containing 10 to 15 per cent. of nitrogen and about 2 per cent. of phosphoric acid. They are sometimes treated with superheated steam or with sulphuric acid, the treatment rendering the nitrogen compounds more readily available.

Leather-Scraps and Leather-Meal are waste products of various factories. When treated with superheated steam and dried or roasted, they can be very finely ground. Roasted, finely ground leather is used to adulterate dried blood, having much the same appearance. The use of these materials in commercial fertilizers is forbidden by law in this State, except the fact be stated on the package.

Meat-Scraps, Tankage, etc., are slaughter-house refuse, dried and ground. It differs from azotin and ammonite in usually containing more bone and, hence, more phosphoric acid. Good tankage contains 10 per cent. or more of nitrogen and often 10 per cent. or more of phosphoric acid.

Nitrogenous Guanos are formed in dry regions. The Peruvian guano was rich in nitrogen, containing 7 per cent. or more, mainly in the form of sulphate of ammonia. Guanos of this kind have largely disappeared from the market.

The following table gives the approximate quantities of nitrogen contained in various fertilizing materials:

TABLE GIVING APPROXIMATE AMOUNT OF NITROGEN IN FERTILIZING MATERIAL.

MATERIALS CONTAINING NITROGEN.	Average per cent. of nitrogen.	Pounds of nitrogen in 2000 pounds of material.
(1) *Mineral materials.*		
Muriate of ammonia	25 to 26	500 to 520
Nitrate of potash	13 to 14	160 to 280
Nitrate of soda	15½ to 16	310 to 320
Sulphate of ammonia	19 to 20½	380 to 410
(2) *Vegetable materials.*		
Cotton-seed meal	6 to 7	120 to 140
Castor bean pomace	5 to 6	100 to 120
Tobacco stems	2 to 2½	40 to 50
(3) *Animal materials.*		
Azotin, ammonite	10 to 12	200 to 240
Dried blood	10 to 15	200 to 300
Dried fish	7 to 8	140 to 160
Hair	14 to 16	280 to 320
Hoof meal, horn dust	10 to 15	200 to 300
Leather scraps, leather meal	7 to 8	140 to 160
Meat scraps	10 to 12	200 to 240
Nitrogenous guanos	7 to 8	140 to 160
Oleomargarine refuse	10 to 12	200 to 240
Tankage	7 to 9	140 to 180
Wool waste	5 to 6	100 to 120

(*b*) *Fertilizing Materials Containing Phosphoric Acid Compounds.*

Phosphoric acid is generally found in combination with lime (calcium), forming, at least, three different compounds, viz.:

(1) Insoluble phosphate of lime.
(2) Soluble phosphate of lime.
(3) Reverted phosphate of lime.

(1) *Insoluble Phosphate of Lime.*

This is known under several other names, as "insoluble calcium phosphate," "normal calcium phosphate," "tri-calcium phosphate," "bone phosphate of lime," etc.

This form of calcium phosphate is called *insoluble* because it does not dissolve in water.

It is found in nature in large quantities in several minerals, which will be noticed later. It also constitutes about 85 per cent. of the ash or inorganic matter of bones. It is also contained in the excrement of animals, as in guano, etc.

Insoluble phosphate of lime is found everywhere in the soil. However, in this form, calcium phosphate has the least value for the farmer, because it is not easily dissolved and can not, therefore, be taken up and used by plants, except very slowly. To make the insoluble phosphate available for plants so that they can take it up, the insoluble phosphate must be converted into some form which is soluble, that is, which dissolves in water. This can be done by treating it with sulphuric acid (oil of vitriol).

(2) *Soluble Phosphate of Lime.*

This is known under several other names as "acid phosphate of lime," "acid calcium phosphate," "acid phosphate," "superphosphate of lime," "superphosphate," "mono calcium phosphate," etc. It is not found naturally occurring.

As indicated above, the soluble calcium phosphate is made by treating insoluble calcium phosphate with sulphuric acid. By this treatment, a portion of the calcium is removed from the phosphate and unites with the sulphuric acid, forming calcium sulphate or sulphate of lime, in addition to the soluble phosphate. This mixture of the soluble phosphate and sulphate of calcium is known as "superphosphate of lime." The phosphate in this form, being easily soluble in water, can be readily taken up by plants and is, therefore, of great value as a fertilizer. The sulphate of lime is also known to have value as a fertilizer. In plain superphosphate of lime, there are generally formed about 116 pounds of sulphate of lime for each 100 pounds of soluble phosphate of lime. The value of superphosphates depends upon the amount of soluble phosphate contained in them.

(3) *Reverted Phosphate of Lime.*

Reverted phosphate of lime is known also as "reverted calcium phosphate," "precipitated phosphate of lime," "di-calcium phosphate," "citrate-soluble phosphate," etc.

When soluble phosphate of lime is allowed to stand for sometime, it will happen under certain conditions that some of the soluble phosphate is changed into a less soluble form of phosphate. This is not the same form as ordinary insoluble calcium phosphate above described; for a reverted phosphate, while insoluble in water, can be readily dissolved by weak acids or by water containing carbonic acid or salts of ammonia. Since the soil and plant roots generally contain acids sufficiently strong to dissolve reverted phosphates, phosphoric acid in this form is generally regarded as very nearly equal to soluble phosphates in value as a fertilizer. The term "reverted" was introduced to express the fact that the phosphoric acid in this form had once been soluble in water but that it had "reverted" or "gone back" to a form insoluble in water.

The reverted form of phosphoric acid is often found in small quantities in connection with insoluble phosphates, and in larger amounts, in guanos; it is also found to a considerable extent in bones and other forms of organic matter.

Summary.—Of the forms of phosphate of lime which are used as food for plants, we have

First, the ordinary *insoluble* phosphate of lime, which can be changed by treatment with sulphuric acid into

Second, the *soluble* phosphate of lime, and this, on standing, may, under certain conditions, undergo change, forming

Third, the *reverted* phosphate of lime, which is insoluble in pure water but soluble in the acids of the soil and plants and in water containing carbon dioxide.

The soluble and reverted forms of phosphoric acid, taken together, are called *available* phosphoric acid.

CHEMICAL DIFFERENCES OF THE THREE PHOSPHATES OF LIME.

	Calcium.	Phosphorus.	Oxygen.	Hydrogen.
	Per cent.	Per cent.	Per cent.	Per cent.
Insoluble phosphate of lime .. / Insoluble calcium phosphate .. / Normal calcium phosphate.... / Tri-calcium phosphate........ / Bone phosphate of lime, etc...	38.7	20.0	41.3	....
Soluble phosphate of lime .... / Acid phosphate of lime .... / Superphosphate of lime....... / Mono-calcium phosphate...... / Acid calcium phosphate, etc ..	17.1	26.5	54.7	1.7
Reverted calcium phosphate .. / Precipitated phosphate of lime.	29.4	22.80	47.0	0.8

We notice the following points of difference in composition:

First. The *insoluble phosphate of calcium* contains the largest amount of calcium, the smallest amount of phosphorus, the smallest amount of oxygen and no hydrogen.

Second. The *soluble phosphate of calcium* contains the smallest amount of calcium and the largest amount of phosphorus, oxygen and hydrogen.

Third. The *reverted calcium phosphate* contains amounts of calcium, phosphorus, oxygen and hydrogen which are intermediate between the other two forms.

With regard to phosphorus, which is the most valuable element in these phosphates of lime, the soluble phosphate of lime contains most of this element; the insoluble phosphate of lime the least; and the reverted phosphate is second in regard to the amount of phosphorus contained in it.

Having called attention to the different kinds of compounds in which phosphoric is found, we are now prepared to consider more intelligently the different materials in which the phosphoric acid compounds of commerce are supplied for fertilizers. The materials which furnish the greatest proportion of phosphoric acid used in making fertilizers are the following: *Bones, bone-ash, bone-black, bone-meal, phosphatic guano, rock-phosphate, superphosphates, Thomas slag, etc.*

Bones.—Bones consist of two quite different kinds of material. The hard portion consists mostly of calcium phosphate or phosphate of lime, and constitutes from one-half to three-fifths of the weight of the bone. The remaining portion consists largely of a soft, flesh-like substance called ossein, or, more commonly, gelatin. It is distributed throughout the entire mass of bone and is rich in nitrogen. When bones are burned, the nitrogenous matter is driven off and only the mineral portion or phosphate of lime remains. Bones, such as are used in making commercial fertilizers, contain 4 to 5 per cent. of nitrogen and from 20 to 25 per cent. of phosphoric acid, equivalent to 45 to 55 per cent. of phosphate of lime.

Bone-Ash.—As the name implies, bone-ash is made simply by burning bones in the open air. The nitrogen is, of course, driven off and lost in burning, and the chief constituent is insoluble calcium phosphate, equivalent to 30 to 35 or more per cent. of phosphoric acid.

Bone-Black, known also as bone-charcoal, is extensively used in refining sugar. After it has been used several times, portions become useless for refining purposes and are then sold as fertilizer. Bone-black is made by heating bones in closed vessels, the air being excluded. By heating bones in this manner, the fat, water, and nitrogen are removed from the bones; and the bone-black remaining consists mainly of insoluble calcium phosphate and carbon or charcoal. The presence of the carbon hinders the decomposition of the phosphate, so that it is, in this form, not readily available as food for plants. Good bone-black may contain 30 or more per cent. of phosphoric acid.

Bone-Meal goes under various names, such as ground bone, bone-flour, bone-dust, etc. We find in the market *raw* bone-meal and *steamed* bone-meal. Raw bone-meal contains the fat naturally present in bones. The presence of the fat is objectionable, because it makes the grinding more difficult and retards the decomposition of the bone in the soil, while fat itself has no value as plant food. When bones are steamed, the fat is removed and the bone is more easily ground. Moreover, the chemical nature of the nitrogen compounds appears to be changed in such a manner that the meal undergoes decomposition in the soil more rapidly than in case of raw bone. The presence of easily decaying nitrogen compounds in bone hastens, in the process of decomposition, to dissolve more or less of the insoluble phosphate. Bone-meal should contain from 3 to 5 per cent. of nitrogen and from 20 to 25 per cent. of phosphoric acid; about one-third to one-fourth of the latter appears to be in readily available condition. Raw bone-meal generally contains somewhat more nitrogen (1 or 2 per cent.) and rather less phosphoric acid than steamed bone-meal.

The fineness of the meal affects its value; the finer the meal, the more readily available is it as plant-food. On account of the increased demand for bones for various purposes, and on account of their increasing value, there is considerable *tendency to adulterate bone-meal* with such substances as lime, gypsum, coal-ashes, ground oyster-shells, ground rock-phosphate, etc.

Phosphatic Guanos, or Rock-Guanos.—Guanos generally consist chiefly of the dung of sea-fowls, though the term is applied to other animal products. They are generally found in beds resembling earthy deposits. The guanos which are called phosphatic contain little or no nitrogen. Their phosphoric acid is generally in the form of insoluble phosphate of lime, iron and alumina. These guanos come mainly from certain islands in the Pacific ocean, and from Caribbean sea and West India islands. The amount of phosphoric acid in different guanos is very variable, ranging from below 15 to over 30 per cent.

Rock-Phosphates are known under several different names, which generally designate the localities from which they come, as South Carolina Rock, Florida Rock, Tennesee Rock, West India Rock, etc. Other forms of mineral phosphates are known under the names of Apatite, Coprolite and Phosphorite, which are found in various places in America and Europe, and some of which are used in making commercial fertilizers. However, the greatest source of supply of phosphoric acid is the phosphate rock of our Southern States. The rock-phosphates are extensively used in making superphosphates. When ground to a very fine flour-like powder, rock-phosphates are called "floats." Rock-phosphates contain usually from 25 to 30 per cent. of phosphoric acid, and some as much as 35 or 40 per cent.

Superphosphates are known under several different names, such as acid phosphate, dissolved bone, dissolved rock, dissolved bone-black, etc. Superphosphates are formed by treating some form of insoluble phosphate of lime, as rock-phosphate, bone, bone ash, etc., with sulphuric acid. By this treatment there are formed soluble phosphate of lime and gypsum (sulphate of lime) in nearly equal proportions. Owing to their comparative cheapness and abundance, rock-phosphates are more often used in making superphosphates than bones, bone-ash or bone-black. The value of a superphosphate depends upon the amount of soluble phosphate of lime present in it together with the amount of reverted phosphate of lime. The amount of soluble phosphoric acid compounds in superphosphates varies with the kind of phosphate used in making superphosphate, and also with other conditions which we need not mention here. Good quality of dissolved bone contains 12 to 18 per cent. of soluble phosphoric acid. Dissolved bone-black contains from below 15 to over 17 per cent. of soluble phosphoric acid. Superphosphate made from rock-phosphate may contain from 12 to 18 per cent. of soluble phosphoric acid.

Thomas Slag is more familiarly known as *odorless phosphate.* It is also known under several other names, such as basic iron slag, Thomas scoria, phosphate slag, etc. This is a comparatively new source of phosphoric acid compounds. It is a by-product formed in the manufacture of iron and steel from certain kinds of iron ore containing phosphorus compounds. In the process phosphate of lime is formed, which is ground to a fine powder. Odorless phosphate is insoluble in water but is somewhat soluble in ammonium citrate solutions and its phosphoric acid is, therefore, available to some extent. The samples of odorless phosphate which we have analyzed at this station generally contained between 19 and 20 per cent. of total phosphoric acid, with 6 to 7 per cent. of available phosphoric acid. The practical results coming from the use of this form of phosphoric acid compounds have been varied, often being most excellent and again very indifferent.

In the table following, we give the amounts of different forms of phosphoric acid found in different phosphate materials :

Table Giving Approximate Amount of Phosphoric Acid in Fertilizing Materials.

Materials containing phosphoric acid.	Available Phosphoric Acid.		Insoluble Phosphoric Acid.		Total Phosphoric Acid.	
	Per cent.	Pounds in 2,000 lbs. of material.	Per cent.	Pounds in 2,000 lbs. of material.	Per cent.	Pounds in 2,000 lbs. of material.
Apatite	....	....	33 to 40	660 to 800	33 to 40	660 to 800
Bone-ash	....	....	32 to 40	640 to 800	32 to 40	640 to 800
Bone-black	....	....	25 to 35	500 to 700	25 to 35	500 to 700
Bone-black (dissolved)	12 to 18	240 to 360	1 to 2	20 to 40	13 to 20	260 to 400
Bone-meal	4 to 8	80 to 160	16 to 17	320 to 340	20 to 25	400 to 500
Bone-meal (free from fat)	....	....	....	....	20 to 22	400 to 440
Bone-meal (from glue factory)	6 to 8	120 to 160	16 to 20	320 to 400	22 to 28	440 to 560
Bone-meal (dissolved)	12 to 18	240 to 360	2 to 8	40 to 140	14 to 20	280 to 400
Caribbean guano	....	....	....	....	18 to 20	360 to 400
Cuba guano	....	....	....	....	12 to 14	240 to 280
Florida rock	....	....	....	....	25 to 35	500 to 700
Florida soft phosphate	....	....	....	....	18 to 20	360 to 400
Keystone concentrated phosphate	35 to 40	700 to 800	7 to 8	140 to 160	45 to 48	900 to 960
Mona Island guano	7 to 8	140 to 160	13 to 15	260 to 300	20 to 22	400 to 440
Navassa phosphate	....	....	....	....	28 to 35	460 to 700
Orchilla guano	....	....	....	....	25 to 30	500 to 600
Peruvian guano	5 to 8	100 to 160	5 to 7	100 to 140	10 to 15	200 to 300
South Carolina rock (ground)	....	....	....	....	25 to 30	500 to 600
South Carolina rock (floats)	....	....	....	....	25 to 30	500 to 600
South Carolina rock (dissolved)	10 to 12	200 to 240	2 to 4	40 to 80	12 to 16	240 to 320
Thomas Slag (American)	6 to 7	120 to 140	12 to 13	240 to 260	18 to 20	360 to 400

(c) *Fertilizing Materials Containing Potash Compounds.*

The more common sources of potash compounds for use as fertilizers, found in the market, are the following: *Carnallite, cottonseed hull ashes, green-sand marl, kainit, krugite, muriate of potash, nitrate of potash, sulphate of potash, sulphate of potash and magnesia, tobacco stems, wood-ashes, etc.*

Carnallite is one of several products, containing potash compounds, which come from the mines in and around the town of Stassfurt, northern Germany. The supply of potash compounds of various kinds seems practically inexhaustible. Carnallite contains from 20 to 22 per cent. of muriate of potash, equivalent to 13 to 14 per cent. of actual potash, together with chloride of magnesia and a very small amount of sulphate of potash and magnesia. It is essentially a mixed chloride or muriate of potash and magnesia. The material is generally purified and concentrated before reaching market.

Cottonseed Hull Ashes were produced in the south at the cottonseed-oil factories where the hulls, after being removed from the cottonseed, were used as fuel. Such ashes contain from 15 to 25 per cent. of potash, in addition to from 7 to 10 per cent. of phosphoric acid. They formed a very valuable fertilizer and were much used south in the manufacture of commercial fertilizers. This material is not commonly found now.

Green-Sand Marl of New Jersey contains, on an average, about 5 per cent. of potash, which is in an insoluble form, and is, therefore, slow in acting as a fertilizer.

Kainit is the most common product of the German potash mines. It is a mixture of several different compounds, containing 23 to 26 per cent. of sulphate of potash, equivalent to 12 to 14 per cent. of actual potash, together with about 35 per cent. of common salt, some sulphate and chloride of magnesia and a small amount of gypsum.

Krugite is a low-grade potash compound obtained from the German potash mines. It contains from 14 to 16 per cent. of sulphate of potash, equivalent to 8 to 9 per cent. of actual potash, together with considerable gypsum, sulphate of magnesia and some salt.

Muriate of Potash, also a product of the Stassfurt mines, is the main source of supply of potash for commercial fertilizers in our market. As taken from the mine it varies in purity, but is purified and concentrated for market. The muriate of potash most common in the market contains 80 to 85 per cent. of this product, which is equivalent to 50 to 53 per cent. of actual potash. A still more concentrated form, containing 95 to 98 per cent. of pure muriate, is sometimes found in the market.

Nitrate of Potash, commonly called saltpeter or nitre, is a most valuable fertilizing material for potash and nitrogen also. The demand for its use in the manufacture of gunpowder makes it too expensive to use commonly as a fertilizer. It is found in the market as "crude" nitrate of potash, containing about 44 per cent. of actual potash, and also as "double refined" nitrate of potash, containing about 46.5 per cent. of actual potash.

Sulphate of Potash is a product of the German mines. Strictly pure sulphate of potash contains about 54 per cent. of actual potash, but the product found in the market is of variable composition and purity. The highest grade form of commercial sulphate of potash is 90 to 95 per cent. pure and contains from 48 to 51 per cent. of actual potash. Low-grade sulphates of potash contain as little as 30 per cent. of actual potash, together with more or less sulphate of magnesia and common salt.

Sulphate of Potash and Magnesia is known also as double manure salts or simply as double potash salts. This material comes from the German mines, and contains 48 to 52 per cent. of sulphate of potash, equivalent to 26 to 28 per cent. of actual potash. It also contains 32 to 36 per cent. of sulphate of magnesia.

Tobacco Stems contain from 6 to 7 per cent. of potash and about 2 per cent. of nitrogen. They are ground fine and often used in making commercial fertilizers.

Wood-Ashes contain more or less potash, which is present chiefly in the form of carbonate. The amount of potash in commercial wood-ashes varies from below 4 to over 7 per cent., the average being under 5 per cent. Wood-ashes also contain between 1 and 2 per cent. of phosphoric acid. The amount of potash in wood-ashes depends upon a variety of conditions, such as the kind and age of wood, the method of burning, and especially the way in which the ashes are stored. Where ashes have been exposed to the weather or leached, they contain much less potash, often only 1 or 2 per cent. Ashes from lime-kilns and brick-kilns are generally so mixed with refuse matter as to possess little value for use as fertilizers.

Coal-ashes possess little value for the potash contained in them, for it is very small.

Below we present a tabulated summary, showing the amount of potash contained in different commercial fertilizing materials.

TABLE GIVING APPROXIMATE AMOUNT OF POTASH IN FERTILIZING MATERIALS.

MATERIALS CONTAINING POTASH.	Per cent of actual potash.	Pounds of actual potash in 2,000 pounds of material.
Carnallite	13 to 14	260 to 280
Cottonseed-hull ashes	15 to 25	300 to 500
Kainit	12 to 14	240 to 280
Krugite	8 to 9	160 to 180
Muriate of potash (80 to 85 per cent)	50 to 53	1000 to 1060
Nitrate of potash	43 to 44	860 to 880
Sulphate of potash (low grade)	28 to 30	560 to 600
Sulphate of potash (high grade)	48 to 51	960 to 1020
Sulphate of potash and magnesia	26 to 28	520 to 560
Waste from powder works	16 to 18	320 to 360
Wood-ashes (unleached)	4 to 8	80 to 160
Wood-ashes (leached)	1 to 3	20 to 60

(*d*) *Farm-Produced Fertilizing Materials.*

Economic Value of Farm-Manures.—A fair estimate of the fertilizing value of the manure annually produced by the farm animals of the United States places the sum at the enormous figure of over two thousand million dollars. This estimate is based on the number of farm animals and on the amount of nitrogen, potash, and phosphoric acid excreted in their manure. The values given to these forms of plant-food are those commonly assigned to them in the form of commercial fertilizers. A similarly conservative estimate would place the value of the farm-manures produced annually in New York State at one hundred million dollars. It will thus be readily seen that the farm-produced manures assume an economic importance which has not been accorded them by the average farmer.

Definition of Stable or Farmyard Manure.—Stable or farmyard manure consists of the solid and liquid excrements of animals fed upon the farm, mixed with straw and waste products of the farm.

Variation in Composition of Farm-Manures.—The composition of stable-manure varies greatly, depending on several conditions, among which the following may be mentioned :

(1) The kind and age of the animal producing it.
(2) The quantity and quality of the food eaten.
(3) The character and amount of material used for litter.
(4) The length of time the manure has been kept.
(5) The manner in which it has been cared for.

Influence of Kind of Animal on Manure.—*Horse Manure* is difficult to mix thoroughly with litter on account of its being very dry. It is called a "hot" manure, because, on account of its loose texture, it easily undergoes decomposition or fermentation, producing a high degree of heat. On this account it is very liable to lose more or less of its nitrogen in the form of ammonia. It should have very careful treatment in respect to the litter used and also in the application of preservatives. Horses are usually fed with greater uniformity in respect to character of food than other farm animals and there is, therefore, greater uniformity in the composition of horse manure. The urine of horses is particularly rich in nitrogen and potash.

Sheep Manure is quite dry and is commonly the richest of farm-produced manures. Like horse manure, it undergoes fermentation easily and is classed as a "hot" manure. It is similarly very liable to lose ammonia.

Pig Manure varies greatly in composition, but is generally rich, containing considerable water. In decomposing, it produces little heat and is, therefore, called a "cold" manure.

Cow Manure contains as a rule, less fertilizing materials than any of the preceding manures. It contains a large amount of water, and, in decomposing, generates little heat.

Poultry Manure contains a comparatively large amount of all the different forms of plant-food, being especially rich in nitrogen and potash. It undergoes fermentation readily and loses nitrogen unless properly treated with absorbents or preservatives.

Influence of Age of Animal on Manure.—A young, growing animal requires and retains in its body a greater quantity of nitrogen, potash, and phosphoric acid compounds than does a grown animal. Therefore, manure from a young animal is of less value than that from a mature one. Full-grown animals, not varying in weight, excrete essentially all the fertilizing constitutents taken into the body in the food. In the case of growing animals and cows in milk, from 50 to 75 per cent. of the fertilizing constituents of the food passes into the manure; in the case of fattening or working animals, from 90 to 95 per cent.

Influence of Food upon Manure.—In the case of any one class of animals, the value of the manure is, as a rule, more dependent upon the kind of food than any other one condition. It is a serious but not uncommon mistake among farmers to suppose that the process of animal digestion *adds something* to the food. While the food materials are changed more or less completely and appear in the dung and urine in forms different from those existing in the food before it was eaten, and while these forms are, in general, more available as plant-food than the forms existing in the original food, still there can be in the excrement no more nitrogen, potash, phosphoric acid, etc., than there was in the food eaten, and, in most cases, as will be noticed later, there is some loss of fertilizing materials.

Relative Value of Fertilizing Materials in Different Classes of Foods.—The amount of nitrogen, phosphoric acid, and potash in manure depends upon the amount of these materials in the food. From the table given below, it can be seen that concentrated food, such as meat-scrap, cottonseed-meal, linseed meal, and wheat bran must yield richest manures. Next to these foods, would come leguminous plants, such as clover, alfalfa, etc. The cereals, such as wheat, oats, corn, etc., would follow third. Root crops would come last.

TABLE SHOWING APPROXIMATE FERTILIZING VALUE OF SOME COMMON FOODS.

KIND OF FOOD.	Value of nitrogen in 2000 pounds.	Value of phosphoric acid in 2000 pounds.	Value of potash in 2000 pounds.	Total fertilizing value in 2000 pounds.
Meat scrap	$33 00	$2 00	....	$35 00
Cottonseed-meal	21 20	3 00	$1 80	26 00
Linseed-meal	16 50	1 80	1 40	19 70
Gluten-meal	15 00	30	5	15 35
Wheat bran	8 00	2 90	1 60	12 50
Clover hay (red)	6 20	40	2 20	8 80
Alfalfa hay	6 50	50	1 70	8 70
Wheat	7 10	90	60	8 60
Oats	6 20	80	60	7 60
Corn-meal	4 75	60	40	5 75
Timothy-hay	3 75	55	90	5 20
Wheat straw	1 80	15	50	2 45
Skim-milk	1 50	30	20	2 00
Corn ensilage	85	10	35	1 30
Turnips	55	10	40	1 05

It will be readily seen that of two foods costing the same price and having equal feeding value, it is economy for the farmer to use that one which contains the largest amount of fertilizing materials.

Amount of Fertilizing Materials of Food Recovered in Manure.—Generally speaking, manure produced from working or fattening animals contains from 90 to 95 per cent. of the fertilizing constituents contained in the food. Manure made from cows in milk and young, growing animals contains from 50 to 75 per cent. of the fertilizing constituents contained in the food. In the case of animals which are neither increasing in weight nor giving milk, the amount of fertilizing materials in the manure will be exactly equal to that contained in the food eaten. The foregoing statements presuppose that all the dung and urine are saved, a supposition which is not often true, considering the manner in which stable-manure is commonly treated.

The Digestibility of Food and Its Manurial Value.—The solid excrement of animals consist largely of the undigested portions of food; these undigested portions are mostly insoluble and, therefore, not readily available as plant-food. The urine contains those portions of food which have been digested; its constituents are all in a soluble form and readily available as plant-food, and, therefore, more valuable than the insoluble fertilizing materials contained in the solid excrement. It therefore follows that the more digestible a food is, the larger is the proportion of its fertilizing constituents that will appear in the urine, and the greater will be the value of the plant-food in the manure produced.

The Use of Litter.—Litter is used in stables primarily to furnish a clean and comfortable bed for animals. In connection with the manure, it is used to absorb the liquid portion of the manure, thus preventing loss by drainage. The presence of litter mixed with manure makes the manure easier to handle, tends to check and control its decomposition, and in some cases influences both the physical and chemical action of the manure. The materials commonly used for litter are usually not rich in fertilizing materials. The use of too much litter diminishes the relative value of the manure and adds to the cost of handling. Enough should be used not only to absorb and retain the urine, but also to absorb any ammonia formed in the process of decomposition.

Fermentation of Manure.—*Causes.* It is a familiar experience of every farmer that fresh stable-manure, when left in a heap, commences very soon to ferment or undergo decomposition. In this process the vegetable matter used as litter and the excrements pass through several changes. The fermentation is caused by minute living organisms, and varies according to the kind of organisms at work. Some will flourish only in the presence of an abundant supply of air, others will thrive only away from air; some require much moisture, others little, etc. According to circumstances, then, one kind or another will flourish, and the fermentation taking place will vary according as it is caused by the action of one kind of organism or another.

Conditions.—The more important conditions influencing the character of fermentation in manure are the following: (1) temperature, (2) moisture, (3) the amount of air supplied as regulated by looseness or compactness of manure heap, (4) the composition of the manure, and (5) the kind of preservatives added.

Manure ferments more quickly at higher temperatures. Where air is supplied freely, as on the outside of the heap, the temperature may rise as high as 150° F. or even higher. The most favorable temperature seems to be about 130° F. On the inside of the heap, where the supply of air is very limited, a slower form of fermentation occurs and the temperature rarely goes above 95° F.

If a manure heap is too loose, the fermentation is too rapid. The result is that the humus forming material is destroyed and large proportions of nitrogen escape as ammonia. If, however, the manure is too compact, the fermentation may be so slow as not to decompose the manure enough for its most effective use in the soil.

The amount of moisture in manure is an important factor in controlling the rapidity of fermentation. The addition of water causes reduction of temperature and a corresponding slowless of fermentation. Water, when added in sufficient quantities, also fills up the pores of the heap and serves to exclude air, thus retarding the most active form of fermentation.

Manures which are rich in soluble nitrogen decompose more readily than others which contain less soluble nitrogen. Thus urine decomposes much more rapidly than solid excrement.

Changes Produced by Fermentation.—The principal changes that take place in the more common methods of fermentation or "rotting" of manure may be briefly outlined as follows: (1) The carbon of the manure combines, to a greater or less extent, with the oxygen of the air, forming carbon dioxide (carbonic acid gas), which escapes into the air. (2) The nitrogen combines with hydrogen to form ammonia. If the manure heap is dry, the ammonia combines with carbon dioxide, forming ammonium carbonate, which may escape into the air and be lost to the manure. If the heap is kept moist, certain organic acids are formed by the decomposition of the organic matter, and the ammonia, as fast as it is formed, unites with these acids, producing ammonia salts which readily dissolve in water but which do not escape as gases into the air. (3) Considerable water is driven off from the manure by the heat which is produced in the process of fermentation.

Difference between Fresh and Fermented Stable-Manure.—From the foregoing it would follow that fresh stable-manure differs from fermented or "rotted" stable-manure in the following respects: The fresh manure contains (1) more water, and (2) more carbon than the fermented manure; while (3) both contain the same amount of potash, phosphoric acid and nitrogen, provided the process has been carefully managed. In "rotted" manure, (4) the nitrogen is in a more available form as plant-food; the same is also true of the potash and phosphoric acid.

Loss of Fertilizing Materials in Stable-Manure.—There are two principal ways in which stable-manure commonly loses some of its fertilizing constituents: First, by improper methods of fermentation, and second, by leaching. In regrad to the first point, more or less nitrogen is lost by allowing manure to ferment without sufficient moisture; especially is this apt to be true in the case of horse manure, which decomposes very rapidly. A strong odor coming from a manure heap indicates that a wasteful fermentation is taking place. Only nitrogen compounds can be lost by vaporization. By leaching there will be a loss not only of nitrogen compounds but of potash and phosphoric acid also. The common method of storing farmyard-manure for several months under the eaves of the barn often, if not generally, results in a loss of one-third or more of the fertilizing constituents by leaching; and, moreover, the materials thus leached out bv rain are the more easily soluble portions of the manure and hence the more valuable portions. The manure made by farm animals of New York State each year may safely be estimated as having a value of $100,000,000, and probably quite one-third of this amount is lost as a result of wastefulness in not caring properly for it.

Care and Preservation of Farm-Manures.—In caring for farm manures, the main object is to prevent the loss of compounds containing nitrogen, potash and phosphoric acid. From what has been said above in connection with the sources of loss of fertilizing materials in farm-manures, it can be seen that the sources of loss can be avoided by absorbing the liquid manure, by regulating the process of fermentation and by protecting the manure from leaching. We will consider briefly some of the ways in which these objects can be accomplished.

The use of litter absorbs the liquid manure, preserves it to some extent from immediate decomposition, and also holds more or less of the ammonia produced by fermentation, thus preventing its escape into the air. Of the materials in common use *peat* has the largest power of absorbing and holding liquids; peat-moss comes next; spent tan and saw-dust follow; then come straw and similar materials. It has been given as a safe rule to follow that the litter should at least be equal to one-third of the dry matter of the food consumed. The following daily amounts for different animals have been suggested: Sheep, three-fifths of a pound of litter; cattle, 9 pounds; horses, $6\frac{1}{2}$ pounds. In addition to using litter, it is wise to use some other materials for absorbing and preserving the manure. Among such materials are gypsum (land-plaster), kainit, acid phosphate, etc.

Gypsum (land-plaster) has the power of holding ammonia and preventing its loss. It must, however, be moist in order to be effective. The best way to use gypsum is to sprinkle it on the moist dung or urine. Stables in which the excrements are properly treated by this means are noticeably free from offensive odors, as a rule.

Kainit sprinkled upon manure tends to check fermentation and also to attract and hold moisture. One precaution should be observed in the use of kainit; it should be kept from under the feet of animals, since injury may result to the feet of animals treading on it. It is, therefore, best applied to fresh manure and covered with litter.

Acid Phosphate contains a considerable proportion of gypsum and, to this extent, its action is like that of gypsum. The soluble phosphate in the acid phosphate tends to unite with ammonia and prevent its loss and also to check fermentation.

A mixture of acid phosphate and gypsum is strongly recommended by some, using them in about equal proportions.

For average animals, the following amounts of different preservatives may be used daily for each individual:

KIND OF PRESERVATIVE.	For one horse.	For one cow.	For one pig.	For one sheep.
	Pounds.	Pounds.	Ounces.	Ounces.
Gypsum (land-plaster)	1½	1¾	4½	3½
Acid phosphate	1	1⅛	3	2½
Kainit	1⅛	1¼	4	3¼

When a mixture of superphosphate and gypsum is used, take one-half or one-third of the amounts indicated above. One great advantage in using acid phosphate or kainit is that one is adding to the manure an important form of plant-food, in which the manure is naturally deficient. The price at which one can get these materials must determine whether their use is economical or not.

Mixture of different manures, such as cow and horse manures, is advantageous, since one undergoes fermentation slowly and the other rapidly. When mixed, the conditions of moisture are more easily controlled.

Whether stable-manure is stored in sheds, or in cellars or is protected in some other way, it is important to observe the following precautions: (1) The manure should be spread out uniformly; (2) its interior should be protected against the access of air; (3) it should be kept always moist, but not too wet; (4) it should be protected from sunshine; (5) it should be protected from leaching; (6) some form of preservative should be used in the stables in addition to litter.

Liquid and Solid Manure.— It is not an uncommon belief among farmers that urine is worthless for fertilizing purposes, if we may judge anything from the too general practice of allowing the liquid excrements to run to waste through the barn floor. One has only to glance at the composition of the solid and liquid excrements of different animals as given below to see that the liquid is, in most cases, very much more valuable than the solid portions. Not only are the proportions of nitrogen and potash greater, as a rule, in the liquid excrement than in the solid, but, as already noticed, the fertilizing constituents of urine are entirely soluble and therefore more readily available for plant-food than the constituents of solid excrements.

TABLE SHOWING APPROXIMATE COMPOSITION OF SOLID AND LIQUID MANURES.

	Nitrogen.		Phosphoric Acid.		Potash.	
	Solid.	Liquid.	Solid.	Liquid.	Solid.	Liquid.
Cows	0.29	0.58	0.17	....	0.10	0.49
Horses	0.44	1.55	0.17	....	0.35	1.50
Sheep	0.55	1.95	0.31	0.01	0.15	2.26
Swine	0.60	0.43	0.41	0.07	0.13	0.83

TABLE SHOWING APPROXIMATE COMPOSITION OF MIXED STABLE MANURE.

	Per cent. of nitrogen.	Pounds of nitrogen in one ton.	Per cent. of phosphoric acid.	Pounds of phosphoric acid in one ton.	Per cent. of potash.	Pounds of potash in one ton.
Least	0.4	8	0.2	4	0.4	8
Greatest	0.75	15	0.4	8	0.75	15
Average	0.50	10	0.25	5	0.50	10

XI. The Purchase and Use of Fertilizers.

One of the questions, most commonly addressed to us by farmers seeking information, is, "What fertilizer will give me the best results for this or that crop?" It is, of course, impossible to give any definite answer to such a general question involving, as it does, so many different conditions, none of which is clearly known. The composition and physical properties of the soil, the extent and manner in which it has been previously cropped and fertilized, the kind of crop one wishes to grow, all these conditions need to be known and, even then, it will require some special experimenting on the part of the farmer to determine what forms and amounts of fertilizers he can use most economically. The present almost universal method employed by farmers in this State in selecting fertilizers is to select some brand of complete fertilizer that has been recommended to him by some neighbor or dealer. He has no clear ideas regarding the condition of his soil, and the needs of different crops. He thinks that he must have more fertilizer in order to secure better crops and he buys blindly. Under such circumstances, it is safest, as a rule, for a farmer to select a complete fertilizer. However, in so doing, he may be throwing money away by purchasing what his soil and crop may not need, for only one or two of the three chief fertilizing constituents (nitrogen, potash and phosphoric acid) may be needed; and, indeed, it may be that some physical condition of the soil is wrong and that plant-food of any kind is not really needed at all.

In selecting fertilizers for use, we need to consider several important questions, such as the following:

1. Under what circumstances a fertilizer should be used.
2. What constituents of plant-food are needed.
3. In what forms it is best to buy such plant-food as is needed.
4. What amount of each fertilizing constituent is needed.
5. Specific mixtures for different crops.
6. Which is more advantageous, to purchase complete fertilizers or to purchase separate ingredients?
7. To what extent home-mixing is practicable.
8. Special suggestions in connection with the purchase of separate ingredients.
9. Methods and seasons of applying fertilizers.
10. The most advantageous methods of using farm-produced manures.

1. UNDER WHAT CIRCUMSTANCES SHOULD A COMMERCIAL FERTILIZER BE USED.

One must resort to the use of commercial fertilizers when he has exhausted all of the resources of the farm in producing his own fertilizing materials and finds that the use of commercial fertilizers will result in increased crops and profit. When the farmer's crops can not get from the soil as much nitrogen, potash and phosphoric acid as they need, and when the manure made on the farm can not supply the constituents in sufficient quantity, then one may resort successfully to the use of commercial fertilizers.

However, one must distinguish between lack of plant-food in the soil and other conditions which prevent good crops, for lack of food is not the only cause that makes crops suffer. In some soils there is insufficient porosity, which causes the developement of the roots to be checked. Lack of moisture, caking of soil, retention of stagnant water, deficiency of humus, lime, etc., unfavorable weather and other conditions may interefere with the healthy growth of plants and thus cause diminished crops, even when the plant has within reach all the food it needs. Under such circumstances, the unfavorable conditions must be removed to secure good crops, which, according to the demands of special cases, may be done by irrigating, draining, deep culture, better ploughing, harrowing, hoeing, marling, mucking, etc. It may often happen that the soil contains an abundance of plant-food, most of which is still unavailable. Under such circumstances an effort should be made to bring this food into an available condition as rapidly as the plants can use it, and this may be done by an improved system of tillage, together with the application of such indirect fertilizers as have the power to make insoluble plant-food available, to which attention has already been called.

It will thus be seen that it is not always so simple a matter to tell when one should use commercial fertilizers. But the general rule will be to use them when their use is attended with increased profit coming from increased crops.

2. WHAT CONSTITUENTS OF PLANT-FOOD ARE NEEDED.

When it has been clearly settled that a soil needs the addition of plant-food in order to grow crops more successfully, the question at once presents itself as to what kinds of plant-food are required. Does some form of nitrogen need to be supplied, or is it phosphoric acid that is needed, or is it potash? It may be only one, it may be some two, or it may be all three of these constituents are necessary to grow crops to the best advantage. *How can we ascertain what kind of plant-food is required?*

Analysis of Soils.—It was formerly thought that an analysis of the soil would answer this question beyond doubt. But it is now known not to be especially helpful except, perhaps, in a negative way by making known the fact when there is little or no plant-food in the soil. A chemical analysis may show an abundance of plant-food in the soil, and yet this may be mostly unavailable, a fact which is not readily ascertained by our methods of chemical analysis. Again, there may be an abundance of nitrogen, potash and phosphoric acid compounds in the soil in an available condition, and yet the soil may be unproductive from lack of humus, from need of proper drainage, from lack of porosity, or from some other cause which affects the mechanical or physical condition of the soil in such a way as to unfit it for plant growth. Again, we may put upon an acre of soil an amount of fertilizing constituents that will greatly increase the crop, and yet an analysis of the soil before and after the application will show no appreciable difference in the quantity of plant-food present in the acre of soil. However delicate may be the methods of chemical analysis, the methods of plants are still more delicate and plants are able to show differences in soil where chemical analysis distinguishes none.

Indications of Needs of Soil Afforded by Crops.—It is impossible to give any fixed rules which will cover all cases and enable a farmer to tell without any experiment on his part what food constituents his soil lacks. In a general way, the crops themselves may give some valuable suggestions.

(*a*) As a rule, *lack of nitrogen* is indicated, when plants are pale-green in color, or when there is a small growth of leaf or stalk, other conditions being favorable.

(*b*) A bright, deep green color, with a vigorous growth of leaf or stalk, is, in case of most crops, a sign that *nitrogen is not lacking*, but does not necessarily indicate that more nitrogen could not be used to advantage.

(*c*) An excessive growth of leaf or stalk, accompanied by an imperfect bud, flower, and fruit development, indicates *too much nitrogen* for the potash and phosphoric acid present.

(*d*) When such crops as corn, cabbage, grass, potatoes, etc., have a luxuriant, healthful growth, *an abundance of potash* in the soil is indicated; also, when fleshy fruits of fine flavor and texture can be successfully grown.

(*e*) When a soil produces good, early maturing crops of grain, with plump and heavy kernels, *phosphoric acid will not generally be found deficient* in the soil.

Such general indications may often be most helpful, and crops should be studied carefully with these facts in mind.

Experiments in Ascertaining Needs of Crops.—In order to ascertain with greater certainty what food elements are lacking in the soil, the surest way is for each farmer to do some experimenting on his own soil and crops. Apply different kinds of fertilizing materials in different combinations, using for example, potash compounds alone in one place, phosphoric acid compounds in another, nitrogenous materials in another. Then different combinations can be made on other portions of the crop. Some portions of the field can be left without application of any kind. The results can then be studied in the yield of crop. It is generally found that the application of phosphoric acid gives excellent results on fields which have long been cropped with grain without keeping up the supply of plant-food. In other places, it is found that best results are obtained with application of potash compounds. And many cases require a liberal supply of all three forms of plant-food. In carrying on such field-tests, several difficulties may be met. The season may frequently be such as to interfere seriously with the favorable action of the fertilizing materials applied. Thus, a serious drouth may counteract all other conditions and prevent a satisfactory yield. The difference of mechanical condition of the soil on the same farm or even in the same field may prevent a fair comparison of the action of different kinds of fertilizing materials and elements. But, notwithstanding such difficulties, valuable suggestions will be gained from an experimental study of one's soils through the behavior of the crops.

3. IN WHAT FORMS IS IT BEST TO BUY PLANT-FOOD?

We have previously seen that we can obtain nitrogen in several different forms, such as nitrate of soda, sulphate of ammonia, dried blood, tankage, fish-scrap, etc. Similarly we find in the market phosphoric acid obtained from several different sources, and we also find several different potash compounds. When we come to use fertilizing materials as a source of plant-food, we must decide which specific forms we shall apply. To illustrate, in applying some form of nitrogen, shall we use nitrate of soda, or sulphate of ammonia, or dried blood or fish-scrap? Shall we use as our source of phosphoric acid bone-meal, dissolved bone, acid phosphate, dissolved bone-black or Thomas slag? Shall we apply muriate of potash, or sulphate of potash or carbonate of potash? What principles are there to guide us in making the best choice?

In deciding what form of material to use for plant-food, we should be guided by

(1) The availability of the plant-food,

(2) The preference, if any, shown by different plants, and

(3) The comparative economy possible in purchasing different materials.

Availability of Different Forms of Plant-Food.—As a rule, commercial fertilizers are used for the purpose of increasing the single season's crop to which they are applied. Most farmers plan to give to each succeeding crop by itself the plant-food it needs, and to avoid supplying any one crop with more material than it can use to best advantage. This is especially true of those who do not own the farms which they work and who plan each years' work by itself without reference to the future. Under such circumstances a farmer desires to use those forms of fertilizing materials which will be taken up most quickly and completely by the crops. On the other hand, the farmer who owns his land frequently desires to use materials, the plant-food of which will be utilized gradually by crops and which will last through several seasons. It will thus be seen that if one desires a fertilizer which will act at once and be largely used up by the present crop, then he will need to purchase his plant-food in forms different from those purchased by the man who desires more lasting benefits, extending through several seasons.

We will now consider the relative rapidity with which different forms of nitrogen, phosphoric acid, and potash are available for the use of plants.

Nitrogen in the form of *nitrate of soda* acts most quickly upon plants. Under favorable conditions, its influence upon the plant may be seen within twenty-four hours after its application. In the form of *sulphate of ammonia*, nitrogen acts less rapidly than in that of nitrate of soda, but more quickly than in such forms as *dried blood*, *meat-scrap*, etc. Nitrogen in the form of *bone dust*, *ground fish*, and *bone meal* become available still less rapidly than in the form of dried blood. In the forms of *wool waste*, *ground leather*, and similiar materials, nitrogen becomes available with extreme slowness.

Potash in the form of *carbonate*, as in ashes, acts more rapidly than in the form of *sulphate* or *muriate*. Muriate acts with a little greater rapidity than sulphate, but the difference in availability between the different forms of potash is not nearly as strongly marked as in the case of the different forms of nitrogen.

Phosphoric Acid, in the form of *soluble phosphate* of lime (acid phosphate, superphosphate) acts most rapidly. It acts less rapidly in the form of *reverted* or *precipitated phosphate* of lime, and least rapidly in the *insoluble* form, such as ground rock. According to the weight of evidence, soluble phosphoric acid, whether made from bones, bone-black, or rock, has the same effect and value as plant-food, so far as the soluble phosphoric acid is concerned.

The following tables will serve to give a general idea regarding the length of time fertilizing constituents in some different forms will remain in the soil, or, in other words, regarding the relative availability of the different forms of fertilizing constituents:

On Cultivated Clay Loam.

KIND OF FERTILIZER.	Exhausted [in years].	Per cent. remaining in the soil unexhausted at the end of each of first six years.					
		1	2	3	4	5	6
Lime	12	80	65	55	45	35	25
Bone meal	5	60	30	20	10	00	00
Phosphatic guanos	5	50	30	20	10	00	00
Dissolved bones and plain superphosphates	4	20	10	5	00	00	00
High grade ammoniated fertilizers, guano, etc	3	30	20	00	00	00	00
Cotton seed meal	5	40	30	20	10	00	00
Stable manure	5	60	30	20	10	00	00
On Cultivated Light or Medium Soil.							
Lime	10	75	60	40	30	20	15
Bone meal	4	60	30	10	00	00	00
Phosphatic guanos	4	50	20	10	00	00	00
Dissolved bones and plain superphosphates	3	20	10	5	00	00	00
High grade ammoniated fertilizers, guano, etc	3	30	20	00	00	00	00
Cotton seed meal	4	40	30	20	10	00	00
Stable manure	4	60	30	10	00	00	00
On Cultivated Pasture Land.							
Lime	15	80	70	60	50	45	40
Bone meal	7	60	50	40	30	20	10
Phosphatic guanos	6	50	40	30	20	10	00
Dissolved bones and plain superphosphates	4	30	20	10	00	00	00
High grade ammoniated fertilizers, guanos, etc	4	30	20	10	00	00	00
Cotton seed meal	5	40	30	20	10	00	00
Stable manure	7	60	50	40	30	20	10

Sulphate of ammonia, nitrate of soda, sulphate, nitrate and muriate of potash are generally held to be entirely exhausted by the crops grown the season of their application.

Preferences Shown by Plants for Different Forms of Food.— It is a fact of great interest and importance that one form of a fertilizing constituent is preferred by some plants to the same constituent in another form. This preference is indicated by greater yield or better quality of product or by both. Thus, wheat seems to give better results when nitrogen is applied in the form of nitrate of soda than in any other form. Spinach has been found to do better with sulphate of ammonia than nitrate of soda, while the reverse is true of asparagus. The quality of tobacco is injured by potash in the form of muriate and, hence, only sulphate should be used for fertilizing purposes. The quality of sugar beets and of potatoes appears to be better when sulphate of potash is used, while peach trees are said to prefer the muriate.

Much investigation in this interesting field remains yet to be made. The facts now known are meagre, but so far as known they should be utilized. Whenever a plant shows any marked preference for any special form of food, we should supply that particular form if practicable.

Economy in Purchasing Different Forms of Plant-food.— Other things being equal, we can effect considerable saving in pur chasing fertilizing materials by a careful selection based upon a study of market values.

The most expensive form in which nitrogen is usually purchased is that of sulphate of ammonia. When high-grade sulphate of ammonia sells for $70 a ton, each pound of nitrogen in it costs about 17 cents. When high-grade nitrate of soda sells for $45 a ton, each pound of nitrogen in this form costs about 14⅓ cents. As between these two forms, the nitrogen of one is nearly 3 cents a pound cheaper than the nitrogen of the other, and it will, therefore, be found more economical to use nitrate of soda rather than sulphate of ammonia, when special circumstances do not require the use of the latter. Dried blood, containing 13 per cent. of nitrogen, at $40 a ton furnishes nitrogen at an approximate cost of 14½ cents a pound. The nitrogen in fish-scrap may cost somewhat less. In such forms as wool-waste, ground leather and hair, nitrogen may be purchased at much less, but these forms are not economical when anything like quick returns are desired.

The cheapest possible manner in which farmers can provide their crops with nitrogen is by means of such plants as clover. These plants, as previously explained, can supply themselves with nitrogen from the air, and can thus store up nitrogen for future use in the soil. Nitrogen supplied in this way can be made, to a considerable degree, to take the place of the nitrogen of commercial fertilizers, and at a greatly diminished cost. By such means the use of the most expensive of fertilizing materials can be greatly diminished and much saving effected.

Soluble phosphoric acid can in general be more cheaply purchased in the form of dissolved rock than in the form of dissolved bone or bone-black.

Muriate of potash costs less than sulphate, and is, therefore, more economical when its use answers one's purpose. With the exception of a few crops, like tobacco, sugar beets, and potatoes, muriate of potash can nearly always be used to advantage. Potash in the form of carbonate, as found in wood-ashes, is apt to be somewhat expensive. When ashes contain 5 per cent. of potash and 2 per cent of phosphoric acid and cost $10 a ton, each pound of potash costs about 8 cents, while in the form of muriate of sulphate, the cost would be about one-half. It is easily conceivable, however, that on certain soils the use of ashes might prove economical, owing to their indirect action on the soil. The only way of telling with absolute certainty whether ashes will prove more economical than other forms of potash is to make an actual trial.

In applying fertilizers, bulk is often desirable, but in *purchasing commercial fertilizers, the object should be to secure as much nitrogen, potash and phosphoric acid in available forms as possible for one dollar, instead of as many pounds as possible of fertilizer, regardless of the amount of plant-food contained in it.* This is particulary applicable to mixed fertilizers, which at present form the great bulk of fertilizers sold in this State. Since there is smaller bulk to handle in mixing, a smaller number of packages for holding, and, consequently, less weigth and freight, it is, as a rule, more economical to purchase fertilizers in their more concentrated forms. For illustration, it is more economical to purchase one ton of a high-grade fertilizer than three tons of a low-grade fertilizer, one ton of the former containing the same amount of plant-food contained in three tons of the latter; because, in making the latter, three times as much labor is involved in mixing the goods, three times as many packages are required and three times as much freight must be paid, all for the same amount of plant-food.

4. WHAT AMOUNT OF EACH FERTILIZING CONSTITUENT IS NEEDED.

Inseparably connected with the question of what elements of plant-food are needed is the question, "How much of each element is needed?" Perhaps, the question more often asked than any other relates to the quantities in which fertilizers should be applied. Granting that we know fairly well whether we need to use nitrogen, or phosphoric acid or potash compounds, or some combination of these, how can we ascertain how much to put on an acre of land? This question is quite as complicated as the preceding one. A variety of conditions must be considered. If we knew how much available plant-food there were in an acre of soil, and how much the growing crop would require, the matter would be comparatively simple, provided the mechanical condition of the soil was satisfactory. The form of fertilizing material used would also need consideration.

There are two extremes which we must strive to avoid. On the one hand, we can assume that the supply of food in the soil is fairly abundant and make only small additions, thus running the risk of using too small amounts for growing a good crop. On the other hand, we may assume that the supply of food in the soil is decidedly deficient and put on quantities of fertilizing material sufficient in itself to grow a good crop. In this case, we run the risk of putting on more than the present crop needs. If we can not hit upon the desired medium, putting on amounts that will grow the best crop most economically without leaving too much plant-food over, it is better to make the mistake of putting on too much than too little. While only individual experimenting can determine in each case how much nitrogen, potash, and phosphoric acid can be used to best advantage, we can give some suggestions that may be helpful as a guide. We will, therefore, consider some of the conditions which determine the amount of fertilizer to be employed in raising crops most economically.

How Can We Determine the Amount of Available Plant-Food Present in the Soil?—As previously pointed out, this can not be satisfactorily determined by a chemical analysis of the soil. It can really be done only in an indirect way and even then only approximately; and that is by comparing the behavior of crops upon untreated portions of soil with the same crops on other portions of the same soil treated with different quantities of fertilizing materials.

The Kind of Crop Grown.— It is a well-known fact that different crops need different quantities of nitrogen, potash and phosphoric acid compounds. If we know with a fair degree of accuracy how many pounds of nitrogen, potash and phosphoric acid a crop of any kind will remove from the soil, then we have fairly definite knowledge of the amounts of different forms of plant-food to apply to the soil to insure a crop. If we could not depend upon the soil to furnish any plant-food, then we should use, at least, the amounts of fertilizing materials removed by one crop.

In the following table, we give the number of pounds of nitrogen, phosphoric acid and potash used by different kinds of crops grown on one acre of land. The yields have been made variable within fairly wide limits so as to cover most cases found in actual experience. The calculations are based upon the most reliable analyses available.

In studying this table, we must keep in mind that the figures do not in every case represent the amount of plant-food removed from the soil. Thus, with clovers, beans, peas and other leguminous crops, a portion of the nitrogen is obtained from the air and hence we need to apply less nitrogen in the form of fertilizer than appears to be called for by the table. In the case of fruits, like apples, pears, plums, etc., it will be found safe often to apply larger quantities than the table calls for, because the figures in the table do not indicate the demands made by the tree in increasing its growth :

AMOUNT OF FERTILIZING MATERIALS CONTAINED IN ONE CROP GROWN ON ONE ACRE.

KIND OF CROP.	Yield of grain, fruit, etc.	Yield of straw, etc.	Pounds of nitrogen.	Pounds of phosphoric acid.	Pounds of potash.
Apples	10 to 20 tons	....	26 to 52	2 to 4	40 to 80
Barley	20 to 40 bushels	1,350 to 2,700 pounds	37 to 74	11.5 to 23	34 to 68
Beans	20 to 40 bushels	1,800 to 3,600 pounds	50 to 100	20 to 40	35 to 70
Buckwheat	15 to 30 bushels	1,200 to 2,400 pounds	26.5 to 53	10.5 to 21	30 to 60
Cabbage	15 to 30 tons	....	100 to 200	35 to 70	135 to 270
Clover, crimson (green)	....	7½ to 15 tons	65 to 130	20 to 40	70 to 140
Clover, red (hay)	....	1 to 2 tons	41 to 82	9 to 18	44 to 88
Corn	30 to 60 bushels	2,500 to 5,000 pounds	42 to 84	16 to 32	17 to 34
Grapes	1 to 2 tons	3,000 to 6,000 pounds	7 to 14	18 to 36	26 to 52
Hops (whole crop)	1,600 to 3,200 pounds	....	40 to 80	28 to 56	32 to 64
Mixed hay	....	1 to 2½ tons	28 to 70	7 to 17.5	31 to 77
Oats	30 to 60 bushels	1,600 to 3,200 pounds	30 to 60	11 to 22	25 to 50
Onions	350 to 700 bushels	....	28 to 56	10 to 20	20 to 40
Pears	8 to 16 tons	....	16 to 32	5 to 10	13 to 26
Peas	15 to 30 bushels	1,500 to 3,000 pounds	54 to 108	16.5 to 33	26 to 52
Plums	4 to 8 tons	....	15 to 30	2 to 4	20 to 40
Potatoes	100 to 200 bushels	750 to 1,500 pounds	16.5 to 33	10 to 20	31 to 62
Rye	15 to 30 bushels	2,100 to 4,200 pounds	24.5 to 49	13 to 26	21 to 42
Sugar beets	300 to 600 bushels	3,000 to 6,000 pounds	55 to 110	20 to 40	95 to 190
Timothy hay	....	1 to 2 tons	25 to 50	10 to 20	30 to 60
Tobacco	800 to 1,600 lbs. leaves	700 to 1,400 pounds stems	38 to 76	8 to 16	100 to 200
Tomatoes	5 to 10 tons	....	16 to 32	10 to 20	27 to 54
Turnips	350 to 700 bushels	2½ to 5 tons	40 to 80	26 to 52	90 to 180
Wheat	15 to 30 bushels	1,600 to 3,200 pounds	31 to 62	10 to 20	13 to 26

An examination of the foregoing table justifies the assertion, when we consider all the conditions, that the smallest amounts of plant-food we can expect to use on an acre of land with any satisfactory results are the following:

10 pounds of nitrogen.
15 pounds of available phosphoric acid.
20 pounds of potash.

To state this in another form, the foregoing amounts of nitrogen would be contained in 200 pounds of a fertilizer having the following composition:

Nitrogen, 5 per cent.
Available phosphoric acid, 7½ per cent.
Potash, 10 per cent.

This would be regarded as a high-grade fertilizer and on some soils an application of 200 pounds an acre would be considered large, while on others it would be entirely insufficient. The above rule will probably be found fairly safe to follow in fertilizing average crops, when we know nothing at all in regard to soil or crops.

5. SPECIFIC MIXTURES FOR DIFFERENT CROPS.

We will now consider under a separate head in a more specific manner the quantities of different forms of plant-food that can be applied to advantage to one acre of land for different crops.

We must make it clearly understood at the start that no rigidly fixed formulas can be given for any one crop on all soils. The question of quantity of application and of proportion must always, in the very nature of the case, remain more or less a matter of individual experiment. Every field is constantly changing in the extent and character of its needs. The farmer must constantly study results and let the experience of one year suggest to him his plan for the year following. With this preliminary precaution, it may be of interest to consider briefly what has ordinarily been the method of procedure in determining the proportions of nitrogen, phosphoric acid and potash in making fertilizers for different crops.

In making formulas, it was first proposed to make the formula correspond to the analysis of the plant. This method was practiced for some time, when it was found that there was already in the soil more or less available plant-food and that fertilizing material was often applied where one or more constituents could be omitted or reduced in quantity. It was then suggested that soil analysis should form the basis of determining the needs of the soil in different crops, but this failed to produce satisfactory results. The formulas at present used by many have been based, in part, upon the composition of the plant and, in part, upon the actual field-tests.

The amount of nitrogen called for by analysis of plants is generally reduced, because we can depend upon the soil to furnish a considerable amount. In case of leguminous crops, the amount of nitrogen which we need to supply can be reduced to a small fraction of what the plant will use, because such crops can draw their main supply of nitrogen from the air.

The amount of soluble phosphoric acid is originally increased above what plant analysis calls for, because the solubility is more or less decreased after the fertilizer comes into contact with the soil.

The formulas given in the pages following have been drawn from such various sources as could be considered reliable.

In will be noticed that, in giving the amount of fertilizer material to put on one acre of land, a variable rather than a fixed amount is given. To illustrate, instead of prescribing 100 pounds of nitrate of soda for a certain crop, we give the amount as "100 to 200 pounds." This means that, if the land is in good condition, 100 pounds may answer, but if in poor condition, more should be used up to 200 pounds. Thus, it will be seen that even with the most specific directions that can be given, much must be left to the individual for experiment.

The materials which are given for use in the following pages are assumed to have a fairly definite composition and our calculations are based on the following conditions of composition:

(1) Nitrate of soda, 95 to 96 per cent. pure, containing 16 per cent. of nitrogen.

(2) Dried blood, containing 10 per cent. of nitrogen.

(3) Sulphate of ammonia, containing 20 per cent. of nitrogen.

(4) Stable-manure, containing .5 per cent. of nitrogen.

(5) Bone-meal, containing 20 per cent. of total phosphoric acid, one-half being calculated as available during first season on application; also containing 4 per cent. of nitrogen.

Whenever bone-meal is used in a mixture, allowance should be make for its nitrogen and so much less of other forms of nitrogen-materials used.

(6) Dissolved bone, containing 15 per cent. of available phosphoric acid and 3 per cent. of nitrogen.

(7) Dissolved bone-black, containing 15 per cent. of available phosphoric acid.

(8) Dissolved rock, containing 12 per cent. of available phosphoric acid.

(9) Muriate of potash, 80 per cent. pure, containing 50 per cent. of potash.

(10) Sulphate of potash, 90 to 95 per cent. pure, containing 50 per cent. of potash.

(11) Kainit, containing 12 to 13 per cent. of potash.

(12) Wood-ashes, containing 5 per cent. of potash.

ALFALFA.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	1	5 to 10	(1) 30 to 60 lbs. nitrate of soda; or (2) 25 to 50 lbs. sulphate of ammonia; or (3) 50 to 100 lbs dried blood; or (4) 1,000 to 2,000 lbs. stable manure.
Available phosphoric acid	8	30 to 60	(1) 300 to 600 lbs. bone-meal; or (2) 200 to 400 lbs. dissolved bone-meal or bone-black; or (3) 250 to 500 lbs. dissolved rock.
Potash	10	40 to 80	(1) 80 to 160 lbs. muriate; or (2) 80 to 160 lbs. sulphate; or (3) 325 to 650 lbs. kainit; or (4) 800 to 1,600 lbs. wood-ashes.

Suggestions.— Like clover, alfalfa needs only small applications of nitrogen, because it can obtain nitrogen from the air. A liberal supply of phosphoric acid and potash compounds needs to be applied from time to time, the application being made preferably in the fall or early winter. Lime needs to be present in the soil in liberal proportions. When deficient, it can be applied in the form of ground limestone, chalk or marl at the rate of one to three tons an acre, and preferably two or three years before sowing crop.

APPLES.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.	Pounds of different materials for one tree.
Nitrogen	2	8 to 16	(1) 50 to 100 lbs. nitrate of soda; or (2) 40 to 80 lbs. sulphate of ammonia; or (3) 80 to 160 lbs. dried blood; or (4) 1,600 to 3,200 lbs. stable manure.	(1) 1 to 2 lbs. nitrate of soda; or (2) ¾ to 1½ lbs. sulphate of ammonia; or (3) 1½ to 3 lbs. dried blood; or (4) 35 to 70 lbs. stable manure.
Available phosphoric acid	8	30 to 60	(1) 300 to 600 lbs. bone meal; or (2) 200 to 400 lbs. dissolved bone meal or bone black; or (3) 250 to 500 lbs. dissolved rock.	(1) 6 to 12 lbs. bone meal; or (2) 4 to 8 lbs. dissolved bone or bone-black; or (3) 5 to 10 lbs. dissolved rock.
Potash	12	50 to 100	(1) 100 to 200 lbs. muriate; or (2) 100 to 200 lbs. sulphate; or (3) 400 to 800 lbs. kainit; or (4) 1,000 to 2,000 lbs. wood-ashes.	(1) 2 to 4 lbs. muriate; or (2) 2 to 4 lbs. sulphate; or (3) 8 to 16 lbs. kainit; or (4) 20 to 40 lbs. wood-ashes.

Suggestions.—Excessive application of nitrogen compounds to apple orchards is to be avoided because it favors rank growth of tree at the expense of fruit. Fruit trees in bearing require annual application of fertilizers for best results. Applications may be made in fall or spring.

ASPARAGUS.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	5	20 to 40	(1) 120 to 240 lbs. nitrate of soda; or (2) 200 to 400 lbs. dried blood; or (3) 4,000 to 8,000 lbs. stable manure.
Available phosphoric acid	7	30 to 60	(1) 300 to 600 lbs. bone-meal; or (2) 200 to 400 lbs. dissolved bone-meal or bone-black; or (3) 250 to 500 lbs. dissolved rock.
Potash	9	35 to 70	(1) 70 to 140 lbs. muriate; or (2) 70 to 140 lbs. sulphate; or (3) 300 to 600 lbs. kainit; or (4) 700 to 1,400 lbs. wood-ashes.

Suggestions.—Stable manure may be applied every two or three years in the fall after removing plants, and also every year a dressing of phosphoric acid and potash. Nitrate of soda is applied to best advantage in the spring, just as the shoots begin to appear.

BARLEY.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	4	12 to 24	(1) 75 to 150 lbs. nitrate of soda; or (2) 50 to 120 lbs. sulphate of ammonia; or (3) 125 to 250 lbs. dried blood; or (4) 2,500 to 5,000 lbs. stable manure.
Available phosphoric acid	7	20 to 40	(1) 200 to 400 lbs. bone-meal; or (2) 150 to 300 lbs. dissolved bone or bone-black; or (3) 175 to 350 lbs. dissolved rock.
Potash	8	25 to 50	(1) 50 to 100 lbs. muriate; or (2) 50 to 100 lbs. sulphate; or (3) 200 to 400 lbs. kainit; or (4) 500 to 1,000 lbs. wood-ashes.

Suggestions.—Excess of nitrogen as found in stable manure is to be avoided, because the quality of the grain may be injured.

BEANS.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	1	5 to 10	(1) 30 to 60 lbs. nitrate of soda; or (2) 25 to 50 lbs. sulphate of ammonia; or (3) 50 to 100 lbs. dried blood; or (4) 1,000 to 2,000 lbs. stable manure.
Available phosphoric acid...	7	30 to 60	(1) 300 to 600 lbs. bone meal; or (2) 200 to 400 lbs. dissolved bone or bone black; or (3) 250 to 500 lbs. dissolved rock.
Potash	9	35 to 70	(1) 70 to 140 lbs. muriate; or (2) 70 to 140 lbs. sulphate; or (3) 300 to 600 lbs. kainit; or (4) 700 to 1,400 lbs. wood ashes.

Suggestions.—The formula given above applies to beans grown for the seeds. When beans are grown to be eaten green, as for string-beans, three or four times as much nitrogen should be applied as for example 100 to 200 pounds of nitrate of soda for one acre; this is applied preferably in three or four portions at different times rather than all at once. The extra application of nitrogen will develop the foliage and pods and retard ripening.

BEETS.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	5	20 to 40	(1) 120 to 240 lbs. nitrate of soda; or (2) 100 to 200 lbs. sulphate of ammonia; or (3) 200 to 400 lbs. dried blood; or (4) 4,000 to 8,000 lbs. stable manure.
Available phosphoric acid...	6	25 to 50	(1) 250 to 500 lbs. bone meal; or (2) 175 to 350 lbs. dissolved bone or bone black; or (3) 200 to 400 lbs. dissolved rock.
Potash	9	35 to 70	(1) 70 to 140 lbs. muriate; or (2) 70 to 140 lbs. sulphate; or (3) 300 to 600 lbs. kainit; or (4) 700 to 1,400 lbs. wood ashes.

Suggestions.—When beets are grown for sugar, potash is preferably used in the form of sulphate. In growing beets for garden or feeding purposes, somewhat less nitrogen can be used.

BLACKBERRIES.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen........	3	15 to 30	(1) 100 to 200 lbs. nitrate of soda; or (2) 75 to 150 lbs. sulphate of ammonia; or (3) 150 to 300 lbs. dried blood; or (4) 3,000 to 6,000 lbs. stable manure.
Available phosphoric acid...	6	30 to 60	(1) 300 to 600 lbs. bone-meal; or (2) 200 to 400 lbs. dissolved bone or bone-black; or (3) 250 to 500 lbs. dissolved rock.
Potash..........	8	40 to 80	(1) 80 to 160 lbs. muriate; or (2) 80 to 160 lbs. sulphate; or (3) 300 to 600 lbs. kainit; or (4) 800 to 1,600 lbs. wood-ashes.

BUCKWHEAT.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen.......	4	15 to 30	(1) 90 to 180 lbs. nitrate of soda; or (2) 75 to 150 lbs. sulphate of ammonia; or (3) 150 to 300 lbs. dried blood; or (4) 3,000 to 6,000 lbs. stable manure.
Available phosphoric acid...	8	30 to 60	(1) 300 to 600 lbs. bone-meal; or (2) 200 to 400 lbs. dissolved bone or bone-black; or (3) 250 to 500 lbs. dissolved rock.
Potash..........	9	35 to 70	(1) 70 to 140 lbs. muriate; or (2) 70 to 140 lbs. sulphate; or (3) 300 to 600 lbs. kainit; or (4) 700 to 1,400 lbs. wood-ashes.

CABBAGE.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen.......	4	40 to 80	(1) 250 to 500 lbs. nitrate of soda; or (2) 200 to 400 lbs. sulphate of ammonia; or (3) 400 to 800 lbs. dried blood; or (4) 8,000 to 16,000 lbs. stable manure.
Available phosphoric acid...	7	70 to 140	(1) 700 to 1,400 lbs. bone-meal; or (2) 500 to 1,000 lbs. dissolved bone or bone-black; or (3) 600 to 1,200 lbs. dissolved rock.
Potash..........	9	90 to 180	(1) 180 to 360 lbs. muriate; or (2) 180 to 360 lbs. sulphate; or (3) 700 to 1,400 lbs. kainit; or (4) 1,800 to 3,600 lbs. wood-ashes.

CARROTS.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	3	15 to 30	(1) 90 to 180 lbs. nitrate of soda; or (2) 75 to 150 lbs. sulphate of ammonia; or (3) 150 to 300 lbs. dried blood; or (4) 3,000 to 6,000 lbs. stable-manure.
Available phosphoric acid...	7	35 to 70	(1) 350 to 700 lbs. bone-meal; or (2) 250 to 500 lbs. dissolved bone or bone-black; or (3) 300 to 600 lbs. dissolved rock.
Potash	8	40 to 80	(1) 80 to 160 lbs. muriate; or (2) 80 to 160 lbs. sulphate; or (3) 300 to 600 lbs. kainit; or (4) 800 to 1,600 lbs. wood-ashes.

Suggestions.—When stable manure is used, it is preferably applied to the land the preceding year.

CAULIFLOWER.

Same as for cabbage.

CELERY.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	5	40 to 80	(1) 250 to 500 lbs. nitrate of soda; or (2) 200 to 400 lbs. sulphate of ammonia; or (3) 400 to 800 lbs. dried blood; or (4) 8,000 to 16,000 lbs. stable-manure.
Available phosphoric acid...	6	50 to 100	(1) 500 to 1,000 lbs. bone meal; or (2) 350 to 700 lbs. dissolved bone or bone-black; or (3) 400 to 800 lbs. dissolved rock.
Potash	8	65 to 130	(1) 130 to 260 lbs. muriate; or (2) 130 to 260 lbs. sulphate; or (3) 500 to 1,000 lbs. kainit; or (4) 1,300 to 2,600 lbs. wood ashes.

Suggestions.—On muck soils the amount of nitrogen may be decreased and that of potash increased. The direct application of stable-manure has been found often to produce rusty celery.

CHERRIES.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.	Pounds of different materials for one tree.
Nitrogen	2	10 to 20	(1) 60 to 120 lbs. nitrate of soda; or	(1) ½ to 1 lb. nitrate of soda; or
			(2) 50 to 100 lbs. sulphate of ammonia; or	(2) ½ to 1 lb. sulphate of ammonia; or
			(3) 100 to 200 lbs. dried blood; or	(3) 1 to 2 lbs. dried blood; or
			(4) 2,000 to 4,000 lbs. stable manure.	(4) 20 to 40 lbs. stable manure.
Available phosphoric acid	7	35 to 70	(1) 350 to 700 lbs. bone meal; or	(1) 3½ to 7 lbs. bone meal; or
			(2) 250 to 500 lbs. dissolved bone, etc.; or	(2) 2½ to 5 lbs. dissolved bone, etc.; or
			(3) 300 to 600 lbs. dissolved rock.	(3) 3 to 6 lbs. dissolved rock.
Potash	9	45 to 90	(1) 90 to 180 lbs. muriate; or	(1) 1 to 2 lbs. muriate; or
			(2) 90 to 180 lbs. sulphate; or	(2) 1 to 2 lbs. sulphate; or
			(3) 350 to 700 lbs. kainit; or	(3) 3½ to 7 lbs. kainit; or
			(4) 900 to 1,800 lbs. wood ashes.	(4) 9 to 18 lbs. wood ashes.

CLOVER.

Same as for alfalfa.

CORN.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	2	10 to 20	(1) 60 to 120 lbs. nitrate of soda; or (2) 50 to 100 lbs. sulphate of ammonia; or (3) 100 to 200 lbs. dried blood; or (4) 2,000 to 4,000 lbs. stable manure.
Available phosphoric acid	7	35 to 70	(1) 350 to 700 lbs. bone-meal; or (2) 250 to 500 lbs. dissolved bone, etc.; or (3) 300 to 600 lbs. dissolved rock.
Potash	6	30 to 60	(1) 60 to 120 lbs. muriate; or (2) 60 to 120 lbs. sulphate; or (3) 250 to 500 lbs. kainit; or (4) 600 to 1,200 lbs. wood-ashes.

Suggestions.— The nitrogen may be applied to advantage in the form of stable-manure, especially if the soil is at all lacking in humus.

For sweet corn, somewhat larger amounts of nitrogen may be applied.

CUCUMBERS.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	4	30 to 60	(1) 180 to 360 lbs. nitrate of soda; or (2) 150 to 300 lbs. sulphate of ammonia; or (3) 300 to 600 lbs dried blood; or (4) 6,000 to 12,000 lbs. stable manure.
Available phosphoric acid	6	50 to 100	(1) 500 to 1,000 lbs. bone meal; or (2) 350 to 700 lbs. dissolved bone, etc.; or (3) 400 to 800 lbs. dissolved rock.
Potash	8	65 to 130	(1) 130 to 260 lbs. muriate; or (2) 130 to 260 lbs. sulphate; or (3) 500 to 1,000 lbs. kainit; or (4) 1,300 to 26,000 lbs. wood-ashes.

Suggestions.— Too much nitrogen is to be avoided as there will be a tendency to excessive growth of vines, and the fruit will be less firm and more likely to decay. Sulphate of ammonia will often give better results than the more quickly acting nitrate of soda, as the period of growth will be longer and the yield larger. Stable-manure, when used, is preferably applied in fall, followed by sulphate of ammonia in the spring. The potash may be applied in the fall. The phosphoric acid may be applied one-half in the fall and the rest in the spring.

CURRANTS.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	2	10 to 20	(1) 60 to 120 lbs. nitrate of soda; or (2) 50 to 100 lbs. sulphate of ammonia; or (3) 100 to 200 lbs. dried blood; or (4) 2,000 to 4,000 lbs. stable manure.
Available phosphoric acid...	5	25 to 50	(1) 250 to 500 lbs. bone-meal; or (2) 175 to 350 lbs. dissolved bone, etc.; or (3) 200 to 400 lbs. dissolved rock.
Potash	8	40 to 80	(1) 80 to 160 lbs. muriate; or (2) 80 to 160 lbs. sulphate; or (3) 320 to 640 lbs. kainit; or (4) 800 to 1,600 lbs. wood-ashes.

EGG-PLANT.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	4	40 to 80	(1) 240 to 480 lbs. nitrate of soda; or (2) 200 to 400 lbs. sulphate of ammonia; or (3) 400 to 800 lbs. dried blood; or (4) 8,000 to 16,000 lbs. stable manure.
Available phosphoric acid...	5	50 to 100	(1) 500 to 1,000 lbs. bone-meal; or (2) 350 to 700 lbs. dissolved bone, etc; or (3) 400 to 800 lbs. dissolved rock.
Potash	9	90 to 180	(1) 180 to 360 lbs. muriate; or (2) 180 to 360 lbs. sulphate; or (3) 700 to 1,400 lbs. kainit; or (4) 1,800 to 3,600 lbs. wood-ashes.

FLAX.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	3	10 to 20	(1) 60 to 120 lbs. nitrate of soda; or (2) 50 to 100 lbs. sulphate of ammonia; or (3) 100 to 200 lbs. dried blood; or (4) 2,000 to 4,000 lbs. stable manure.
Available phosphoric acid	8	25 to 50	(1) 250 to 500 lbs. bone meal; or (2) 175 to 350 lbs. dissolved bone or bone-black; or (3) 200 to 400 lbs. dissolved rock.
Potash	9	30 to 60	(1) 60 to 120 lbs. muriate; or (2) 60 to 120 lbs. sulphate; or (3) 250 to 500 lbs. kainit; or (4) 600 to 1,200 lbs. wood ashes.

GOOSEBERRIES.

Same as currants.

GRAPES.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	2	8 to 16	(1) 50 to 100 lbs. nitrate of soda; or (2) 40 to 80 lbs. sulphate of ammonia; or (3) 80 to 160 lbs. dried blood; or (4) 1,600 to 3,200 lbs. stable manure.
Available phosphoric acid	8	30 to 60	(1) 300 to 600 lbs. bone meal; or (2) 200 to 400 lbs. dissolved bone, etc.; or (3) 250 to 500 lbs. dissolved rock.
Potash	11	45 to 90	(1) 90 to 180 lbs. muriate; or (2) 90 to 180 lbs, sulphate; or (3) 350 to 700 lbs. kainit; or (4) 900 to 1,800 lbs. wood-ashes.

Suggestions.—Much of the nitrogen can be supplied by growing clover between rows and turning under. Excessive use of stable-manure is believed to produce a growth of weakened vitality, not able readily to withstand attacks of fungous diseases. Once in a few years lime may be applied to advantage.

GRASS FOR PASTURES.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	2	15 to 30	(1) 90 to 180 lbs. nitrate of soda; or (2) 75 to 150 lbs. sulphate of ammonia; or (3) 150 to 300 lbs. dried blood; or (4) 3,000 to 6,000 lbs. stable-manure.
Available phosphoric acid...	8	30 to 60	(1) 300 to 600 lbs. bone-meal; or (2) 200 to 400 lbs. dissolved bone, etc.; or (3) 250 to 500 lbs. dissolved rock.
Potash	10	40 to 80	(1) 80 to 160 lbs. muriate; or (2) 80 to 160 lbs. sulphate; or (3) 275 to 550 lbs. kainit; or (4) 800 to 1,600 lbs. wood-ashes.

Suggestions.—It is probable that the droppings from animals will furnish most of the nitrogen needed, but pains should be taken occasionally to run some kind of smoothing harrow over the ground to distribute the droppings evenly.

GRASS FOR LAWNS.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	5	20 to 40	(1) 120 to 240 lbs. nitrate of soda; or (2) 100 to 200 lbs. sulphate of ammonia; or (3) 200 to 400 lbs. dried blood; or (4) 4,000 to 8,000 lbs. stable manure.
Available phosphoric acid ...	6	25 to 50	(1) 250 to 500 lbs. bone-meal; or (2) 175 to 350 lbs. dissolved bone, etc.; or (3) 200 to 400 lbs. dissolved rock.
Potash	8	30 to 60	(1) 60 to 120 lbs. muriate; or (2) 60 to 120 lbs. sulphate; or (3) 250 to 500 lbs. kainit; or (4) 600 to 1,200 lbs. wood-ashes.

Suggestions.—As a more specific mixture, we suggest the following: 100 lbs. nitrate of soda, 100 lbs. bone-meal, 100 lbs. acid phosphate (dissolved rock), and 100 lbs. muriate of potash an acre.

Grass for Meadows.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	4	15 to 30	(1) 90 to 180 lbs. nitrate of soda; or (2) 75 to 150 lbs. sulphate of ammonia; or (3) 150 to 300 lbs. dried blood; or (4) 3,000 to 6,000 lbs. stable-manure.
Available phosphoric acid	7	30 to 60	(1) 300 to 600 lbs. bone-meal; or (2) 200 to 400 lbs. dissolved bone, etc.; or (3) 250 to 500 lbs. dissolved rock.
Potash	9	35 to 70	(1) 70 to 140 lbs. muriate; or (2) 70 to 140 lbs. sulphate; or (3) 275 to 550 lbs. kainit; or (4) 700 to 1,400 lbs. wood-ashes.

Suggestions.— The fact can not be too strongly emphasized that meadows from which the grass is cut year after year should be regularly fertilized every year in a liberal manner.

Hops.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	3	20 to 40	(1) 120 to 240 lbs. nitrate of soda; or (2) 100 to 200 lbs. sulphate of ammonia; or (3) 200 to 400 lbs. dried blood; or (4) 4,000 to 8,000 lbs. stable-manure.
Available phosphoric acid	6	35 to 70	(1) 350 to 700 lbs. bone-meal; or (2) 250 to 500 lbs. dissolved bone, etc.; or (3) 275 to 550 lbs. dissolved rock.
Potash	12	100 to 200	(1) 200 to 400 lbs. muriate; or (2) 200 to 400 lbs. sulphate; or (3) 800 to 1,600 lbs. kainit; or (4) 2,000 to 4,000 lbs. wood-ashes.

HORSE RADISH.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	4	15 to 30	(1) 90 to 180 lbs. nitrate of soda; or (2) 75 to 150 lbs. sulphate of ammonia; or (3) 150 to 300 lbs. dried blood; or (4) 3,000 to 6,000 lbs. stable manure.
Available phosphoric acid...	6	25 to 50	(1) 250 to 500 lbs. bone-meal; or (2) 175 to 350 lbs. dissolved bone, etc.; or (3) 200 to 400 lbs. dissolved rock.
Potash	9	35 to 70	(1) 70 to 140 lbs. muriate; or (2) 70 to 140 lbs. sulphate; or (3) 275 to 550 lbs. kainit; or (4) 700 to 1,400 lbs. wood-ashes.

LETTUCE.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	5	40 to 80	(1) 250 to 500 lbs. nitrate of soda; or (2) 200 to 400 lbs. sulphate of ammonia; or (3) 400 to 800 lbs. dried blood; or (4) 8,000 to 16,000 lbs. stable manure.
Available phosphoric acid...	6	50 to 100	(1) 500 to 1,000 lbs. bone-meal; or (2) 350 to 700 lbs. dissolved bone, etc.; or (3) 400 to 800 lbs. dissolved rock.
Potash	9	75 to 150	(1) 150 to 300 lbs. muriate; or (2) 150 to 300 lbs. sulphate; or (3) 600 to 1,200 lbs. kainit; or (4) 1,500 to 3,000 lbs. wood-ashes.

Suggestions.— When lettuce is grown under glass, use about half as much nitrogen and a half more phosphoric acid and potash than indicated above.

MILLET.

Same as for meadow grass.

MUSKMELONS.

Same as for cucumbers.

NURSERY STOCK.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	3	10 to 20	(1) 60 to 120 lbs. nitrate of soda; or (2) 50 to 100 lbs. sulphate of ammonia; or (3) 100 to 200 lbs. dried blood; or (4) 2,000 to 4,000 lbs. stable manure.
Available phosphoric acid...	6	25 to 50	(1) 250 to 500 lbs. bone-meal; or (2) 175 to 350 lbs. dissolved bone, etc.; or (3) 200 to 400 lbs. dissolved rock.
Potash	7	30 to 60	(1) 60 to 120 lbs. muriate; or (2) 60 to 120 lbs. sulphate; or (3) 240 to 480 lbs. kainit; or (4) 600 to 1,200 lbs. wood-ashes.

Suggestions.— Excess of nitrogen produces a rapid but weak growth of wood.

OATS.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	4	12 to 24	(1) 75 to 150 lbs. nitrate of soda; or (2) 60 to 120 lbs. sulphate of ammonia; or (3) 120 to 240 lbs. dried blood; or (4) 2,500 to 5,000 lbs. stable manure.
Available phosphoric acid...	6	20 to 40	(1) 200 to 400 lbs. corn-meal; or (2) 140 to 280 lbs. dissolved bone, etc.; or (3) 160 to 320 lbs. dissolved rock.
Potash	9	30 to 60	(1) 60 to 120 lbs. muriate; or (2) 60 to 120 lbs. sulphate; or (3) 250 to 500 lbs. kainit; or (4) 600 to 1,200 lbs. wood-ashes.

ONIONS.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	5	45 to 90	(1) 270 to 540 lbs. nitrate of soda; or (2) 225 to 450 lbs. sulphate of ammonia; or (3) 450 to 900 lbs. dried blood; or (4) 9,000 to 18,000 lbs. stable manure.
Available phosphoric acid...	6	55 to 110	(1) 550 to 1,100 lbs. bone-meal; or (2) 385 to 770 lbs. dissolved bone, etc.; or (3) 450 to 900 lbs. dissolved rock.
Potash	9	80 to 160	(1) 160 to 320 lbs. muriate; or (2) 160 to 320 lbs. sulphate; or (3) 650 to 1,300 lbs. kainit; or (4) 1,600 to 3,200 lbs. wood-ashes.

Suggestions.— Fresh stable-manure is to be avoided on account of weed-seeds and also a tendency to favor the growth of onion maggots. Stable-manure is preferably used in soil two years before planting onions. An excess of nitrogen delays the ripening and injures the keeping qualities of onions.

PARSNIPS.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	3	20 to 40	(1) 120 to 240 lbs. nitrate of soda; or (2 100 to 200 lbs. sulphate of ammonia; or (3) 200 to 400 lbs. dried blood; or (4) 4,000 to 8,000 lbs. stable-manure.
Available phosphoric acid	9	55 to 110	(1) 550 to 1,100 lbs. bone-meal; or (2) 375 to 750 lbs. dissolved bone, etc.; or (3) 450 to 900 lbs. dissolved rock.
Potash	8	50 to 100	(1) 100 to 200 lbs. muriate; or (2) 100 to 200 lbs. sulphate; or (3) 400 to 800 lbs. kainit; or)4) 1,000 to 2,000 lbs. wood-ashes.

Suggestions.— Stable-manure, when used, is preferably applied during preceding year.

PEACHES.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	2	15 to 30	(1) 90 to 180 lbs. nitrate of soda; or (2) 75 to 150 lbs. sulphate of ammonia; or (3) 150 to 300 lbs. dried blood; or (4) 3,000 to 6,000 lbs. stable manure.
Available phosphoric acid	5	40 to 80	(1) 400 to 800 lbs. bone-meal; or (2) 280 to 560 lbs. dissolved bone, etc.; or (3) 320 to 640 lbs. dissolved rock.
Potash	7	55 to 110	(1) 110 to 220 lbs. muriate; or (2) 110 to 220 lbs. sulphate; or (3) 450 to 900 lbs. kainite; or (4) 1,100 to 2,200 lbs. wood-ashes.

Suggestions.— Much of the nitrogen may be furnished by raising leguminous crops between the rows of trees and turning under for green manure. It is claimed that large applications of potash enable the trees more readily to withstand the disease known as "peach yellows."

Pears.

Same as for apples.

Peas.

Same as for beans.

Suggestions.—When peas are raised for picking green, larger amounts of nitrate of soda can be used to advantage.

Plums.

Same as for cherries.

Potatoes.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	.4	30 to 60	(1) 180 to 360 lbs. nitrate of soda; or (2) 150 to 300 lbs. sulphate of ammonia; or (3) 300 to 600 lbs. dried blood.
Available phosphoric acid	6	40 to 80	(1) 400 to 800 lbs. bone-meal; or (2) 275 to 550 lbs. dissolved bone, etc.; or (3) 325 to 650 lbs. dissolved rock.
Potash	9	65 to 130	(1) 130 to 260 lbs. muriate; or (2) 130 to 260 lbs. sulphate; or (3) 520 to 1,040 lbs. kainit.

Suggestions.—The use of stable-manure appears to favor the growth of potato-scab. When used, stable-manure should be applied to a preceding crop. Wood-ashes are also reported to favor the attack of the scab. It is commonly held that sulphate of potash produces potatoes of better quality than does muriate. The testimony on this point is conflicting.

Pumpkins.

Same as for cucumbers.

Quinces.

Same as for apples.

RADISHES.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	3	15 to 30	(1) 90 to 180 lbs. nitrate of soda; or (2) 75 to 150 lbs. sulphate of ammonia; or (3) 150 to 300 lbs. dried blood; or (4) 3,000 to 6,000 lbs. stable manure.
Available phosphoric acid	7	35 to 70	(1) 350 to 700 lbs. bone meal; or (2) 250 to 500 lbs. dissolved bone, etc.; or (3) 280 to 560 lbs. dissolved rock.
Potash	9	45 to 90	(1) 90 to 180 lbs. muriate; or (2) 90 to 180 lbs. sulphate; or (3) 350 to 700 lbs. kainit; or (4) 900 to 1,800 lbs. wood ashes.

RASPBERRIES.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	2	12 to 24	(1) 75 to 150 lbs. nitrate of soda; or (2) 60 to 120 lbs. sulphate of ammonia; or (3) 120 to 240 lbs. dried blood; or (4) 2,400 to 4,800 lbs. stable manure.
Available phosphoric acid	7	40 to 80	(1) 400 to 800 lbs. bone meal; or (2) 280 to 560 lbs. dissolved bones, etc.; or (3) 320 to 640 lbs. dissolved rock.
Potash	10	60 to 120	(1) 120 to 240 lbs. muriate; or (2) 120 to 240 lbs. sulphate; or (3) 480 to 960 lbs. kainit; or (4) 1,200 to 2,400 lbs. wood ashes.

RYE.

Same as for oats.

Suggestions.— Nitrogen is preferably applied in the form of nitrate of soda rather than stable manure. Excessive use of nitrogen should be avoided.

SORGHUM.

Same as for corn.

SPINACH.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	2	15 to 30	(1) 90 to 180 lbs. nitrate of soda; or (2) 75 to 150 lbs. sulphate of ammonia; or (3) 150 to 300 lbs. dried blood; or (4) 3,000 to 6,000 lbs. stable manure.
Available phosphoric acid...	7	55 to 110	(1) 550 to 1,100 lbs. bone-meal; or (2) 375 to 750 lbs. dissolved bone, etc.; or (3) 450 to 900 lbs. dissolved rock.
Potash	5	40 to 80	(1) 80 to 160 lbs. muriate; or (2) 80 to 160 lbs. sulphate; or (3) 320 to 640 lbs. kainit; or (4) 800 to 1,600 lbs. wood ashes.

SQUASHES.

Same as for cucumbers.

STRAWBERRIES.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	3	25 to 50	(1) 150 to 300 lbs. nitrate of soda; or (2) 125 to 250 lbs. sulphate of ammonia; or (3) 250 to 500 lbs. dried blood; or (4) 5,000 to 10,000 lbs. stable manure.
Available phosphoric acid...	7	55 to 110	(1) 550 to 1,100 lbs. bone-meal; or (2) 375 to 750 lbs. dissolved bone, etc.; or (3) 450 to 900 lbs. dissolved rock.
Potash..........	9	70 to 140	(1) 140 to 280 lbs. muriate; or (2) 140 to 280 lbs. sulphate; or (3) 550 to 1,100 lbs. kainit; or (4) 1,400 to 2,800 lbs. wood ashes.

TOBACCO.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	4	30 to 60	(1) 180 to 360 lbs. nitrate of soda; or (2) 150 to 300 lbs. sulphate of ammonia; or (3) 300 to 600 lbs. dried blood; or (4) 6,000 to 12,000 lbs. stable manure.
Available phosphoric acid...	6	50 to 100	(1) 500 to 1,000 lbs. bone-meal; or (2) 350 to 700 lbs dissolved bone, etc.; or (3) 400 to 800 lbs dissolved rock.
Potash	10	80 to 160	(1) 160 to 320 lbs. sulphate; or (2) 1,600 to 3,200 lbs. wood-ashes.

Suggestions.—Stable-manure may advantageously be applied to preceding crop. Potash should be used only in form of sulphate.

TOMATOES.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	4	25 to 50	(1) 150 to 300 lbs. nitrate of soda; or (2) 125 to 250 lbs. sulphate of ammonia; or (3) 250 to 500 lbs. dried blood; or (4) 5,000 to 10,000 lbs. stable-manure.
Available phosphoric acid...	6	35 to 70	(1) 350 to 700 lbs. bone-meal; or (2) 250 to 500 lbs. dissolved bone, etc.; or (3) 280 to 560 lbs. dissolved rock.
Potash	7	40 to 80	(1) 80 to 160 lbs. muriate; or (2) 80 to 160 lbs. sulphate; or (3) 320 to 640 lbs. kainit; or (4) 800 to 1,600 lbs. wood-ashes.

TURNIPS.

Same as for beets.

WATERMELONS.

Same as for cucumbers.

WHEAT.

	Per cent.	Pounds for one acre.	Pounds of different materials for one acre.
Nitrogen	4	12 to 24	(1) 75 to 150 lbs. nitrate of soda; or (2) 60 to 120 lbs. sulphate of ammonia; or (3) 120 to 240 lbs. dried blood; or (4) 2,400 to 4,800 lbs. stable-manure.
Available phosphoric acid...	7	20 to 40	(1) 200 to 400 lbs. bone-meal; or (2) 140 to 280 lbs. dissolved bone, etc.; or (3) 160 to 320 lbs. dissolved rock.
Potash	4	12 to 24	(1) 25 to 50 lbs. muriate; or (2) 25 to 50 lbs. sulphate; or (3) 100 to 200 lbs. kainit; or (4) 250 to 500 lbs. wood-ashes.

6. WHICH IS MORE ADVANTAGEOUS, TO PURCHASE COMPLETE FERTILIZERS OR TO PURCHASE SEPARATE INGREDIENTS?

The question of home mixing of fertilizers is now being much discussed. Not a few farmers have adopted the plan of purchasing unmixed ingredients and mixing them at home. When a farmer once tries this method, he rarely purchases a ready-mixed complete fertilizer after that. It is pertinent in this connection to consider both sides of the question, both the advantages and disadvantages of purchasing unmixed fertilizing ingredients.

Economy.—The average retail price of a ton of mixed fertilizer is from $8 to $10 above the market value of its unmixed ingredients. Taking the 232 different brands of fertilizers collected during the spring of 1895, we find the average retail selling price to have been $31.43, while the unmixed materials would have cost about $22, leaving a difference of about $9.50. In other States the difference is found to be as high as $10 or more. This difference represents the cost of mixing, freight, profit, etc. It is readily seen that a portion, at least, of the difference can be saved by purchasing unmixed ingredients. Many farmers who have done their own mixing, estimate that the mixing costs them 75 cents a ton on an average.

Definite Knowledge of Materials Used.—When separate materials are purchased, the farmer can more closely ascertain whether his goods are what they claim to be. Ground leather cannot be passed for nitrate of soda, sulphate of ammonia, etc. In mixed goods it is not easy to detect inferior articles. The chances are that the farmer will get better materials in unmixed than in mixed goods, although this would not be true in dealing with the most reliable manufacturers.

Variation of Mixture to Suit Different Crops.—By careful observation and experiment the farmer can change his mixture so as to adapt it more nearly to the needs of his crops and soil. Manufacturers claim to manufacture goods which are specifics for different crops. But it is noticed that the special mixtures for the same crop, as made by different manufacturers vary quite as much as do mixtures for different crops. For illustration, taking 40 different potato-manures sold in this State, we find that they vary in nitrogen from 1.50 to 6 per cent.; in available phosphoric acid, from 4.75 to 11 per cent.; and in potash, from 2.50

to 11.50 per cent.; and yet each claims to be exactly adapted to the needs of the potato crop. We have met with instances where the manufacturer used the same formula as a special for different crops whose needs were quite unlike. It is safe to say that, without any experience, the farmer can hit the needs of his soil and crops by mere guess quite as closely as do some of the complete fertilizers. The farmer can ascertain what particular forms and quantities of materials are best suited to his needs.

Educational Value.—There is little of educational value in using an unknown mixture. To purchase intelligently unmixed fertilizing materials will ultimately lead in most cases to a well-grounded knowledge of the science of agriculture. One will seek to know what the different forms of plant-food are, what they do, from what sources they can be obtained, and how he can use them to best advantage. He will become to some extent an investigator, and will, of necessity, take a deeper interest in his work. His entire system of farming will be lifted to a higher plane and his more intelligent labor will yield more profitable results.

The chief disadvantages connected with purchasing separate materials are the following: (1) On small purchases little or no reduction of price is made. This may often be true, but in such cases it is easily possible for farmers to combine and order larger lots. In the large dairy sections of the state this may be especially true. (2) It is claimed that, owing to lack of proper facilities, the farmer cannot make mixtures that will be even and fine. So far as actual results go, it is found that farmers can and do make mixtures which are, on an average, very satisfactory in their practical working as compared with mixtures of manufacturers.

7. To What Extent Home-Mixing is Practicable.

The conveniences needed to do one's own mixing are the following: A tight barn floor, or earth floor that is hard, smooth, dry and under cover; platform scales, shovel, iron hand-rake or hoe and a sand-screen. Farmers are advised, if they do their own mixing, not to attempt to treat bones or rock with sulphuric acid (oil of vitriol) but to purchase their superphosphate from the manufacturer.

The advantages connected with having the mixing of fertilizers done at a factory are the following: First, the mixing is apt to be more thoroughly done at the factory. Second, the factory should be able to do mixing in large quantities more economically, since it has all facilities required. As a rule, it costs the farmer from $2.50 to $3.00 to have the mixing and rebagging done at a factory for each ton of materials.

When the farmer prefers to purchase separate materials and do his mixing at home, the following suggestions may be helpful: If one has purchased the different materials in the right weights, such as he wants to use for mixing, then no weighing is necessary, as he has simply to mix all the materials he has. If he makes different mixtures, then the different materials should be weighed accurately. If the material is at all lumpy, it should be sifted with a sand screen, the lumps separated and then pulverized before being added to the pile of fine material. When the materials have been thus prepared, the most bulky material is spread out upon the floor in an oblong pile that varies from 6 to 10 inches in depth. The top is leveled off and then a layer of the next material is put on, not quite so thick, and so on until the different constituents have been added to the pile, care being taken to make such material cover the one under it evenly over the whole surface. Then, one should commence at one end and shovel over the pile, reaching clear to the bottom every time. After mixing well, the mixed portion is passed behind. When the whole pile has been treated once in this way, then the mixed pile is leveled, swept up around the edges and again treated in the same manner. This process should be repeated three or four times. Any lumps noticed at any time should be thoroughly broken up. If greater thoroughness is desired, the mixture may be sifted or screened before sacking. It is convenient to weigh into sacks which will hold from 100 to 150 pounds. One should take great pains to purchase his materials in finely powdered and perfectly dry condition, if he plans to mix the materials at home.

8. SPECIAL SUGGESTIONS RELATING TO THE PURCHASE OF SEPARATE FERTILIZING INGREDIENTS.

In addition to what has been already stated, there are some other suggestions which it is well to heed in connection with the purchase of separate fertilizing materials.

Purchase High-Grade Materials.—It will almost invariably be found more economical to purchase high-grade fertilizing materials.

In *applying* fertilizers, bulk is often desirable, but in *purchasing* commercial fertilizers, the object should be to secure as much nitrogen, potash and phosphoric acid in available forms as possible for one dollar, instead of as many pounds as possible of fertilizer, regardless of the amount of plant-food contained in it. This is particularly applicable to mixed fertilizers, which at present form the great bulk of fertilizers sold in this State. Since there is smaller bulk to handle in mixing, a smaller number of packages for holding, and, consequently, less weight and freight, it is, as a rule, more economical to purchase fertilizers in their more concentrated forms. For illustration, it is more enconomical to purchase one ton of a high-grade fertilizer than three tons of a low-grade fertilizer, one ton of the former containing the same amount of plant-food contained in three tons of the latter; because, in making the latter, three times as many packages are required and three times as much freight must be paid, all for the same amount of plant-food.

Fineness and Dryness of Fertilizers Important.—Fertilizers can not, as a rule, be in too finely powdered condition nor can they be too dry. With many materials, bone for example, the availability as plant-food is directly dependent upon the fineness of division. Two commercial fertilizers containing the same amount of plant-food in the same forms may differ considerably in respect to the availability of that food and, consequently, in respect to their agricultural value, if one is coarsely and the other finely ground. Excessive moisture in fertilizers is undesirable on several grounds. First, the larger the amount of moisture, the smaller will be the amount of plant-food in a ton. Second, excess of moisture causes the particles to stick together and is likely to result in caking and in clogging when used in drills. Third, an excess of moisture favors the decomposition and loss of nitrogen in many forms of organic matter. This is shown by the fact that some fertilizers give off a very offensive odor if allowed to become damp, while they are comparatively free from disagreeable odors if they are thoroughly dry. A strong odor in a fertilizer is an indication that organic matter is decomposing and nitrogen is being lost and indicates weakness and loss rather than strength as a fertilizer.

Taking Advantage of Fluctuating Prices.—By watching the market variations, it is possible to save more or less. It often happens that lower prices prevail during that part of the year when the farmer has most leisure. In any case, where home-mixing is practised, it should be done before the beginning of the busy season.

Making Club-Fertilizers.—In some towns farmers club together and purchase their separate ingredients, each one doing his own mixing himself. In other cases the club decides upon a definite formula and sends out specifications to manufacturers for furnishing the same already mixed and sacked, letting the contract to the lowest responsible bidder. One of the most successful instances of this sort is the Riverhead Town Agricultural Society of Long Island. They have found that a fertilizer containing 4 per cent. of nitrogen, 8 per cent. of available phosphoric acid and 10 per cent. of actual potash is well adapted to their conditions for growing potatoes. They require the nitrogen to be distributed in three different forms, one-half being fish-scrap; one-fourth, nitrate of soda; and one-fourth, sulphate of ammonia. The potash must be in form of muriate. For the season of 1895 they were able to get 1,200 tons of this mixture made at $29.32 a ton. Commercial fertilizers of similar composition sold for $36 to $40 at the same time. The actual saving affected by the members of this club amounts to not less than $10,000 a year.

Where to Purchase Unmixed Materials.—Any large manufacturer of fertilizers will generally fill orders for separate ingredients. Farmers are advised to write to three or four different firms and get their prices. In comparing price, one should take into consideration the question of freight. The schedule of prices given later may be used as a general guide in regard to what one should pay for different forms of materials.

Farmers will find their chief difficulty in knowing in what forms and quantities to order separate fertilizer constituents.

The suggestions found in the preceding pages giving this information in regard to our more common crops will be found helpful.

Below is given a list of manufacturers who are willing to sell unmixed goods direct to farmers. A few firms indicate their preference of selling through local agents where these are already established.

Armour & Company, 205 La Salle St., Chicago, Ill.

H. J. Baker & Bro., 93 William St., New York City.

Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.

Bradley Fertilizer Co., 92 State St., Boston, Mass.

Brown & Gilman Fertilizer Co., 118 South Delaware Ave., Philadelphia, Pa.

Chicopee Guano Co., 140 Maiden Lane, New York City.

Clark's Cove Fertilizer Co., 81 Fulton St., New York City.
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.
Eastern Farm Supply Association, Montclair, N. J.
Farmers' Fertilizer Co., 135 Lock St., Syracuse, N. Y.
Geo. B. Forrester, 169 Front St., New York City.
Great Eastern Fertilizer Co., Rutland, Vt.
Hallock & Duryee Fertilizer Co., Mattituck, L. I., N. Y.
Lister's Agricultural Chemical Works, Newark, N. J.
Frederick Ludlam, 108 Water St., New York City.
Mapes Formula and Peruvian Guano Co., 143 Liberty St., New York City.
Maryland Fertilizing and Manufacturing Co., 30 So. Holliday St., Baltimore, Md.
Robert L. Merwin, 88 Wall St., New York City.
Munroe, Lalor & Co., Oswego, N. Y.
North-Western Fertilizer Co., Union Stock Yards, Chicago, Ill.
Pacific Guano Co., Rochester, N. Y. (or New York City.)
Moro Phillips Chemical Co., 131 South Third St., Philadelphia, Pa.
Rasin Fertilizer Co., 35 Chamber of Commerce, Baltimore, Md.
Standard Fertilizer Co., Farlow Building, State St., Boston, Mass.
Swift & Company, Union Stock Yards, Chicago, Ill.
Ellsworth Tuthill & Co., Promised Land, L. I.
Tygert-Allen Fertilizer Co., 2 Chestnut St., Philadelphia, Pa.
M. E. Wheeler & Co., Rutland, Vt.
Williams & Clark Fertilizer Co., 81 Fulton St., New York City.

9. METHODS AND SEASONS OF APPLYING FERTILIZERS.

The method to be used in applying a fertilizer depends primarily upon the efficiency with which the constituents of the fertilizer are distributed most thoroughly and uniformly throughout the portion of soil where the plant roots are. The effect of a fertilizer is lost so far as it does not reach the plant roots. Pains must be taken to secure even and complete distribution of fertilizers on or in the soil, since it is desired to have the food reach every plant in the field. In order to distribute small quantities of concentrated fertilizers over a broad area, it is well to dilute by mixing with some such substance as dry earth, road-dust, sifted coal-ashes or sand.

Drilling and Broadcasting.—As between applying fertilizers with the drill or by broadcasting, the best results are given sometimes by one and sometimes by the other method, according to the crop and special conditions. Labor is saved by using the drill, while the best ultimate results appear more often to come from broadcasting, ploughing or harrowing in accordance to circumstances. When a fertilizer is especially needed by a crop in its earliest stages, there is advantage in drilling it in with the seed. When concentrated fertilizers are to be distributed broadcast, it is desirable that they should be somewhat diluted.

Distribution of Soluble Fertilizers.—Materials which are readily soluble can be scattered over the surface. After the first fall of rain they distribute themselves throughout the soil very completely and uniformly. Such materials are nitrate of soda, sulphate of ammonia, soluble phosphates and soluble potash salts. These materials are preferably used in case of top-dressing.

Distribution of Fertilizers not readily Soluble.—Materials which are not readily soluble are preferably well mixed through and beneath the soil. Thus, dried blood, bone-meal, fish-scrap and similar materials are best placed at greater or less depth beneath the soil, because under these conditions they become soluble more rapidly and are retained more surely by the soil.

Time of Application.—Fertilizers which dissolve easily and diffuse through soil rapidly, and which are not readily retained by the soil, are best applied only when the crop is ready to utilize them. If put on too early, there is danger of their being leached from the soil and carried more or less beyond the reach of the plant and thus lost. Nitrates and, to a less extent, ammonia compounds come under this precaution. Hence, it is not wise ordinarily to apply guano, ammonia compounds or nitrate of soda in the fall, except in climates which have a dry fall and winter. Their application should be deferred until spring. In wet springs, ammonia compounds are preferably applied rather than nitrate of soda; or, if nitrate of soda is used, loss may be avoided by making several small applications, instead of one at the start. Care should be taken, however, not to make applications of nitrate of soda too late in the season, as the maturing of the crop will be retarded and there will be an excessive growth of stems and leaves.

Fertilizers which do not dissolve readily or which do not diffuse through the soil rapidly are better applied to the land before the crop commences its growth. To this class belong stable-manure, bone-meal, dried blood, tankage, cottonseed-meal, ground rock, and to some extent, soluble phosphates and potash compounds.

Special Precautions.— In applying highly concentrated commercial fertilizers, it is wise to prevent the fertilizer coming in contact with the seeds or foliage of plants.

Fertilizers containing ammonia compounds should not be mixed with wood-ashes, lime, or Thomas slag (odorless phosphate), since some of the ammonia is likely to be lost.

On soils of loose texture and small retentive power, it is best to use, for the most part, those forms of fertilizers which are not too easily soluble, in order to make as small as possible the losses occasioned by heavy rains. Animal and vegetable materials are especially suited for such cases.

10. THE MOST ADVANTAGEOUS METHODS OF USING FARM-PRODUCED MANURES.

Under this head we will discuss some of the more common points relating to the use of stable-manure in its application to different soils and crops.

Exclusive and Long-continued Use not Advised.— The average farm-produced manure is a one-sided fertilizer, being excessively rich in nitrogen in comparison with potash and phosphoric acid. A ton of good stable-manure contains:

10 pounds of nitrogen,
.5 pounds of phosphoric acid, and
10 pounds of potash.

Now, if we compare these proportions of plant-food with those found in different plants or with commercial fertilizers which are successfully applied to different crops, we are readily impressed with the one-sided character of stable-manure as a nitrogenous plant-food. Where there is in the soil a sufficient amount of available potash and phosphoric acid to balance the excess of nitrogen furnished by the application, then most excellent crops are secured by the exclusive use of stable-manure. But it must be evident that, under such treatment, the crops each year take from the soil more potash and phosphoric acid than is replaced by the stable-manure. Hence, each year the available supply of these two constituents in the soil becomes less; and, when they are insufficient to balance the nitrogen applied, then crops become smaller and further exclusive applications of stable-manures fail to produce the results once secured. It is, therefore, easily possible to exhaust a soil by long-continued, exclusive use of stable-manure; and this is just what has occurred on many farms in this state.

Stable-Manure Supplemented by Commercial Fertilizers.—In order to use our farm-produced manures to the best advantage on the average soil as found at present in this State, we need to supplement them with commercial fertilizers containing available phosphoric acid and potash. To give a roughly approximate idea, we might say that for every ton of stable manure applied, it would be well to use with it from 50 to 100 pounds of acid phosphate and from 25 to 50 pounds of high-grade muriate or sulphate of potash. This is best accomplished in the manner described on page 81.

Use of Fresh Manure.—The statements below apply to fresh manure containing only small amounts of coarse litter. It appears to be the prevailing belief both in theory and practice that best results are ordinarily secured by applying stable-manure to the soil in as fresh condition as possible. Mixed with the soil, fresh manure decomposes readily, having its own constituents made more available as plant-food, and, morever, rendering available some of the insoluble plant-food previously in the soil. In this way losses from destructive forms of fermentation, leaching, etc., are mainly prevented.

Fresh manure gives better results than rotted manure on heavy clay soils, when one desires to lighten the condition of the soil. However, when one desires direct fertilizing action promptly, fresh manure gives sufficiently quick returns on light soils, becoming available as fast as the plant needs it, if the season is not too dry. On heavy clay soils, manure decomposes slowly and the constituents of fresh manure may not become available as fast as needed. On this account, it may happen that on heavy soils little benefit is seen from the application of fresh manure until the second season after its application.

In dry hot seasons an excessive application of fresh stable-manure tends to "burn out" the soil, this tendency being more noticeable in light than in heavy soils.

Fresh manure has a tendency to favor rapid growth of foliage and stems at the expense of fruit and grain. It is, therefore, more suitable for grasses, forage plants and leafy crops than for grains.

Such crops as potatoes, sugar beets and tobacco appear to be injured in quality by the direct application of stable manure. It is advised in such cases to apply the manure in the fall previous to the spring in which the crops are to be put in, thus allowing time for a considerable amount of decomposition.

When fresh stable-manure contains much coarse, undecomposed litter, it is better not to apply it until the coarse portion has become more or less decomposed.

Use of Rotted Manure.—In rotted manure, the fertilizing constituents, as a whole, are in readily available form for the use of plants. Such manure is less bulky and more easily distributed than fresh manure. It is also less likely to promote the too rapid growth of stems and leaves as in the case of fresh manure. For the improvement of the mechanical condition of a soil, the best results come from using rotten manure on light soils. It must, however, be remembered that on such soils there is more or less danger that some portion of the valuable fertilizing constituents may be leached out and lost. On this account it is found advisable to apply such manure to light soils only a short time before it is needed by the crop. In general, rotted manure is better adapted to spring applications. It is better to apply rotted manure on light soils at frequent intervals in small amounts.

In warm, moist climates, it makes much less difference whether the manure is applied in fresh or rotted condition. In cold climates, however, the use of decomposed manure is preferable.

Methods of Application.—Three methods of applying manure on the field are in common practice. We will briefly consider each of these:

(*a*) *Applying in Heaps.*

By this method the manure is distributed in heaps over the field and permitted to lie some time before being spread. This method is objectionable for several reasons. The labor of handling is increased; there is danger of loss from decomposition and leaching; the manure is not uniformly distributed, the spots beneath the heaps being more thoroughly manured on account of the leaching. Storing manure in very large heaps is less objectionable, provided the heap is carefully covered with earth and not allowed to lie too long.

(*b*) *Applying Broadcast.*

By this method the manure is spread more or less completely and evenly on the field, being plowed in at once or allowed to lie some time on the surface. This is preferably practiced on the level field, where there is little danger from surface washing. In late fall and early spring, there is likely to be very little loss of nitrogen. On a loose soil, there may be loss from leaching, if the manure is spread long before the crop is put into the soil; but in average experience, this is not apt to be considerable. This method has the advantage of uniform distribution as the liquid portion is evenly by degrees mixed with the soil. When the manure is leached of its soluble nitrogen compounds, it does not decompose so readily. On this account it is well, in case of light or porous soils, to plow the manure in as soon as spread.

In regard to the depth at which manure should be plowed in, it is safe to say that in very compact soils, the depth should not be greater than 4 inches, while in lighter soils the depth may be increased. It is important that the manure be near enough the surface to allow access of sufficient moisture and air, in order that decomposition may not be too much delayed.

(*c*) *Applying in Row.*

This method has the advantage of placing the manure where it will reach the plant most quickly and of enabling one to use smaller amounts than in broadcasting. It is especially applicable for forcing some garden crops. Rotted manure gives good results when used this way.

XII. The Arithmetic of Fertilizers.

When we desire to know the amount of nitrogen, potash and phosphoric acid contained in different forms and materials or to make up formulas from materials of known composition, or to determine the commercial value of any single material or of any mixture, it is necessary to go through various mathematical processes, most of which are comparatively simple and easily understood. So many inquiries have come to us on questions involving simple calculations, that it is thought advisable to present a somewhat systematic consideration of some of the more common problems met with. Some calculations, which it might be desirable to use at times, involve more knowledge of chemistry than can be given in a simple treatise of this kind.

Before taking up a consideration of the mathematical details we will make a brief explanation of the different terms used in expressing fertilizer guarantees and analyses, because an accurate knowledge of such terms is important, especially in making commercial valuations and in planning formulas.

We shall, therefore, consider under the general head given above the following topics:

1. Explanation of terms used in stating guarantee-analyses of fertilizers.
2. Total constituents of fertilizers.
3. Commercial valuation of fertilizers.
4. How to calculate amounts of materials to be used in making home-made fertilizers.

1. EXPLANATION OF TERMS USED IN STATING GUARANTEE-ANALYSES OF FERTILIZERS.

In examining the guarantee-analyses of different manufacturers, we find much variation in the terms used. Some forms are simple, stating only the most essential points, while others are complicated and confusing to the average farmer. We propose here briefly to explain all the different forms which are apt to be met. The following list contains most of the terms used in stating manufacturers' guarantee-analyses:

Nitrogen is expressed as

(a) Nitrogen, (b) ammonia, (c) nitrogen equal (or equivalent) to ammonia.

Phosphoric Acid is expressed as

(a) Phosphoric acid, (b) soluble phosphoric acid, (c) reverted phosphoric acid, (d) precipitated phosphoric acid, (e) available phosphoric acid, (f) soluble and available phosphoric acid, (g) insoluble phosphoric acid, (h) total phosphoric acid, (i) phosphoric acid equal (or equivalent) to bone phosphate of lime.

Potash is expressed as

(a) Potash, (b) potash (actual), (c) potash s. (or sul.), (d) potash (soluble), (e) potash as sulphate, (f) potash equal (or equivalent) to sulphate of potash, (g) sulphate of potash, (h) potassium oxide.

Nitrogen.

(*a*) *Nitrogen* is a gas and, in this form, can not be used in fertilizers. Therefore, whenever we speak of nitrogen in fertilizers, we do not mean that nitrogen exists in them as simple nitrogen. As previously stated, the nitrogen in fertilizers is always combined with other elements and may be present in one or more different forms; (1) in the form of nitrates, as nitrate of soda; (2) in the form of ammonia compounds, as sulphate of ammonia; and (3) in the form of organic matter, animal or vegetable, as dried blood, meat, tobacco stems, etc. Chemical analysis according to official methods does not attempt to ascertain and state in which form or forms the nitrogen is present in a fertilizer.

When, therefore, nitrogen is expressed in an analysis or guarantee simply as "nitrogen," it refers to the entire amount of nitrogen present without regard to the particular form or forms in which it is present.

(*b*) *Ammonia* consists of *nitrogen combined with hydrogen.* A pound of nitrogen will form more than a pound of ammonia, because the ammonia formed from a pound of nitrogen will contain that pound of nitrogen plus the necessary amount of hydrogen added to form ammonia. The chemical relations of nitrogen and ammonia are such that 14 pounds of nitrogen, will unite with exactly 3 pounds of hydrogen, and will, therefore, produce just 17 pounds of ammonia; or 1 pound of nitrogen will make 1.214 pounds of ammonia.

Manufacturers very commonly express the amount of nitrogen in the equivalent of ammonia, probably for the reason that, expressed as ammonia, larger figures are obtained than would be, if expressed as nitrogen; and the fertilizers appear to farmers to contain more nitrogen. This method is not in accordance with present legal requirements, and *farmers should know that "nitrogen" and "ammonia" are not the same thing, since one pound of ammonia contains only about eight-tenths of a pound of nitrogen.*

(*c*) *Nitrogen equal* (*or equivalent*) *to Ammonia* is a form of expression which simply means that the nitrogen is stated not as nitrogen but as ammonia.

It would be better on every account if all guarantees stated simply nitrogen and never mentioned ammonia at all. As a matter of fact, compounds of ammonia are quite uncommon in commercial fertilizers, because nitrogen in this form is the most expensive and therefore least used. Strictly speaking, the term ammonia should never be used except when sulphate of ammonia or some similar compound is present in the fertilizer.

Phosphoric Acid.

(*a*) *Phosphoric Acid*, as used in connection with fertilizers, is a compound containing phosphorus and oxygen, which in fertilizers is found never by itself, but in combination with lime. Phosphoric acid stands for a certain amount of phosphate of lime. We may say roughly that one part of phosphoric acid is equivalent to about two parts of phosphate of lime. But we know that phosphoric acid exists in several different forms. (See page 65.)

(*b*) *Soluble Phosphoric Acid* represents the amount of phosphate of lime that dissolves easily in water. As explained already, *soluble* calcium phosphate is formed by treating with sulphuric acid some form of insoluble calcium phosphate, such as bones, bone-ash, South Carolina rock, etc. The phosphate thus formed is readily *soluble* in water.

(*c*) *Reverted Phosphoric Acid* is formed from soluble phosphoric acid under certain conditions into which we need not inquire here. Suffice it to say, that the soluble compound of phosphoric acid often changes, to some extent, on standing into a form, which, while less soluble, is still quite readily available as plant-food.

(*d*) *Precipitated Phosphoric Acid* is simply another name for the reverted form.

(*e*) *Available Phosphoric Acid* includes both the soluble and reverted forms of phosphoric acid, because both forms are available for the use of plants.

(*f*) *Soluble and Available Phosphoric Acid* is an expression which means the same as available.

(*g*) *Insoluble Phosphoric Acid* represents that form of phosphate of lime which is insoluble in water and which is of least value for agricultural purposes.

(*h*) *Total Phosphoric Acid* represents the entire phosphoric acid compounds without regard to the forms in which they exist. The total phosphoric acid is, therefore, the sum of the soluble, reverted and insoluble forms, or, to state it in another way, the sum of the available and insoluble forms.

(*i*) *Phosphoric Acid equal (or equivalent) to Bone Phosphate of Lime* is an expression which usually means nothing more or less than insoluble phosphoric acid. The expression is apt to be misleading, as it appears to imply that the phosphoric acid is derived from bone. It is applied probably to ground rock even more often than to bone.

Potash.

(*a*) *Potash*, as used in connection with fertilizers, always means a compound containing potassium and oxygen, known as potassium oxide. Potash or potassium oxide is never found as such in fertilizers, but chemists use this form of expressing the results of analysis as a convenient standard for reference. Fertilizers generally contain potash in such forms as sulphate of potash, muriate of potash or carbonate of potash. Instead of stating the amount of sulphate, muriate or carbonate of potash present in a fertilizer, its equivalent amount is stated only in the form of potash in giving the results of analysis.

(*b*) *Potash Actual* is simply another expression for potash, as distinct from the sulphate, muriate, etc.

(*c*) *Potash S.* (*or Sul.*) means sulphate of potash. This is quite often used by manufacturers in giving guarantees. It is very misleading and, when used, is evidently employed for the purpose of making purchasers think that it is actual potash. One pound of potash is equivalent to 1.85 pounds of sulphate of potash; and so, in stating a guarantee as sulphate, the manufacturer makes it appear that his goods contain more potash than they really do.

(*d*) *Potash Soluble* represents the amount of potash that dissolves in water and is available for the use of the plants. The different forms of potash commonly used in fertilizers are readily soluble in water.

(*e*) *Potash as Sulphate* means simply sulphate of potash.

(*f*) *Potash equal* (*or equivalent*) *to Sulphate of Potash* is an expression which means simply sulphate of potash. When the potash is present as muriate, this expression should never be used.

(*g*) *Sulphate of Potash* signifies, or should signify, that this compound is actually present in the fertilizer and there is no muriate of potash present.

(*h*) *Potassium Oxide* means the same as potash or actual potash.

2. TOTAL CONSTITUENTS OF FERTILIZERS.

If we add together the figures representing the different constituents of a fertilizer (the nitrogen, the total phosphoric acid, and the potash), we shall find, as a rule, that the sum amounts to only 20 or 30 per cent. or pounds per hundred. The question often arises, "Why does the sum of the constituents in the analysis of a fertilizer amount to only 20 or 30 per cent. and what is the remaining portion, amounting to 70 or 80 per cent. made up of?" A few illustrations will, perhaps, suffice to make the matter clear.

High-Grade Fertilizers.—Taking a fairly high-grade fertilizer, we find by analysis that it contains:

Nitrogen	4 per cent.
Available phosphoric acid	8 "
Insoluble " "	2 "
Potash	10 "

If the nitrogen comes from dried blood or meat, it will take about 10 pounds of such material to furnish 1 pound of nitrogen. Since there are 4 per cent. of nitrogen, or 4 pounds of nitrogen in 100 pounds of fertilizer, it will take 40 pounds of dried blood to furnish this amount of nitrogen. The amount of bone and sulphuric acid necessary to make a phosphate containing 8 pounds of available phosphoric acid and 2 pounds of insoluble phosphoric acid would amount to about 40 pounds. If the potash is present in form of high-grade sulphate, about 20 pounds of such sulphate would be required to be equivalent to 10 pounds of potash. Tabulating the foregoing figures, we have the following:

	Pounds.
Dried blood required to furnish 4 pounds of nitrogen	40
Bone and sulphuric acid required to furnish phosphates containing 8 pounds of available and 2 pounds of insoluble phosphoric acid	40
Sulphate of potash equivalent to 10 pounds of potash	20
Total	100

In a fertilizer of this character, we can easily account for the entire amount of material.

Low-Grade Fertilizers.—Taking now a low-grade fertilizer, we find its composition to show:

Nitrogen	1 per cent.
Available phosphoric acid	5 "
Insoluble	1 "
Potash	1 "

We will suppose that the nitrogen and phosphoric acid come from the sources as indicated above and that the potash comes from kainit, 8 pounds of kainit containing 1 pound of potash. Then we can tabulate our statement as follows:

	Pounds.
Dried blood required to furnish 1 pound of nitrogen	10
Bones, etc., required to furnish 5 pounds of available and 1 pound insoluble phosphoric acid	24
Kainit equivalent to 1 pound of potash	8
Moisture, dirt, etc	58
Total	100

We could, of course, vary the sources of materials used and get other figures, but these illustrations serve to give a fair idea of what a hundred pounds of a fertilizer may be made, and why a statement of analysis does not account for more than 20 or 30 pounds of fertilizing materials in a hundred pounds of fertilizer.

COMMERCIAL VALUATION OF FERTILIZERS.

What is a Commercial Valuation of a Fertilizer?— The commercial valuation of a fertilizer consists in estimating the approximate value or money-cost of the essential fertilizing ingredients (nitrogen, phosphoric acid, and potash) in one ton of fertilizer.

In making a commercial valuation of a fertilizer, one uses either the figures given in the guarantee-analysis or preferably the figures given in the Station's analysis, as a basis for calculation. This enables one to know how many pounds of nitrogen, of phosphoric acid and of potash there are in one ton of fertilizer.

The prices to be used in calculating a commercial valuation are furnished in a schedule prepared annually by experiment stations. This price-list for the year 1895 we give below.

Prices of Nitrogen, Phosphoric Acid and Potash Adopted by Experiment Stations.— The trade-values in the following schedule represent the average prices at which, in the six months preceding March the respective ingredients, in the form of unmixed raw materials, could be bought at retail for cash in our large markets, Boston, New York and Philadelphia. These prices also correspond to the average wholesale prices for the six months preceding March, plus about 20 per cent. in case of goods for which there are wholesale quotations.

It must be kept in mind that these trade-values are changing from time to time. In the fertilizer bulletins, which are issued not less often than twice a year, we always give the latest trade-values adopted. Whenever in the following pages reference is made to the price-list, consult the latest.

	1895. Cents per lb.
Nitrogen in ammonia salts	18½
Nitrogen in nitrates	15
Organic nitrogen in dry and fine-ground fish, meat and blood, and in high-grade mixed fertilizers	16½
Organic nitrogen in cottonseed-meal and castor-pomace	12
Organic nitrogen in fine-ground bone and tankage	16
Organic nitrogen in fine-ground medium bone and tankage	14
Organic nitrogen in medium bone and tankage	11
Organic nitrogen in coarse bone and tankage	5
Organic nitrogen in hair, horn-shavings and coarse fish-scraps	5
Phosphoric acid, soluble in water	6
Phosphoric acid, soluble in ammonium citrate	5½
Phosphoric acid in fine bone and tankage	5½
Phosphoric acid in fine medium bone and tankage	4½
Phosphoric acid in medium bone and tankage	3
Phosphoric acid in coarse bone and tankage	2
Phosphoric acid in fine-ground fish, cottonseed-meal, castor, pomace and wood-ashes	5
Phosphoric acid insoluble in ammonium citrate, in mixed fertilizers	2
Potash as high-grade sulphate, in forms free from muriates (chlorides) in ashes, etc.	5¼
Potash in muriate	4½

Valuation of Fertilizing Ingredients in Foods.

Organic nitrogen	15
Phosphoric acid	5
Potash	5

In mixed fertilizers, *organic nitrogen* is reckoned at 16½ cents a pound, the price of nitrogen in raw materials of the best quality, *insoluble phosphoric acid* is reckoned at 2 cents; *potash* is rated at 4½ cents, if sufficient chlorine be present in the fertilizer to combine with it to make muriate; if there is more potash present than will combine with the chlorine, then this excess of potash is reckoned at 5¼ cents per pound.

Valuation and Cost of Fertilizers.—The total cost (to the farmer) of a ton of commercial fertilizer may be regarded as consisting of the following elements: (1) Retail cash cost, in the market, of unmixed trade materials; (2) cost of mixing; (3) cost of transportation; (4) storage, commissions to agents and dealers, selling on long credit, bad debts, etc. While the *total* *cost* of a fertilizer is made up of several different elements, a *commercial valuation* includes only the first of the elements entering into the total cost, that is, the retail cash cost in the market of unmixed raw materials.

Valuation and Agricultural Value.—The *agricultural value* of a fertilizer depends upon its *crop-producing power*. A commercial valuation does not necessarily have any relation to crop-producing value. For a particular soil and crop, a fertilizer of comparatively low commercial valuation may have a higher agricultural value; while for another crop on the same soil or the same crop on another soil the reverse might be true.

SIMPLE RULE FOR CALCULATING APPROXIMATE COMMERCIAL VALUATION OF FERTILIZERS.

Multiply the per cent. of nitrogen by 3 and add to the product the figures representing the per cent. of available phosphoric acid and of potash. The sum expresses in dollars and cents the approximate commercial valuation of the fertilizer.

Example.—A fertilizer contains

Nitrogen	4.13 per cent.
Available phosphoric acid	8.52 per cent.
Potash	10.54 per cent.

4.13 (per cent. of nitrogen) multiplied by three, equals	$12.39
8.52 (per cent. of available phosphoric acid)	8.52
10.54 (per cent. of potash)	10.54
Total, per ton	$31.45

If a fertilizer contains only one or two of the three essential fertilizing ingredients, the rule can be applied in a modified form. In case of fine bone-meal, use the total phosphoric acid in place of the available in making the calculation.

While this rule is not exact, it gives results that are fairly accurate and has the great advantage of simplicity. It does not take the insoluble phosphoric acid into consideration at all.

For the benefit of those who desire a more exact method of calculating the commercial valuation of fertilizers, we give below a more detailed rule. But previously we give methods for calculating from one compound to another, and also methods for making valuations of unmixed fertilizing materials.

RULES FOR CALCULATING FROM ONE COMPOUND INTO OTHER COMPOUNDS.

(a) *Compounds Containing Nitrogen.*

(1) To change ammonia into an equivalent amount of nitrogen, multiply the amount of ammonia by 0.82.

(2) To change nitrogen into an equivalent amount of ammonia, multiply the amount of nitrogen by 1.21.

(3) To change nitrate of soda into an equivalent amount of ammonia, divide the amount of nitrate of soda by 5.

(4) To change nitrate of soda into an equivalent amount of nitrogen, divide the amount of nitrate of soda by 6.

(5) To change nitrogen into an equivalent amount of nitrate of soda, multiply the nitrogen by 6.

(6) To change sulphate of ammonia into an equivalent amount of ammonia, divide the amount of pure sulphate of ammonia by 4.

(7) To change ammonia into an equivalent amount of sulphate of ammonia, multiply the amount of ammonia by 4.

(8) To change nitrate of potash into an equivalent amount of nitrogen, divide the amount of nitrate of potash by 7.2.

(b) *Compounds Containing Potash.*

(9) To change muriate of potash into an equivalent amount of actual potash, multiply the amount of muriate by 0.63.

(10) To change actual potash into an equivalent amount of muriate of potash, multiply the amount of actual potash by 1.6.

(11) To change sulphate of potash into an equivalent amount of actual potash, multiply the amount of sulphate of potash by 0.54.

(12) To change actual potash into an equivalent amount of sulphate of potash, multiply the amount of actual potash by 1.85.

(13) To change nitrate of potash into an equivalent amount of actual potash, multiply the amount of nitrate of potash by 0.46.

(14) To change actual potash into an equivalent amount of nitrate of potash, multiply the amount of actual potash by 2.15.

RULES FOR MAKING VALUATIONS OF UNMIXED FERTILIZING MATERIALS.

(a) *Materials Containing Nitrogen.*

(1) *Sulphate of Ammonia. Rule.* Multiply the given per cent. of ammonia by 0.82 and this product by the price of one

pound of nitrogen in the form of ammonia (see price list on page 132.) Multiply this product by 20.

Example: A sample of ammonium sulphate tests 24 per cent. ammonia; what is its commercial valuation?

24 (per cent. of ammonia) × 0.82 = 19.68 per cent. of nitrogen.

19.68 × 18½ cents = 364 cents, value of nitrogen in 100 lbs. of ammonium sulphate.

364 cents × 20 = $72.80, value of nitrogen in one ton of ammonium sulphate.

(2) *Nitrate of Soda. Rule.* Multiply the test per cent. of nitrate of soda by 16½ and this product by the price of one pound of nitrogen in the form of nitrates (see price-list on page 132). Multiply the last result by 20.

Example: What is the valuation of one ton of nitrate of soda which tests 98 per cent.?

"Nitrate of soda testing 98 per cent." means that in every 100 pounds of material there are 98 pounds of pure nitrate of soda.

0.98 × 16½ = 16.17 per cent. nitrogen in nitrate of soda.

16.17 × 15 cents = 242½ cents × 20 = $48.50 a ton.

When the per cent. of nitrogen is given, then the first step is omitted.

(*b*) *Materials Containing Phosphoric Acid.*

Rule. Multiply the given amount of available phosphoric acid by the price of one pound of soluble phosphoric acid (see price-list on page 132) and the result by 20.

If the amount of insoluble phosphoric acid is given, multiply this by 40 and add to foregoing amount.

Example: What is the commercial valuation of one ton of dissolved bone-black testing 16 per cent. of available phosphoric acid?

16 × 6 cents = 96 cents × 20 = $19.20 a ton.

If this sample were known also to contain 2 per cent. of insoluble phosphoric acid, then

2 × 40 cents = 80 cents and $19.20 + 0.80 = $20.

(*c*) *Materials Containing Potash.*

(1) *Sulphate of Potash. Rule.* Multiply the test per cent. sulphate of potash by 0.54 and the product by the price of one pound of potash in the form of sulphate (see price-list on page 132). Multiply this product by 20.

Example: What is the commercial valuation of one ton of sulphate of potash which tests 50 per cent. (low-grade) sulphate?

$50 \times 0.54 = 27$ per cent. of actual potash.

$27 \times 5\frac{1}{4}$ cents = \$1.42, value of 100 pounds of sulphate of potash.

$\$1.42 \times 20 = \$28.40$, value of one ton of sulphate of potash testing 50 per cent. sulphate.

Example: What is the valuation of one ton of sulphate of potash which tests 95 per cent. (high-grade) sulphate of potash?

$95 \times 0.54 = 51.3$ per cent. of actual potash.

$51.3 \times 5\frac{1}{4}$ cents = 269 cents $\times 20 = \$53.80$ value of one ton of sulphate of potash testing 50 per cent. sulphate.

When the per cent. of actual potash is given, the first step can be omitted, and the per cent. of actual potash multiplied by the price and then by 20.

(2) *Muriate of Potash. Rule.* Multiply the given per cent. of muriate by 0.63 and the result by the price of one pound of potash in the form of muriate (see price-list on page 132). Multiply this result by 20.

Example: What is the valuation of one ton of muriate of potash testing 85 per cent. muriate?

$85 \times 0.63 = 53.55$ per cent. of actual potash. $53.55 \times 4\frac{1}{2}$ cents = 241 cents $\times 20 = \$48.20$ a ton.

SECOND METHOD FOR MAKING COMMERCIAL VALUATIONS OF MIXED FERTILIZING MATERIALS.

Rule. Multiply the given per cent. of each constituent (nitrogen, phosphoric acid and potash) by its list-price, add the products and multiply the sum by 20.

Example: What is the valuation of one ton of a commercial fertilizer having the following guarantee-analysis?

Nitrogen	2 (to 3) per cent.
Available phosphoric acid	8 (to 10) "
Potash	3 (to 5) "

In each case where a guarantee-analysis gives two figures, always use the lower, because the law takes only the lower guarantee into consideration.

2 (per cent. nitrogen) $\times$ 16½ cents (price of 1 lb. nitrogen) =	0.33 cents.
8 (per cent. av. phos. acid) $\times$ 6 cents (price of 1 lb. av. phos. acid) =	0.48 "
3 (per cent. potash) $\times$ 5 cents (price of 1 lb. potash) =	0.15 "
Total value of 100 pounds of fertilizer =	0.96 "
0.96 cents + 20 = \$19.20 a ton	

When the nitrogen is given in the form of ammonia, first change to equivalent of nitrogen (see (1) page 134) and then follow above rule.

When the potash is given in the form of sulphate, first change to equivalent of actual potash (see (11) page 134) and then follow rule.

4. HOW TO CALCULATE AMOUNTS OF MATERIALS TO BE USED IN MAKING A HOME-MADE FERTILIZER.

There will probably be little demand for information in regard to quantities of different materials to be used in making home-made fertilizers, since the subject is treated in a specific manner on pp. 96–114. But it will, at least, be of interest to learn how different materials may be put together to make up a given formula.

Suppose that we desire to make a mixture containing

Nitrogen	4 per cent.
Available phosphoric acid	8 "
Potash	10 "

Suppose, in addition, that we have on hand for our purpose the following materials:

Nitrate of soda containing 16 per cent. of nitrogen.

Acid phosphate containing 15 per cent. of available phosphoric acid.

Muriate of potash containing 50 per cent. of actual potash.

How many pounds of each of these materials shall we take to make one ton of a mixture having the composition given above?

To contain 4 per cent. of nitrogen, the ton must contain 80 pounds. The material which we use contains 16 pounds of nitrogen in 100 pounds, and hence 500 pounds of nitrate of soda would be required to furnish 80 pounds of nitrogen.

To contain 8 per cent. of available phosphoric acid, the ton must contain 160 pounds. Our material contains in 100 pounds 15 pounds of available phosphoric acid and hence 1067 pounds of acid phosphate would be required to furnish 160 pounds of available phosphoric acid.

To contain 10 per cent. of actual potash, the ton must contain 200 pounds. Our muriate of potash is one-half actual potash and hence 400 pounds of muriate would be required to furnish 200 pounds of actual potash.

We should, then, have the following amounts of materials to be used for one ton of fertilizer:

500	pounds nitrate of soda
1067	pounds acid phosphate
400	pounds muriate or potash

1967 pounds of these mixed materials furnish the amount of nitrogen, potash and phosphoric acid we need for one ton of our formula. How shall we make the mixture up to one ton? We simply add 33 pounds of sand or other inert matter as a "filling," and we thus obtain one ton of a fertilizer having the composition given above.

By adding one more ton of filling, we should have two tons of a fertilizer of the following composition:

Nitrogen	2	per cent.
Available phosphoric acid	4	"
Potash	5	"

By way of further illustration, we add several formulas and the details of their make-up.

No. 1. HIGH-GRADE.—(*Complete*).

KIND OF MATERIAL.	Pounds of material.	Pounds of nitrogen in material.	Pounds of available phosphoric acid in material.	Pounds of potash in material.
Dissolved bone black	700	......	119.0	......
Dissolved bone-meal	500	12.5	88.0	......
Dried blood	200	20.0	......	......
Nitrate of soda	200	32.0	......	......
Sulphate of ammonia	100	20.5	......	......
Muriate of potash	200	......	......	100.0
Sulphate of potash	100	......	......	50.0
Pounds of materials	2,000	85.0	207.0	150.0
Per cent	......	4.25	10.35	7.50

No. 2. MEDIUM-GRADE.—(*Complete.*)

KIND OF MATERIAL.	Pounds of material.	Pounds of nitrogen in material.	Pounds of available phosphoric acid in material.	Pounds of potash in material.
Dissolved bone-black	1,200	....	204.0	....
Tankage	500	35.0	50.0	....
Nitrate of soda	100	16.0	....	....
Muriate of potash	200	....	....	100.0
Pounds of material	2,000	51.0	254.0	100.0
Per cent		2.55	12.70	5.00

No. 3. LOWER-GRADE.—(*Complete.*)

KIND OF MATERIAL.	Pounds of material.	Pounds of nitrogen in material.	Pounds of available phosphoric acid in material.	Pounds of potash in material.
Dissolved South Carolina rock	1,600	....	240.0	....
Dried ground fish	150	10.5	12.0	....
Nitrate of soda	100	16.0	....	....
Muriate of potash	150	....	....	75
Pounds of material	2,000	26.5	252.0	75
Per cent		1.32	12.6	3.75

No. 4. HIGHLY AMMONIATED BONE SUPERPHOSPHATE.

KIND OF MATERIAL.	Pounds of material.	Pounds of nitrogen in material.	Pounds of available phosphoric acid in material.	Pounds of potash in material.
Dissolved bone-meal	1,300	32.5	227.5	....
Nitrate of soda	200	32.0	....	....
Sulphate of ammonia	200	41.0	....	....
Dried blood	100	10.0	....	....
Dried fish	200	14.0	16.0	....
Pounds of material	2,000	129.5	243.5	....
Per cent		6.48	12.28	....

No. 5. Ordinary Ammoniated Bone Superphosphate.

KIND OF MATERIAL.	Pounds of material.	Pounds of nitrogen in material.	Pounds of available phosphoric acid in material.	Pounds of potash in material.
Dissolved bone-black	1,700	....	289.0	....
Nitrate of soda	100	16.0	....	....
Dried fish	200	14.0	16.0	....
Pounds of material	2,000	30.0	305.0	....
Per cent	....	1.50	15.25	....

No. 6. Ordinary Ammoniated Mineral Superphosphate.

KIND OF MATERIAL.	Pounds of material.	Pounds of nitrogen in material.	Pounds of available phosphoric acid in material.	Pounds of potash in material.
Dissolved South Carolina rock	1,800	....	270.0	....
Nitrate of soda	100	16.0	....	....
Sulphate of ammonia	100	20.5	....	....
Pounds of material	2,000	36.5	270.0	....
Per cent	....	1.83	13.50	....

No. 7. Complete Fertilizer High in Phosphoric Acid.

KIND OF MATERIAL.	Pounds of material.	Pounds of nitrogen in material.	Pounds of available phosphoric acid in material.	Pounds of potash in material.
Keystone concentrated phosphate	500	....	190.0	....
Dissolved South Carolina rock	600	....	90 0	....
Dissolved bone meal	500	12.5	88.0	....
Dried fish	100	7.0	8.0	....
Tankage	100	7.0	10.0	....
Cottonseed-hull ashes	200	....	15.0	40.0
Pounds of material	2,000	26.5	401.0	40.0
Per cent	....	1.33	20.05	2.0

No. 8. Superphosphate with Much Potash.

KIND OF MATERIAL.	Pounds of material.	Pounds of nitrogen in material.	Pounds of available phosphoric acid in material.	Pounds of potash in material.
Dissolved South Carolina rock	1,300	....	195.0	....
Cotton-seed hull ashes	500	....	37.5	100
Muriate of potash	200	....	....	100
Pounds of material	2,000	....	232.5	200
Per cent	....	....	11.63	10.00

No. 9. High-grade Plain Superphosphate.

KIND OF MATERIAL.	Pounds of material.	Pounds of nitrogen in material.	Pounds of available phosphoric acid in material.	Pounds of potash in material.
Keystone concentrated phosphate	600	....	228.0	....
Dissolved bone black	700	....	119.0	....
Dissolved South Carolina rock	700	....	105.0	....
Pounds of material	2,000	....	452.0	....
Per cent	....	....	22.60	....

No. 10. Lower Grade Plain Superphosphate.

KIND OF MATERIAL.	Pounds of material.	Pounds of nitrogen in material.	Pounds of available phosphoric acid in material.	Pounds of potash in material.
Dissolved South Carolina rock	1,200	....	180.0	....
Odorless phosphate (Thomas slag meal)	800	....	160.0	....
Pounds of material	2,000	....	340.0	....
Per cent	....	....	17.00	....

XIII. Average Composition and Value of Different Fertilizing Materials and of Farm Crops. Tabulated Compilation.

In the tables following, we print a compilation of data, showing the manurial composition and value of a large number of different kinds of materials. The different kinds of materials given are tabulated and presented under the following heads:

1. Materials used in fertilizers.
2. Hay and dry coarse fodders.
3. Green fodders.
4. Straw, chaff, leaves, etc.
5. Roots, bulbs, tubers, etc.
6. Grains and other seeds.
7. Mill products.
8. Fruits.
9. Vegetables.
10. Dairy products.
11. Farm animals.
12. By-products and waste materials.

1. MATERIALS USED IN FERTILIZERS.

	Pounds of nitrogen in 2,000 pounds of material.	Pounds of Phosphoric Acid in 2,000 Pounds of Material.			Pounds of potash in 2,000 pounds of material.	Approximate fertilizing valuation of 2,000 pounds.
		Available.	Insoluble.	Total.		
Apatite	....	....	660 to 800	660 to 800	....	$13 00 to 16 00
Ashes (anthracite coal)	....	....	....	2 to 3	2 to 3	0 15 to 0 20
Ashes (bituminous coal)	....	....	....	8 to 10	8 to 10	0 50 to 0 70
Ashes (lime-kiln)	....	....	....	20 to 25	20 to 30	1 50 to 2 00
Ashes (spent tan-bark)	....	....	....	30 to 40	30 to 50	2 to 3
Ashes (wood, leached)	....	....	....	20 to 30	20 to 60	2 to 5
Ashes (wood, unleached)	....	....	....	30 to 40	80 to 160	6 to 10
Azotin (ground meat, etc., free from fat)	200 to 400	....	....	60 to 80	....	30 to 40
Bone-ash	....	....	640 to 800	640 to 800	....	13 to 16
Bone-black	....	....	500 to 700	500 to 700	....	10 to 14
Bone-black (dissolved)	....	240 to 360	20 to 40	260 to 400	....	15 to 22
Bone-meal	70 to 90	80 to 160	320 to 340	400 to 500	....	22 to 30
Bone-meal (free from fat)	100 to 120	....	400 to 440	400 to 440	....	35 to 40
Bone-meal (from glue factory)	30 to 40	120 to 160	320 to 400	440 to 560	....	18 to 22
Bone-meal (dissolved)	50 to 70	240 to 360	40 to 140	280 to 400	....	23 to 35
Carnallite	....	....	....	....	260 to 280	12 to 13
Castor-bean pomace	100 to 120	....	....	40 to 50	20 to 25	15 to 18
Cottonseed-hull ashes	....	140 to 160	....	160 to 180	300 to 500	23 to 34
Cottonseed-meal	120 to 140	....	....	30 to 60	30 to 40	17 to 22
Dried blood	200 to 300	....	....	35 to 40	....	35 to 50
Dried fish	140 to 160	50 to 60	100 to 120	150 to 180	10 to 15	31 to 36
Florida rock	....	....	500 to 700	500 to 700	....	10 to 14
Florida soft phosphate	....	....	360 to 400	360 to 400	....	7 to 8
Hair	280 to 320	....	....	....	....	14 to 16
Hoof-meal, horn-dust	200 to 300	....	....	35 to 40	....	10 to 15
Kainit	....	....	....	....	240 to 280	11 to 12
Keystone concentrated phosphate	....	700 to 800	140 to 160	900 to 960	....	41 to 47
Krugite	....	....	....	....	160 to 180	8 to 9
Leather-scraps, leather-meal	140 to 160	....	....	....	....	7 to 8

1. MATERIALS USED IN FERTILIZERS — (*Concluded*).

	Pounds of nitrogen in 2,000 pounds of material.	POUNDS OF PHOSPHORIC ACID IN 2,000 POUNDS OF MATERIAL.			Pounds of potash in 2,000 pounds of material.	Approximate fertilizing valuation of 2,000 pounds.
		Available.	Insoluble.	Total.		
Lobster shells	70 to 90	....	....	60 to 80	....	$0 12 to 0 15
Marls (New Jersey greensand)	....	....	....	20 to 80	70 to 140	4 to 8
Mud (fresh-water)	20 to 40	....	....	4 to 5	4 to 5	3 to 6
Meat-scraps	200 to 240	....	....	....	....	30 to 36
Muriate of ammonia	500 to 520	....	....	....	....	92 to 96
Muriate of potash (80 to 85 per cent pure)	....	....	....	....	1000 to 1060	45 to 48
Nitrate of potash	260 to 280	....	....	....	810 to 880	84 to 88
Nitrate of soda	310 to 320	....	....	....	....	46 to 48
Nitrogenous guanos	140 to 160	140 to 160	120 to 140	260 to 300	40 to 60	33 to 38
Oleomargarine refuse	200 to 240	....	....	10 to 20	....	30 to 36
Peat	15 to 20	....	....	2 to 4	5 to 10	2 to 3
Peruvian guano	140 to 160	100 to 160	100 to 140	200 to 300	....	30 to 36
Soot	....	....	....	....	30 to 40	1 50 to 2 00
South Carolina rock (ground)	....	....	500 to 600	500 to 600	....	10 to 12
South Carolina rock (floats)	....	....	500 to 600	500 to 600	....	10 to 12
South Carolina rock (dissolved)	....	200 to 240	40 to 80	240 to 320	....	13 to 16
Sulphate of ammonia	380 to 410	....	....	....	....	70 to 76
Sulphate of potash (low-grade)	....	....	....	....	560 to 600	29 to 31
Sulphate of potash (high-grade)	....	....	....	....	960 to 1020	50 to 54
Sulphate of potash and magnesia	....	....	....	....	520 to 560	27 to 29
Tankage	140 to 180	100 to 120	100 to 120	200 to 240	....	28 to 36
Thomas slag	....	120 to 140	240 to 260	360 to 400	....	11 to 13
Tobacco stalks	70 to 80	....	....	10 to 20	100 to 120	16 to 19
Tobacco stems	40 to 50	....	....	10 to 20	140 to 160	12 to 15
Waste from powder works	40 to 60	....	....	....	320 to 360	23 to 28
Wool-waste	100 to 120	....	....	4 to 8	20 to 60	6 to 10

HAY AND DRY COARSE FODDERS — GREEN FODDERS.

	Pounds of nitrogen in one ton.	Pounds of phosphoric acid in one ton.	Pounds of potash in one ton.	Approximate fertilizing valuation of 2,000 pounds.
2. Hay and Dry Coarse Fodders.				
Alfalfa	44.0	10.6	34.0	$8 80
Blue melilot	38.4	10.8	56.0	9 10
Buckwheat (Japanese)	32.6	17.0	66.4	9 05
Buttercups	20.4	8.2	16.2	4 25
Carrot tops (dry)	62.5	12.2	97.6	14 90
Clover (alsike)	46.6	14.0	40.2	9 70
Clover (Bokhara)	40.0	8.8	37.0	8 30
Clover (crimson)	45.0	13.5	50.0	9 90
Clover (mammoth red)	44.6	11.0	24.4	8 50
Clover (medium red)	41.8	8.8	44.0	8 90
Clover (white)	55.0	10.4	36.2	10 60
Corn fodder (with ears)	36.0	11.0	18.0	6 85
Corn stover (without ears)	22.4	6.0	26.4	5 00
Cow-pea (whole plant)	39.0	10.6	29.4	7 85
Daisy (white)	5.6	8.8	25.0	2 50
Daisy (ox-eye)	6.0	9.0	25.0	2 60
Hungarian grass	24.0	7.0	26.0	5 25
Italian rye-grass	23.0	11.0	25.0	5 25
June grass	21.0	7.4	29.2	5 00
Kentucky blue grass	23.8	8.0	31.4	5 55
Meadow fescue	20.0	8.0	42.0	5 50
Meadow foxtail	30.8	8.8	40.0	7 05
Mixed grasses	28.0	7.0	30.8	6 10
Orchard grasses	26.2	8.2	37.6	6 20
Perennial rye-grass	24.6	11.2	31.0	5 80
Redtop	23.0	7.2	20.4	4 85
Rowen of mixed grasses	32.0	9.2	30.0	6 75
Salt marsh hay	23.6	5.0	14.4	4 50
Serradella	54.0	15.6	13.0	9 50
Soja bean (whole plant)	46.4	13.4	21.6	8 70
Tall meadow-oat grass	23.2	6.4	34.4	5 50
Timothy hay	25.2	9.2	30.6	5 75
Vetch and oats	27.4	10.6	18.0	5 55
Yellow trefoil	42.8	8.6	19.6	7 85
3. Green Fodders.				
Alfalfa	14.4	2.6	11.2	2 85
Buckwheat	10.2	2.2	8.6	2 05
Clover (alsike)	8.8	2.2	4.0	1 65
Clover (crimson)	8.6	2.6	9.8	1 90
Clover (red)	10.6	2.6	9.2	2 20
Clover (white)	11.2	4.0	4.8	2 10
Corn fodder	8.2	3.0	6.6	1 70
Corn fodder (ensilage)	5.6	2.2	7.4	1 30
Cow pea	5.4	2.0	6.2	1 20
Flat pea	22.6	3.6	11.6	4 15
Horse bean	13.6	6.6	27.4	3 75
Hungarian grass (German millet)	7.8	3.2	11.0	1 90
Meadow-grass	8.8	3.0	12.0	2.05
Millet (common)	12.2	3.8	8.2	2.45
Millet (Japanese)	10.6	4.0	6.8	2.15
Mixed pasture grasses	18.2	4.6	15.0	3.70
Oat-fodder	9.8	2.6	7.6	2.00
Peas	10.0	3.6	11.2	2.25

STRAW, CHAFF, LEAVES, ETC.—ROOTS, BULBS, TUBERS, ETC.—GRAINS AND OTHER SEEDS.

	Pounds of nitrogen in one ton.	Pounds of phosphoric acid in one ton.	Pounds of potash in one ton.	Approximate fertilizing valuation of 2,000 pounds.
3. *Green Fodders—(Concluded).*				
Prickley comfrey	8.4	2.2	15.0	$2 10
Rye-fodder	6.6	3.0	14.6	1 85
Rye-grass (Italian)	10.8	5.8	22.8	3 05
Rye-grass (perennial)	9.4	5.6	22.0	2 80
Serradella	8.2	2.8	8.4	1 80
Soja-bean	5.8	3.0	10.6	1 55
Sorghum	8.0	1.6	6.4	1 60
Timothy grass	9.6	5.2	15.2	2 45
Vetch and oats	4.8	1.8	15.9	1 60
White lupine	8.8	7.0	34.6	3 40
Yellow lupine	10.2	2.2	3.0	1 80
Young grass	10.0	4.4	23.2	2 90
4. *Straw, Chaff, Leaves, etc.*				
Barley-chaff	20.2	5.4	20.0	4 30
Barley-straw	26.2	6.0	41.8	6 30
Bean-shells	29.6	11.0	27.6	6 35
Buckwheat-hulls	9.8	1.4	10.4	2 05
Buckwheat-straw	26.0	12.2	48.2	7 10
Cabbage leaves (air-dried)	4.8	15.0	34.2	3 20
Cabbage-stalks (air-dried)	3.6	21.2	69.8	5 10
Carrots (stalks and leaves)	10.2	4.2	7.4	2 10
Corn-cobs	10.0	1.2	12.0	2 15
Corn-hulls	4.6	0.4	4.8	0 95
Hops	50.6	35.0	40.0	11 35
Oak leaves	16.0	6.8	3.0	2 90
Oat-chaff	12.8	4.0	20.8	3 15
Oat-straw	12.4	4.0	24.8	3 30
Pea-shells	27.2	11.0	27.6	6 00
Pea-straw (cut in bloom)	45.8	13.6	46.4	9 85
Pea-straw (ripe)	20.8	7.0	20.2	4 50
Potato stalks and leaves	9.8	1.2	1.4	1 60
Rye-straw	9.2	5.6	15.8	2 45
Sugar-beet stalks and leaves	7.0	1.4	3.2	1 30
Turnip stalks and leaves	6.0	2.6	4.8	1 25
Wheat-chaff	15.8	14.0	8.4	3 50
Wheat-straw	11.8	2.4	10.2	2 40
5. *Roots, Bulbs, Tubers, etc.*				
Beets (red)	4.8	1.8	8.8	1 25
Beets (sugar)	5.0	2.0	10.0	1 35
Beets (yellow fodder)	3.8	1.8	9.2	1 10
Carrots	3.0	2.0	10.0	1 05
Mangolds	4.0	2.0	8.0	1 10
Potatoes	4.2	1.5	10.0	1 20
Rutabagas	4.0	2.5	10.0	1 20
Turnips	4.0	2.0	8.0	1 10
6. *Grains and Other Seeds.*				
Barley	40.0	15.0	12.0	7 35
Beans	80.0	24.0	24.0	14 40
Buckwheat	28.8	8.8	4.2	5 00

MILL PRODUCTS — FRUITS — VEGETABLES.

	Pounds of nitrogen in one ton.	Pounds of phosphoric acid in one ton.	Pounds of potash in one ton.	Approximate fertilizing valuation of 2,000 pounds.
6. *Grains, etc.*— (Concluded).				
Corn kernels	36.4	14.0	8.0	$6 55
Corn kernels and cobs, cob-meal	30.0	12.0	8.8	5 55
Hempseed	50.0	35.0	20.0	10 25
Linseed	64.0	26.0	20.0	11 90
Lupines	110.0	17.5	23.0	18 50
Millet, common	45.0	18.0	9.0	8 10
Millet, Japanese	35.0	14.0	8.0	6 35
Oats	40.0	16.0	12.0	7 40
Peas	85.0	25.0	25.0	15 25
Rye	35.0	16.0	11.0	6 60
Soja-beans	106.0	38.0	40.0	19 80
Sorghum	30.0	16.0	8.5	5 75
Wheat, spring	47.0	16.0	10.0	8 35
Wheat, winter	45.0	15.0	10.0	8 00
7. *Mill Products.*				
Corn-meal	35.0	13.0	9.0	6 35
Corn-and-cob-meal	28.0	12.0	10.0	5 30
Ground barley	31.0	13.0	7.0	5 65
Ground oats	37.0	15.0	12.0	6 90
Pea meal	60.0	16.0	20.0	10 80
Rye flour	34.0	17.0	13.0	6 60
Wheat flour	44.0	11.0	11.0	7 70
8. *Fruits.*				
Apples	2.6	0.2	4.0	60
Apricots	3.8	1.2	6.0	95
Blackberries	3.0	2.0	4.0	1 05
Cherries	3.6	1.2	4.0	80
Grapes	3.2	1.8	5.5	85
Pears	2.0	0.6	1.6	40
Plums	3.6	0.4	5.0	80
Prunes	3.2	1.4	6.2	85
Raspberries	3.0	10.0	7.0	1 30
Strawberries	3.0	2.2	6.0	85
9. *Vegetables.*				
Asparagus stems	6.0	1.6	6.0	1 30
Beets, red	5.0	2.0	9.0	1 30
Cabbages	7.6	2.2	9.0	1 70
Carrots	3.2	2.0	10.0	1 10
Cauliflower	2.6	3.2	7.2	90
Cucumbers	3.2	2.4	4.8	85
Horse-radish root	7.2	1.4	23.2	2 30
Lettuce	4.6	1.4	7.4	1 15
Onions	2.8	1.0	2.0	55
Parsnips	4.4	4.0	12.5	1 50
Peas, garden	71.6	16.8	20.2	12 60
Peas, whole plant	50.0	12.0	40.0	10 10
Pumpkins, whole fruit	2.2	3.2	2.0	60
Rhubarb, stems and leaves	2.6	0.4	7.2	75
Spinach	10.0	3.2	5.4	1 95
Sweet corn cobs	4.2	1.0	4.4	90
Sweet corn husks	3.6	1.4	4.4	85

DAIRY PRODUCTS — FARM ANIMALS — BY-PRODUCTS AND WASTE MATERIALS.

	Pounds of nitrogen in one ton.	Pounds of phosphoric acid in one ton.	Pounds of potash in one ton.	Approximate fertilizing valuation of 2,000 pounds.
9. *Vegetables* — (Concluded).				
Sweet corn kernels	9.2	1.4	4.8	$1 70
Sweet corn stalks	5.6	2.8	8.2	1 40
Tomatoes, fruit	3.2	1.0	5.4	80
Tomatoes, vines	6.4	1.4	10.0	1 55
10. *Dairy Products.*				
Butter	2.0	....	....	30
Buttermilk	10.0	3.0	2.0	1 75
Cheese, whole-milk	75.0	15.0	6.0	12 30
Cheese, half-skim	105.0	15.0	6.0	16 80
Cheese, separator-skim	150.0	15.0	6.0	23 55
Cream	10.0	3.0	2.0	1 75
Milk	10.0	6.0	3.5	2 00
Skim-milk	10.0	7.0	4.0	2 05
Whey	2.5	6.0	3.0	85
11. *Farm Animals.*				
Beef	72.0	8.6	10.4	11 75
Calf	50.0	27.6	5.0	9 15
Ox	53.2	37.2	3.5	10 00
Pig	40.0	9.0	18 0	7 35
Sheep	45.0	24.5	3.0	8 15
12. *By-products and Waste Materials.*				
Apple-pomace	4.6	0.4	2.6	85
Buckwheat middlings	28.0	14.0	7.0	5 25
Corn-cobs	10.0	1.2	12.0	2 15
Cottonseed hulls	15.0	3.6	21.6	3 50
Cottonseed-meal	133.0	54.0	36.0	24 45
Glucose refuse (starch feed)	52.4	6.0	3.0	8 30
Gluten-meal	100.0	6.5	1.0	15 40
Hominy feed	32.6	20.0	10.0	6 40
Hop refuse	20.0	4.0	2.0	3 30
Linseed-meal, old process	110.0	33.0	27.0	19 50
Linseed-meal, new process	115.0	37.0	28.0	20 50
Malt sprouts	71.0	29.0	33.0	13 75
Oat-bran	45.0	22.0	13.0	8 50
Rye-bran	46.5	46.0	28.0	10 65
Rye-middlings	37.0	25.0	16.0	7 60
Spent brewers grains, dry	61.0	25.0	31.0	11.95
Spent brewers grains, wet	18.0	6.0	1.0	3 05
Wheat-bran	55.0	58.0	32.0	12 75
Wheat-middlings	53.0	19.0	12.5	9 50

XIV. The New York Fertilizer Law and its Meaning.

The legislative enactment in regard to the purchase and sale of fertilizers in this State became a law on May 24, 1890. Its execution was placed in the charge of the Geneva Experiment Station, which, in July, 1890, organized the work and began active operations. The first prosecution begun under the provisions of this law was successful in the County Court, but, on appeal to the Supreme Court, was thrown out on account of a technical defect in one portion of the law. This defect was remedied by an amendment which became operative May 9, 1894. The Station was, therefore, unable to carry out prosecutions under the law of 1890, and the first opportunity to execute, in this respect, the provisions of the amended law came with the samples collected in the summer and fall of 1894.

During the summer and fall of 1894, 165 samples of fertilizers were collected, out of which eleven brands fell so far below the guaranteed analysis as to call for prosecution on the part of the Station. These cases were distributed as follows: two each in Oneida, Monroe and Yates counties; one each in Erie and Albany counties; and three in New York city. The witnesses of the Station appeared before different grand juries and succeeded in securing several indictments. The goods in these cases showed a deficiency, expressed in money value, varying all the way from $1.50 to $6 per ton. Two brands were deficient in potash alone; five in phosphoric acid alone; one in both potash and nitrogen; and three in both phosphoric acid and nitrogen.

Since July, 1890, there have been collected and analyzed over 2,300 samples of commercial fertilizers. There are now on the Station books the addresses of over 120 firms doing business in this State. Of these there are 53 firms whose goods are manufactured in other States.

Since October, 1890, there have been published 16 fertilizer bulletins containing 660 pages. Of each of these an average of more than 15,000 copies has been distributed among the farmers of this State, making an aggregate of 11,000,000 pages.

In June, 1895, the following circular was sent to all manufacturers of fertilizers selling goods in this State:

We desire to call your special attention to some points regarding the New York Fertilizer Law, about which there appears to be more or less confusion in the minds of manufacturers and dealers.

FIRST. FORM OF STATEMENT OF GUARANTEE-ANALYSIS.

1. *Nitrogen.*—In a guarantee-analysis, the law permits statement in the form of *either nitrogen or ammonia*, or in both forms at once.

2. *Phosphoric Acid.*—In order to comply with section 1 of the law, *two forms of phosphoric acid must be stated* in a guarantee-analysis, *both soluble* phosphoric acid *and available* phosphoric acid.

To give only available phosphoric acid, or to give only total phosphoric acid is a clear violation of the provisions of the law, provided other forms are present. There is nothing in the law to prevent the statement of reverted phosphoric acid, or insoluble phosphoric acid, or total phosphoric acid *in addition to* the soluble and available forms; but these two latter forms, soluble and available phosphoric acid, must both be stated when present.

3. *Potash.*—In a guarantee-analysis, *potash* (K_2O) *soluble in distilled water must be given.*

There is no provision which would prevent one expressing the equivalent of potash (K_2O) in the form of sulphate or muriate of potash *in addition to* potash (K_2O); but, if only one form is given, it must always be that of potash (K_2O) soluble in distilled water. To state only the amount of sulphate of potash or muriate of potash, or to use alone such expressions as "potash s." or "potash sul." is a clear violation of the provisions of the law.

4. *Suggested Form of Statement of Guarantee-Analysis.*—For the sake of uniformity and simplicity, we suggest to manufacturers of fertilizers the following form of statement of guarantee-analysis as one *which will be accepted by this Station as conforming with the provisions of the law:*

Nitrogen	......	per cent.
Soluble phosphoric acid	......	"
Available phosphoric acid	......	"
Potash (K_2O)	......	"

In place of nitrogen or in addition to it, may be given the amount of ammonia equivalent to nitrogen in a fertilizer.

The other forms of phosphoric acid (reverted, insoluble and total) may be added. In case no available phosphoric acid is present, then total alone may be stated.

The equivalent of potash (K_2O) in the form of sulphate or muriate of potash may be stated in addition.

Omission to state the guarantee of any constituent will be interpreted as meaning that that constituent is not present in the fertilizer and it will be so stated in our future bulletins.

SECOND. VARIABLE LIMITS IN STATEMENT OF PERCENTAGE COMPOSITION.

In the interest of clearness and simplicity, we suggest that manufacturers give only the one figure representing the lower limit of guarantee instead of stating a lower and upper limit. Several manufacturers have voluntarily adopted this system already. Hereafter, in our publication of guarantee-analyses, we shall state only the lower limit, because this is the only figure officially recognized by us as representing the guarantee.

THIRD. NAME OF MANUFACTURER ON PACKAGES.

The law says in section 1: "A legible statement of the analysis of the goods and OF THE PERSON, FIRM OR CORPORATION WHO HAVE MANUFACTURED THE SAME, shall be on or attached to *each package* of fertilizer offered for sale for use in this State.

We have recently found numerous violations of this clearly stated provision of the law, no name of manufacturer being given. Agents will be held responsible for handling goods whose packages are not properly marked, when such goods are manufactured by parties residing outside of the State.

FOURTH. GUARANTEE-ANALYSIS ON SMALL PACKAGES.

A special investigation by our agent shows that it is a universal practice to omit altogether stating any guarantee-analysis on packages of fertilizers put up in small quantities of a few pounds or less, especially such as are sold for use on house-plants. This is a clear violation of the law and in all such cases found by our agent in the future the law will be strictly enforced.

FIFTH ANNUAL STATEMENT.

Attention is called to the second section of the law, which provides that manufacturers and certain agents "shall between the first and twentieth days of July, *in each year*, furnish the Director of the New York State Agricultural Experiment Station at Geneva, a list of the commercial fertilizers they manufacture or offer for sale for use in this State, with the names or brands by which they are known on the market, and the several percentages of nitrogen or its equivalent of ammonia, or phosphoric acid, both soluble and available and of potash, etc."

We call the attention of the manufacturers of fertilizers to these provisions of the law and ask their co-operation in helping us to carry them out effectually. It is the intention of the Station to prosecute vigorously all such violations of the law as those alluded to above, whenever they come to our knowledge. We shall regard it as a favor if any one will call our attention to violations of the law which come within their knowledge.

By order of the Board of Control,

L. L. VAN SLYKE,

Acting Director.

New York State Fertilizer Law.

CHAP. 437.

AN ACT for the protection and education of farmers and manufacturers in the purchase and sale of fertilizers.

Approved by the Governor May 24, 1890. Passed, three-fifths being present.

This act was amended by

CHAP. 601, LAWS OF NEW YORK.

AN ACT to amend chapter four hundred and thirty-seven of the Laws of eighteen hundred and ninety, entitled "An act for the protection and education of farmers and manufacturers in the purchase and sale of fertilizers."

Became a law May 9, 1894, with the approval of the Governor. Passed, three-fifths being present.

Chapter 437 as amended by chapter 601, Laws of New York, reads as follows:

Amendments are in italics.

§ 1. All commercial fertilizers which shall be offered for sale, to be used in this state, shall be accompanied by an analysis stating the percentages contained therein, of nitrogen or its equivalent of ammonia, of soluble and available phosphoric acid, the available phosphoric acid either to be soluble in water or in a neutral solution of citrate of ammonia as determined by the methods agreed upon by the American Society of Agricultural Chemists, and of potash soluble in distilled water. A legible statement of the analysis of the goods *and of the person, firm or corporation, who have manufactured the same*, shall be printed on or attached to each package of fertilizer offered for sale for use in this state, and where fertilizers are sold in bulk, to be used in this state, an analysis shall accompany the same, with an affidavit that it is a true representation of the contents of the article or articles.

§ 2. Manufacturers residing in this state, and agents or sellers of fertilizers made by persons residing outside the limits of this state, shall between the first and twentieth days of July, in each year, furnish to the director of the New York State Agricultural Experiment Station at Geneva, a list of the commercial fertilizers they manufacture or offer for sale for use in this state, with the names or brands by which they are known on the market, and the several percentages of nitrogen or its equivalent of ammonia, of phosphoric acid, *both* soluble and available, and of potash either single or combined, contained in said fertilizer, as called for in section one of this act. Whenever any fertilizer or fertilizing ingredients are shipped or sold in bulk, for use by farmers in this state, a statement must be sent to the director of the New York State Agricultural Experiment Station at Geneva, giving the name of the goods so shipped, and accompanied with an affidavit from the seller, giving an analysis of such percentage guaranteed.

§ 3. Whenever a correct chemical analysis of any fertilizer offered for sale in this state shall show a deficiency of more than one-third of one per centum of nitrogen or its equivalent of ammonia, or one-half of one per centum of available phosphoric acid or one-half of one per centum of potash soluble in distilled water, such statements shall be deemed false within the meaning of this act. This act shall apply to all articles of fertilizers offered or exposed for sale for use in the state of New York, the selling price of which is ten dollars per ton or higher, and of which they are part or parcel, and of any element into which they enter as fertilizing materials, among which may be enumerated nitrate of soda, sulphate of ammonia, dissolved bone black and bone black undissolved, any phosphate rock, treated or untreated with sulphuric or other acids, ashes from whatever source obtained, potash salts of all kinds, fish scraps, dried or undried, also all combinations of phosphoric acid, nitrogen or potash, from whatever source obtained, as well as every article that is or may be combined for fertilizing purposes.

§ 4. All manufacturers or dealers exposing or offering for sale in this state fertilizers containing roasted leather or any other form of inert nitrogenous matter shall, in legible print, state the fact on the package in which the fertilizers are exposed or offered for sale.

§ 5. Every person, firm or corporation violating any of the provisions of this act *shall be guilty of a misdemeanor*, and shall upon conviction thereof, for the first offense be punished by a fine of not less than fifty dollars, nor more than two hundred dollars, and for the second offense by double the amount, in the discretion of the court; such fines to be paid to the officer whose duty it is to enforce the provisions of this act, to be used by him for that purpose, and to be accounted for to the comptroller.

§ 6. The Director of the New York State Agricultural Experiment Station at Geneva is charged with the enforcement of the provisions of this act, and shall prosecute in the name of the people for violation thereof; and for that purpose he may employ agents, counsel, chemists and experts, and the court of special sessions shall have concurrent jurisdiction to hear and determine charges for violating the provisions of this act committed in their respective counties, subject to the power of removal provided in chapter one of title six of the code of criminal procedure.

§ 7. And the said Director of the New York State Agricultural Experiment Station at Geneva, or his duly authorized agents, shall have full access, egress and ingress to all places of business, factories, buildings, cars, vessels, or other places where any manufactured fertilizer is sold, offered for sale or manufactured. Such Director shall also have the power to open any package, barrel or other thing containing manufactured fertilizer, and may take therefrom sufficient samples; and whenever any such fertilizer is so taken for samples, it may be divided into different portions, and one or more portion sealed in such a way that it can not be opened without upon examination giving evidence of having been opened to the person sealing the same, and delivered to the person from whom said sample is taken, and to any other person that may be agreed upon, by the said director, or his agents, who takes the same and the person from whom it is taken, which portion so delivered may upon consent of the parties be delivered to a chemist for the purpose of being analyzed other than the chemist employed by said Director.

§ 8. The sum of twenty thousand dollars, or so much thereof as may be necessary, is hereby appropriated out of any money in the treasury not otherwise appropriated, to be used by said Director of the New York State Agricultural Experiment Station at Geneva, as shall be authorized by the board of control thereof, in enforcing the provisions of this act. Said sum shall be paid to said Director by the treasurer upon the warrant of the comptroller, upon vouchers, to be approved by the comptroller, in such sums and at such times as said Director may require, who shall file a statement for what purposes he desires the same.

§ 9. Agents, representatives or sellers of manufactured fertilizers or fertilizing material made or owned by parties outside of this state, and offered for sale for use in this state, shall conform to the provisions of this act, and shall be subject to its penalties, and in all particulars shall take the place of their non-resident principals.

§ 10. Chapter two hundred and twenty-two of the laws of eighteen hundred and seventy-eight is hereby repealed.

§ 11. This act shall take effect immediately.

XV. Analyses of Commercial Fertilizers Collected during the Spring of 1895.

SUMMARY OF RESULTS.

During the spring of 1895, there were collected 260 samples of commercial fertilizers, representing 232 different brands.

Of these 232 different brands, 221 contained nitrogen varying in amount from 0.65 to 12.25 per cent. The average of all the guarantee-analyses was 2.70 per cent. of nitrogen, while the average amount found by the Station analysis was 2.79 per cent.

There were 200 brands which contained available phosphoric acid, varying in amount from 0.95 to 19.14 per cent. The average amount of available phosphoric acid found by Station analysis exceeded the average guarantee-analyses by 0.62 per cent., the average of all the guarantee-analyses being 7.97 per cent. and the average actually found being 8.59 per cent.

There were 205 brands which contained potash, varying from 0.53 to 32.44 per cent. The average amount of potash found by our analysis exceeded the average guarantee-analysis by 0.45 per cent., the average of all the guarantee-analyses being 4.90 per cent., and the average actually found being 5.35 per cent.

The retail price of the brands analyzed varied from $13 to $150 a ton and averaged $31.43.

Of the 232 different brands collected, 136 were below the manufacturer's guarantee-analysis in one or more constitutents, in amounts varying from 0.01 to 3.78 per cent.

The amount of nitrogen was below the guarantee-analysis of the manufacturer in 73 brands, the deficiency varying from 0.01 to 3.24 per cent. and averaging 0.36 per cent. In 44 of the 73 brands, the deficiency was less than 0.25 per cent.; in 10 brands, it was over 0.25 and below 0.50 per cent.; in 11 brands, it was over 0.50 and below 1 per cent.; in 6 brands, the deficiency was over 1 and below 2 per cent.; and in 2 brands, it was over 3 per cent.

The amount of phosphoric acid was below the manufacturer's guarantee-analysis in 56 brands, the deficiency varying from 0.06 to 3.78 per cent. and averaging 0.66 per cent. In 20 of the 56 brands, the deficiency was less than 0.25 per cent.; in 13 cases, it was above

0.25 and below 0.50 per cent.; in 11 brands, it was above 0.50 and below 1 per cent.; in 7 brands, the deficiency was above 1 and below 2 per cent.; in 3 brands, it was above 2 and below 3 per cent.; and in 2 cases, it was above 3 per cent.

The amount of potash was below the manufacturer's guarantee-analysis in 41 different brands, the deficiency varying from 0.01 to 3.56 per cent. and averaging 0.57 per cent. In 14 of the 41 brands, the deficiency was below 0.25 per cent.; in 10 brands, it was above 0.25 and below 0.50 per cent.; in 13 brands, it was above 0.50 and below 1 per cent.; in 2 brands, the deficiency was above 1 and below 2 per cent.; and in 1 brand it was over 3 per cent.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name of brand.	Locality where sample was taken.	Station number.
Acme Fertilizer Co., Maspeth, L. I.	Acme Fertilizer No. 1.	Parkville.	1,778
Acme Fertilizer Co., Maspeth, L. I.	Acme Fertilizer No. 2.	Parkville.	1,779
Acme Fertilizer Co., Maspeth, L. I.	Potato fertilizer.	Bridgehampton.	1,881
Alafia River M. L. Co., Syracuse, N. Y.	Florida ground bone and potash.	Syracuse.	1,904
Albert, H. & E., Biebrich, Germany.	Highly concentrated horticultural manure.	New York city.	1,891
Albert, H. & E., Biebrich, Germany.	Highly concentrated special garden manure.	New York city.	1,892
Albert, H. & E., Biebrich, Germany.	Highly concentrated fruit tree manure.	New York city.	1,893
Armour & Co., Chicago, Ill.	All soluble.	Oswego.	2,022
Armour & Co., Chicago, Ill.	Ammoniated bone and potash.	Oswego.	2,021
Armour & Co., Chicago, Ill.	Bone and blood.	Oneida. Oswego.	1,926 2,020
Armour & Co., Chicago, Ill.	Pure bone meal.	Oswego.	2,023
Armour & Co., Chicago, Ill.	Raw bone meal.	Oswego.	2,024

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	3.70	8	......	9	
Found.	3.44	6.15	8.01	9.89	$35 00
Below guarantee.	0.26	1.85			
Guaranteed.	4.95	8	......	5	
Found.	3.70	5.52	7.72	5.24	35 00
Below guarantee.	1.25	2.48			
Guaranteed.	3.30	......	7	9	
Found.	3.31	5.85	9.18	8.12	36 00
Below guarantee.				0.88	
Guaranteed.		......	16	3	
Found.		5.45	15.47	3.53	22 00
Below guarantee.			0.53		
Guaranteed.	12	13	13	21	
Found.	11.33	14.23	14.44	19.84	150 00
Below guarantee.	0.67			1.16	
Guaranteed.	13.25	11.50	11.50	26	
Found.	12.25	11.43	11.43	25.32	120 00
Below guarantee.	1.00	0.07	0.07	0.68	
Guaranteed.	6	18	18	36	
Found.	5.97	19.14	19.14	32.44	120 00
Below guarantee.	0.03			3.56	
Guaranteed.	2.90	8	11	4	
Found.	3.35	7.67	12.29	3.58	32 00
Below guarantee.		0.33		0.42	
Guaranteed.	2.05	6	8	1.10	
Found.	2.35	6.48	10.27	1.60	26 00
Below guarantee.					
Guaranteed.	5.75	......	10		
Found.	5.60	6.50	13.60		27 00 29 00
Below guarantee.	0.15				
Guaranteed.	2.90	......	22.90		
Found.	2.28	7.57	26.70		29 00
Below guarantee.	0.62				
Guaranteed.	3.70	......	22		
Found.	3.96	6.84	25.81		30 00

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Armour Packing Co., Kansas City, Mo.	Beef bone fine ground.	Oneida.	1,941
Armour Packing Co., Kansas City, Mo.	Blood and bone.	Oneida.	1,940
Armour Packing Co., Kansas City, Mo.	Fine ground beef bone.	Oneida.	1,931
Baker, H. J. & Bro., New York city.	Complete cabbage manure.	Parkville.	1,781
Baker, H. J. & Bro., New York city.	Complete potato manure.	Parkville.	1,780
Bowker Fertilizer Co., Boston, Mass.	Ammoniated dissolved bone.	Lyons.	2,009
Bowker Fertilizer Co., Boston, Mass.	Farm and garden phosphate.	Rome.	1,908
Bowker Fertilizer Co., Boston, Mass.	Hill and drill.	Orient.	1,852
Bowker Fertilizer Co., Boston, Mass.	Hill and drill.	Lyons.	2,011
Bowker Fertilizer Co., Boston, Mass.	Potato and vegetable manure.	East Williston. Lyons.	1,832 2,008
Bowker Fertilizer Co., Boston, Mass.	Stockbridge manure for potatoes and vegetables.	Jamaica. Lyons.	1,816 2,010
Bowker Fertilizer Co., Boston, Mass.	Sure crop.	Cazenovia.	1,945

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	2.90	......	25.20		$26 00
Found.	3.78	9.02	23.04		
Below guarantee.			2.16		
Guaranteed.	6.19	......	14.65		26 00
Found.	5.52	7.79	13.72		
Below guarantee.	0.67		0.93		
Guaranteed.	3.34	9	25		27 00
Found.	2.42	13.99	28.34		
Below guarantee.	0.92				
Guaranteed.	4.70	5	......	7	38 00
Found.	4.58	6.24	6.24	7.89	
Below guarantee.	0.12				
Guaranteed.	3.30	5	......	10	37 00
Found.	3.46	6.26	6.26	10.84	
Guaranteed.	1.65	8	10	2	28 00
Found.	2.09	8.86	12.27	2.48	
Guaranteed.	1.65	8	10	2	29 00
Found.	1.82	6.96	11.68	2.28	
Below guarantee.		1.04			
Guaranteed.	2.50	9	12	2	32 00
Found.	2.24	10.61	13.53	2.42	
Below guarantee.	0.26				
Guaranteed.	2.05	8	10	2	30 00
Found.	2.29	8.08	11.19	2.71	
Guaranteed.	2.50	8	10	4	33 00 35 00
Found.	2.48	9 86	12.90	4.47	
Below guarantee.	0.02				
Guaranteed.	3.30	6	8	7	36 00 45 00
Found.	3.52	8.92	10.22	6.94	
Below guarantee.				0.06	
Guaranteed.	0.83	8	10	1	25 00
Found.	1.09	10.06	14.09	1.42	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bradley Fertilizer Co., Boston, Mass.	Ammoniated dissolved bones.	Rome.	1,907
Bradley Fertilizer Co., Boston, Mass.	Complete manure for potatoes and vegetables.	Flatlands.	1,786
Bradley Fertilizer Co., Boston, Mass.	Complete manure for potatoes and vegetables.	Canastota.	1,937
Bradley Fertilizer Co., Boston, Mass.	Farmers's new method.	East Williston.	1,830
Bradley Fertilizer Co., Boston, Mass.	Niagara phosphate.	Lyons.	2,014
Bradley Fertilizer Co., Boston, Mass.	Patent superphosphate of lime.	Greenport.	1,834
Bradley Fertilizer Co., Boston, Mass.	Potato manure.	East Williston.	1,831
Chemical Company of Canton, Baltimore, Md.	Ammoniated bone superphosphate.	Skaneateles.	2,029
Clark's Cove Guano Co., New York City.	Atlas bone phosphate.	Moravia.	1,963
Clark's Cove Guano Co., New York City.	Bay State fertilizer.	Moravia.	1,964
Clark's Cove Guano Co., New York City.	Defiance complete fertilizer.	Utica. Moravia.	1,897 1,965
Clark's Cove Guano Co., New York City.	Great Planet "A" manure.	Flatlands.	1,787

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	1.65	7	8	1	$29 00
Found.	1.85	8.46	10.21	1.44	
Guaranteed.	3.70	8.50	10	7	
Found.	3.67	7.92	9.67	7.56	36 00
Below guarantee.	0.03	0.58			
Guaranteed.	3.70	8	9	6	
Found.	3.78	7.88	10.14	6.97	....
Below guarantee.		0.12			
Guaranteed.	1.65	8	10	3	33 00
Found.	2.75	8.22	9.97	3.65	
Guaranteed.	0.83	7	8	1.10	26 00
Found.	1.19	8.49	10.22	1.40	
Guaranteed.	2.50	9	11	2	
Found.	2.80	8.71	11.99	2.62	36 00
Below guarantee.		0.29			
Guaranteed.	2.70	6	8	6	
Found.	2.86	5.93	7.85	6.55	33 00
Below guarantee.		0.07			
Guaranteed.	1.65	8	10	2	28 00
Found.	2.20	8.90	9.92	2.13	
Guaranteed.		13	14		
Found.		9.22	17.34		....
Below guarantee.		3.78			
Guaranteed.	2.50	9	10	2	
Found.	2.61	8.65	12.68	2.20	....
Below guarantee.		0.35			
Guaranteed.	0.83	6	8	2	25 00
Found.	1.38	7.55	11.15	2.18	....
Guaranteed.	3.48	7.50	8.40	7.50	
Found.	3.64	8.18	10.31	7.36	36 00
Below guarantee.				0.14	

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers guaranteed by manufacturers, and as found by

MANUFACTURERS.	Trade name or brand.	Locality where sample was taken.	Station number.
Clark's Cove Guano Co., New York City.	Great Planet "B" manure.	Flatlands.	1,788
Clark's Cove Guano Co., New York City.	King Philip Alkaline guano.	Utica. Canastota.	1,896 1,939
Clark's Cove Guano Co., New York City.	Unicorn ammoniated super-phosphate.	Utica. Moravia.	1,898 1,962
Coe, E. Frank, New York City.	XXV Ammoniated bone super-phosphate.	Cazenovia.	1,948
Coe, E. Frank, New York City.	Dissolved bone.	Skaneateles.	2,033
Coe, E. Frank, New York City.	Excelsior potato fertilizer.	Parkville.	1,777
Coe, E. Frank, New York City.	Gold brand Excelsior guano.	Orient.	1,842
Coe, E. Frank, New York City.	Ralston's Knickerbocker phosphate.	Lyons.	1,995
Coe, E. Frank, New York City.	Red brand Excelsior guano.	Parkville. Orient.	1,776 1,841
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Ammoniated bone super-phosphate	Medina.	1,972
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Ammoniated practical super-phosphate.	Medina.	1,986
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Ammoniated wheat and corn phosphate.	Jamaica Medina.	1,817 1,971

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	4.95	5	7	7	
Found.	4.76	6.23	7.45	8.43	$37 00
Below guarantee.	0.19				
Guaranteed.	1.25	6	7	3	30 00
Found.	1.44	6.46	9.60	3.03	
Guaranteed.	1.85	8.50	10	2.25	32 00
Found.	1.93	8.78	12.13	2.27	
Guaranteed.	1.00	9	10	1	24 00
Found.	1.33	10.49	13.85	1.35	
Guaranteed.		12	......		17 00
Found.		13.62	16.12		
Guaranteed.	2.50	8	9	8	38 00
Found.	2.88	8.23	8.93	8.93	
Guaranteed.	2.50	8	9	6	
Found.	2.39	8.68	10.69	5.92	32 00
Below guarantee.	0.11			0.08	
Guaranteed.	1.65	8	9	1.35	
Found.	2.08	9.63	12.60	1.32	27 00
Below guarantee.				0.03	
Guaranteed.	3.30	9	10	6	
Found.	3.18	8.45	9.28	5.90	36 00 35 00
Below guarantee.	0.12	0.55		0.10	
Guaranteed.	2.90	10	11	1	
Found.	3.01	9.86	10.95	1.20	30 00
Below guarantee.		0.14			
Guaranteed.	0.83	8	9	1	24 00
Found.	1.11	8.11	10.32	1.38	
Guaranteed.	2.05	10	11	1.60	35 00
Found.	2.20	10.05	11.22	1.89	28 00

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURERS.	Trade name or brand.	Locality where sample was taken.	Station number.
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Cereal phosphate.	Scriba.	2,028
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Hanlon Brothers, special phosphate.	Medina.	1,969
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	New rival ammoniated superphosphate.	Albion.	1,985
Crocker Fertilizer & Chemical Co. Buffalo, N. Y.	Onion, celery and potato fertilizer.	Canastota.	1,934
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Potato, hop and tobacco phosphate.	Jamaica.	1,818
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Special bean fertilizer.	Medina.	1,970
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Special potato manure.	Medina. Scriba.	1,973 2,027
Cumberland Bone Phosphate Co., Portland, Me.	Fruit and vine.	Scriba.	2,026
Cumberland Bone Phosphate Co., Portland, Me.	Guano.	Scriba.	2,025
Cumberland Bone Phosphate Co., Portland, Me.	Seeding-down fertilizer.	Rome.	1,911
Cumberland Bone Phosphate Co., Portland, Me.	Super-phosphate.	Southampton. Rome.	1,886 1,912
Darling, L. B.	Fine ground bone.	New Suffolk.	1,879

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	0.83	8	9	3.24	$30 00
Found.	0.87	8.94	11.38	3.75	
Guaranteed.		10	11	8	
Found.		9.79	10.75	9.11	25 00
Below guarantee.		0.21			
Guaranteed.	1.25	10	11	1	26 00
Found.	1.29	10.22	12.59	1.81	
Guaranteed.	3.30	7	8	9.50	......
Found.	4.89	7.38	8.41	9.62	
Guaranteed.	2.05	10	11	3.25	
Found.	2.36	9.92	12.09	3.65	36 00
Below guarantee.		0.08			
Guaranteed.	0.83	8	9	3.24	
Found.	1.09	7.78	11.07	3.59	27 00
Below guarantee.		0.22			
Guaranteed.	3.70	8	9	5.40	
Found.	3.68	8.40	9.58	5.54	36 00 38 00
Below guarantee.	0.02				
Guaranteed.	0.83	4	10	8	34 00
Found.	2.45	6.94	8.05	9.77	
Guaranteed.	1.00	8	10	2	30 00
Found.	2.07	8.68	10.45	2.45	
Guaranteed.	1.25	8	12	2	
Found.	1.18	7.94	10.15	2.20	28 00
Below guarantee.	0.07	0.06			
Guaranteed.	2.05	8	10	2	33 00
Found.	2.17	8.76	10.44	2.47	32 00
Guaranteed.	2.50	......	20		
Found.	2.14	6.69	25.72		33 00
Below guarantee.	0.36				

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by mannfacturers and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Eastern Farmers' Supply Association, Montclair, N. J.	Cabbage manure.	Jamaica.	1,801
Eastern Farmers' Supply Association, Montclair, N. J.	Corn and grain manure.	Jamaica.	1,888
Eastern Farmers' Supply Association, Montclair, N. J.	Farm manure.	Jamaica.	1,889
Eastern Farmers' Supply Association, Montclair, N. Y.	Long Island special.	Jamaiea.	1,802
Eastern Farmers' Supply Association, Montclair, N. J.	Market garden manure.	Jamaica.	1,800
Eastern Farmers' Supply Association, Montclair, N. Y.	Potato manure.	Jamaica.	1,887
Farmers' Fertilizer Co., Syracuse, N. Y.	Fair and Square.	Syracuse.	1,901
Farmers' Fertilizer Co., Syracuse, N. Y.	Lot No. 10.	Skaneateles.	2,030
Farmers' Fertilizer Co., Syracuse, N. Y.	Lot No. 4.	Skaneateles.	2,031
Farmers' Fertilizer Co., Syracuse. N. Y.	Lot No. 5.	Skaneateles.	2,032
Farmers' Fertilizer Co., Syracuse, N. Y.	Reaper brand.	Syracuse.	1,903
Farmers' Fertilizer Co., Syracuse, N. Y.	Standard ammoniated bone phosphate.	Syracuse.	1,902

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 lbs. of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	4.95	5	6	5	
Found.	4.94	5.53	6.55	5.33	$34 00
Below guarantee.	0.01				
Guaranteed.	3.30	9	10	5.50	
Found.	3.39	9.26	9.66	5.14	32 00
Below guarantee.				0.36	
Guaranteed.	2.50	10	11	2.50	
Found.	2.80	10.75	11.27	2.45	29.50
Below guarantee.				0.05	
Guaranteed.	3.48	7.50	8.50	8	34 00
Found.	4.92	7.60	9.33	9.88	
Guaranteed.	3.30	7	8	7	
Found.	3.39	6.41	8.39	10	32 00
Below guarantee.		0.59			
Guaranteed.	2 50	6.50	7.50	6	
Found.	2.57	7.52	9.70	3.57	29.50
Below guarantee.				2.43	
Guaranteed.	2.50	7	8	0.54	
Found.	2.99	6.49	9.67	0.53	26 00
Below guarantee.		0.51		0.01	
Guaranteed.		12	......		17 00
Found.		12.26	13.02		
Guaranteed.		14	.....		18 00
Found.		14.15	14.89		
Guaranteed.		10	......	5	
Found.		9.53	10.11	5.94	23 00
Below guarantee.		0.47			
Guaranteed .	1.65	5.50	7.50	4.30	
Found.	1.22	5.65	8.01	3.45	26 00
Below guarantee.	0.43			0.85	
Guaranteed.	0.83	9	11	3.25	
Found.	0.65	10.07	11.72	3.01	24 00
Below guarantee.	0.18			0.24	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Farmers' Fertilizer Co., Syracuse, N. Y.	Standard special formula.	Syracuse.	1,900
Finster, John, Rome, N. Y.	Home-made bone Eagle phosphate.	Rome.	1,906
Forrester, Geo. B., New York City.	Complete cabbage manure.	Bensonhurst.	1,785
Forrester, Geo. B., New York City.	Complete potato manure.	Bensonhurst. Jamaica.	1,784 1,805
Great Eastern Fertilizer Co., Rutland, Vt.	General garden special.	Flatbush. Southold.	1,791 1,848
Hallock & Duryee Fertilizer Co., Mattituck, N. Y.	Cutchogue farmers' club fertilizer.	Mattituck.	1,874
Hallock & Duryee Fertilizer Co., Mattituck, N. Y.	Lupton's potato manure.	Mattituck.	1,865
Hallock & Duryee Fertilizer Co., Mattituck, N. Y.	Mattituck fertilizer.	Mattituck.	1,864
Hallock & Duryee Fertilizer Co., Mattituck, N. Y.	No. 1 for potatoes.	Mattituck.	1,861
Hallock & Duryee Fertilizer Co., Mattituck, N. Y.	No. 2. for cabbage.	Mattituck.	1,862
Hallock & Duryee Fertilizer Co., Mattituck, N. Y.	Phelps cabbage, grain and vegetable fertilizer.	Flatlands.	1,793
Hallock & Duryee Fertilizer Co., Mattituck, N. Y.	Phelps challenge brand, grain and vegetable fertilizer.	Jamaica.	1,821

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	0.83	8	10	2.15	
Found.	0.75	7.67	8.86	1.28	$23 00
Below guarantee.	0.08	0.33		0.87	
Guaranteed.	2.50	8	9	2	
Found.	0.78	8	11.12	1.18	25 00
Below guarantee.	1.72			0.82	
Guaranteed.	4.50	5	......	6.50	38 00
Found.	5.24	7.23	7.23	9.67	
Guaranteed.	3.70	5.50	......	10	37 00
Found.	3.97	7.73	7.73	10.66	38 00
Guaranteed.	3.30	6	......	8	
Found.	3.60	6.60	7.31	7.93	34 00
					36 00
Below guarantee.				0.07	
Guaranteed.	4.10	8	......	10	
Found.	3.87	7.55	8.17	11.18	29 00
Below guarantee.	0.23	0.45			
Guaranteed.	3.30	......	7	9	
Found.	3.12	6.70	7.32	10.19	32 00
Below guarantee.	0.18				
Guaranteed.	3.30	......	5	7	28 00
Found.	3.58	4.68	5.32	7.26	
Guaranteed.	3.30	7	7	9	33 00
Found.	3.87	8.06	8.21	10.99	
Guaranteed.	4.10	6	......	6	
Found.	4.31	7.37	7.70	5.64	33 00
Below guarantee.				0.36	
Guaranteed.	4.10	6	......	7	
Found	4.14	6.12	6.74	6.64	36 00
Below guarantee.				0.36	
Guaranteed.	3.30	8	......	6	
Found.	3.58	7.77	8.46	6.33	33 00
Below guarantee.		0.23			

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURERS.	Trade name or brand.	Locality where sample was taken.	Station number.
Hallock & Duryee Fertilizer Co., Mattituck, N. Y.	Phelps Challenge brand potato vegetable fertilizer No. 2.	Flatlands.	1,792
Hallock & Duryee Fertilizer Co., Mattituck, N. Y.	Special garden fertilizer.	Mattituck.	1,863
Hendrickson, Isaac C., Jamaica, N. Y.	High grade fertilizer.	Jamaica.	1,803
Hendrickson, Isaac C., Jamaica, N. Y.	Long Island fertilizer.	Jamaica.	1,804
Hess, S. M. & Bro., Philadelphia, Pa.	Ammoniated bone superphosphate.	Bridgehampton.	1,885
Hess, S. M. & Bro., Philadelphia, Pa.	Ground bone.	Bridgehampton.	1,884
Hess, S. M. & Bro., Philadelphia, Pa.	Keystone dissolved bone phosphate.	Mattituck.	1,870
Hess, S. M. & Bro., Philadelphia, Pa.	Potato and truck manure.	Southold.	1,851
Imperial Guano Co., Norfolk, Va.	Long Island special for potatoes and truck.	Hollis.	1,823
Imperial Guano Co., Norfolk, Va.	Quick top dressing for spinach.	Hollis.	1,822
Imperial Guano Co., Norfolk, Va.	7 per cent. guano for potatoes.	Flatbush. Hollis.	1,783 1,824
Imperial Guano Co., Norfolk, Va.	10 per cent. guano.	Flatlands. Hollis.	1,782 1,833

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	3.30	5	......	10	
Found.	2.83	5.49	5.88	10.08	$36 00
Below guarantee.	0.47				
Guaranteed.	3.30	11	......	2	33 00
Found.	3.47	11.21	11.53	2.01	
Guaranteed.	3.30	......	8	8	
Found.	2.00	4.87	8.44	12.93	35 00
Below guarantee.	1.30				
Guaranteed.	2.50	6	......	6	
Found.	2.45	3.31	8.57	4.86	30 00
Below guarantee.	0.05	2.69		1.14	
Guaranteed.	1.65	8	......	2	
Found.	1.61	9.53	10.47	2.24	......
Below guarantee.	0.04				
Guaranteed.	2.50	......	18		......
Found.	2.87	5.88	24.52		
Guaranteed.	0.83	8	10	1	26 00
Found.	1.17	11.42	12.18	1.26	
Guaranteed.	2.50	8	......	6	
Found.	2.28	8.81	9.54	6.39	33 50
Below guarantee.	0.22				
Guaranteed.	3.70	7	9	7	
Found.	4.27	6.93	7.88	7.45	35 00
Below guarantee.		0.07			
Guaranteed.	8.20	5	7	3	
Found.	8.18	4.77	5.65	3.94	46 00
Below guarantee.	0.02	0.23			
Guaranteed.	5.75	7	......	7	
Found.	5.90	6.54	8.25	7.63	...... 42 00
Below guarantee.		0.46			
Guaranteed.	8.20	6	......	3	
Found.	8.00	5.60	6.35	4.85	...... 46 00
Below guarantee.	0.20	0.40			

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURERS.	Trade name or brand.	Locality where sample was taken.	Station number.
Liebig Manufacturing Co., Carteret, N. J.	Dissolved bone and potash.	Moravia.	1,961
Liebig Manufacturing Co., Carteret, N. J.	High grade bone and potash.	Moravia.	1,960
Liebig Manufacturing Co., Carteret, N. J.	Potato and corn ammoniated super-phosphate.	Lyons.	2,012
Liebig Manufacturing Co., Carteret, N. J.	Sun ammoniated super-phosphate.	Lyons.	2,013
Lister's Agricultural Chemical Works, Newark, N. J.	Animal bone fertilizer, special L. I. brand.	New Suffolk.	1,875
Lister's Agricultural Chemical Works, Newark, N. J.	Cauliflower and cabbage fertilizer.	Jamaica.	1,799
Lister's Agricultural Chemical Works, Newark, N. J.	Celebrated ground bone.	New Suffolk.	1,877
Lister's Agricultural Chemical Works, Newark, N. J.	Corn fertilizer No. 2.	Orient.	1,854
Lister's Agricultural Chemical Works, Newark, N. J.	Potato fertilizer No. 2.	Lyons.	2,001
Lister's Agricultural Chemical Works, Newark, N. J.	Potato manure.	Jamaica. Orient.	1,798 1,853
Lister's Agricultural Chemical Works, Newark, N. J.	Standard pure bone super-phosphate of lime.	Lyons.	2,000
Lister's Agricultural Chemical Works, Newark, N. J.	Success.	New Suffolk. Cazenovia.	1,876 1,949

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.		12	......	2	$22.00
Found.		14.61	16.16	2.96	
Guaranteed.		10	......	3	22.00
Found.		12.02	15.30	4.93	
Guaranteed.	2.90	6	7	6	
Found.	2.87	8.31	9.03	6.41	35.00
Below guarantee.	0.03				
Guaranteed.	0.83	10	11	1	23.00
Found.	1.77	11.14	12.28	2.23	
Guaranteed.	1.80	9.25	......	4	32.00
Found.	2.14	9.97	11.96	4.42	
Guaranteed.	3.70	7.50	......	7	
Found.	3.63	8.19	9.10	7.69	35.00
Below guarantee.	0.07				
Guaranteed.	2.70	......	12		30.00
Found.	2.84	6.23	14.12		
Guaranteed.	1.80	9.25	......	4	30.50
Found.	2.24	10.17	11.95	4.73	
Guaranteed.	1.80	9.25	......	4	32.00
Found.	2.41	10.06	11.78	4	
Guaranteed.	3.70	7.50	......	7	35.00
Found.	3.76	7.63	8.86	7.56	34.50
Guaranteed.	2.35	10	......	1.50	
Found.	2.36	9.25	12.50	2.25	30.00
Below guarantee.		0.75			
Guaranteed.	1.25	9.50	......	2	29.00
Found.	1.34	9.52	12.37	2.29	24.00

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Lister's Agricultural Works, Newark, N. J.	Vegetable compound.	Orient.	1,855
Ludlam, Frederick, New York city.	A. B. F. brand.	Calverton.	1,858
Ludlam, Frederick, New York city.	Cereal brand.	Moravia.	1,959
Ludlam, Frederick, New York city.	Dragon's tooth brand.	Woodhaven. Moravia.	1,828 1,957
Ludlam, Frederick, New York city.	Kainit.	Bridgehampton.	1,880
Ludlam, Frederick, New York city.	Riverhead Town Agricultural Society formula.	Northville.	1,869
Ludlam, Frederick, New York city.	Sickle brand.	Moravia.	1,958
Mapes Formula and Peruvian Guano Company, New York city.	"A" brand manure.	Orient.	1,843
Mapes Formula and Peruvian Guano Company, New York city	Ammoniated dissolved bone and potash.	Cazenovia.	1,947
Mapes Formula and Peruvian Guano Company, New York city.	Cabbage and cauliflower manure.	Jamaica. Mattituck.	1,815 1,871
Mapes Formula and Peruvian Guano Company, New York city.	Complete manure for light soils.	Jamaica.	1,814
Mapes Formula and Peruvian Guano Company, New York city.	Fruit and vine manure.	Canastota.	1,938

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	3.70	7.25	......	7	
Found.	3.62	7.73	8.89	7.28	$34 50
Below guarantee.	0.08				
Guaranteed.	1.65	8	......	2	
Found.	1.98	7.91	11.28	2.87	32 00
Below guarantee.		0.09			
Guaranteed.	0.83	8	10	1	
Found.	0.82	9.17	13.29	1.30	26 00
Below guarantee.	0.01				
Guaranteed.	3.30	7	......	7	38 00
Found.	3.35	9.66	11.82	7.03	40 00
Guaranteed.				11	14 50
Found.				15.90	
Guaranteed.	4.10	8	......	10	
Found.	4.01	8.37	10.19	10.54	29 00
Below guarantee.	0.09				
Guaranteed.		10	12	1	23 00
Found.		12.49	14.48	1.51	
Guaranteed.	2.50	10	12	2.50	36 00
Found.	2.80	10.37	12.49	3.52	
Guaranteed.	1.25	10	12	1.50	
Found.	1.70	9.81	12.48	2.09	29 00
Below guarantee.		0.19			
Guaranteed.	4.10	6	6	6	38 00
Found.	4.31	6.62	7.60	6.53	39 90
Guaranteed.	4.95	6	8	6	
Found.	4.86	6.41	8.51	6.94	42 00
Below guarantee.	0.09				
Guaranteed.	1.65	5	7	11	......
Found.	2.16	6.71	7.81	11.80	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Mapes Formula and Peruvian Guano Company, New York City.	Potato manure.	Cazenovia.	1,946
Mapes Formula and Peruvian Guano Company, New York City.	Potato manure, L. I. special.	Flatlands.	1,790
Maryland Fertilizer and Manufacturing Co., Baltimore, Md.	Globe complete manure.	Lyons.	1,997
Maryland Fertilizer and Manufacturing Co., Baltimore, Md.	Linden superphosphate.	Lyons.	1,998
Miller Fertilizer Co., Baltimore, Md.	Dissolved South Carolina bone.	Moravia.	1,951
Miller Fertilizer Co., Baltimore, Md.	Fine ground bone.	Moravia.	1,950
Miller Fertilizer Co., Baltimore, Md.	Harvest Queen.	Moravia.	1,955
Miller Fertilizer Co., Baltimore, Md.	Hustler phosphate.	Moravia.	1,954
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Buffalo fertilizer.	Lyons.	2,003
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Buffalo guano.	Rome.	1,910
Milsom Rendering and Fertilizer Co., Buffalo, N Y.	Buffalo guano.	Lyons.	2,002
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Cyclone bone meal.	Albion.	1,980

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed. Found.	3.70 3.71	8 8.98	8 10.01	6 7.38	$43 00
Guaranteed. Found.	3.30 3.39	6 6.10	...... 8.25	7 7.31	37 00
Guaranteed. Found.	1.43 1.54	9 10.02	10 10.26	1.50 2.29	28 00
Guaranteed. Found.		8.75 9.97	9.75 12.10	2.25 2.56	26 00
Guaranteed. Found.		14 14.87	...... 16.08		16 00
Guaranteed. Found. Below guarantee.	2.50 2.36 0.14	...... 4.36	15 14.02 0.98		30 00
Guaranteed. Found.	1.00 1.08	10 10.03	11.50 13.33	2.25 2.45	25 00
Guaranteed. Found.	0.83 1.01	9 9.79	10 10.76	2.25 2.58	24 00
Guaranteed. Found. Below guarantee.	1.85 1.85	9 8.86 0.14	10 10.60	1.50 1.74	30 00
Guaranteed. Found. Below guarantee	2.05 2.11	9 8.25 0.75	10 9.88	1.50 2.02	28 00
Guaranteed. Found. Below guarantee.	0.83 1.00	10 9.47 0.53	11 11.09	1 1.30	25 00
Guaranteed. Found.	2.50 3.75	...... 6.70	22 24.43		29 00

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers and as found by

MANUFACTURERS.	Trade name or brand.	Locality where sample was taken.	Station number.
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Potato, hop and tobacco phosphate.	Calverton.	1,859
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Potato, hop and tobacco phosphate.	Rome.	1,909
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Special bean fertilizer.	Albion.	1,979
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Special potato fertilizer.	Albion.	1,987
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Vegetable bone fertilizer.	Calverton. Lyons.	1,860 2,004
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Wheat, oats and barley phosphate.	Albion.	1,978
Mittenmaier, Louis & Sons, Rome, N. Y.	Pride of America.	Rome.	1,905
Moller & Co., Maspeth, L. I.	Champion No. 1.	Canarsie.	1,796
Moller & Co., Maspeth, L. I.	Champion No. 1.	Southold.	1,846
Moller & Co., Maspeth, L. I.	Champion No. 2.	Southold.	1,797
Munroe, Lalor & Co., Oswego, N. Y.	Canada hardwood ashes.	Skaneateles.	2,034
National Fertilizer Co., Bridgeport, Conn.	Ammoniated bone phosphate.	Southold.	1,850

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	2.50	8	9	6	
Found.	2.48	8.81	10.11	5.18	$32 00
Below guarantee.	0.02			0.82	
Guaranteed.	2.05	8	9	4	
Found.	1.85	8.10	9.49	3.60	32 00
Below guarantee.	0.20			0.40	
Guaranteed.	0.83	10	11	4	
Found.	1.06	8.21	10.36	5.11	25 00
Below guarantee.		1.79			
Guaranteed.	1.65	8	10	8	
Found.	1.72	8.17	9.91	8.02	31 00
Guaranteed.	4.10	8	9	5	
Found.	3.76	9.68	11.45	4.25	37 00 35 00
Below guarantee.	0.34			0.75	
Guaranteed.	1.25	9	10	2	
Found.	1.24	9.01	10.70	1.99	24 00
Below guarantee.	0.01			0.01	
Guaranteed.	1.65	......	6	3	
Found.	0.77	1.78	3.24	3.61	28 00
Below guarantee.	0.88		2.36		
Guaranteed.	3.30	......	7	6	
Found.	3.27	5.65	8.67	6.71	37 00
Below guarantee.	0.03				
Guaranteed.	3.30	......	9	6	
Found.	3.10	5.36	8.26	6.90	32 00
Below guarantee.	0.20		0.74		
Guaranteed.	4.10	......	7	5	
Found.	3.39	5.55	8.73	5.37	37 00
Below guarantee.	0.71				
Guaranteed.		......	......	......	
Found.		0.84	1.48	4.82	13 00
Guaranteed.	1.65	7	9	2	
Found.	1.81	10.81	11.82	2.49	29 00

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's complete fertilizer.	East Marion.	1,840
National Fertilizer Co., Bridgeport, Conn.	Chittenden's root fertilizer.	Queens.	1,827
National Fertilizer Co., Bridgeport, Conn.	Fish and potash.	Mattituck.	1,872
Northwestern Fertilizer Co., Chicago, Ill.	Horseshoe brand fine raw bone.	Lyons.	1,996
Northwestern Fertilizer Co., Chicago, Ill.	Horseshoe brand prairie phosphate.	Lyons.	1,999
Oakfield Fertilizer Co., Buffalo, N. Y.	Domestic.	Locke.	2,016
Oakfield Fertilizer Co., Buffalo, N. Y.	Golden Sheaf.	Locke.	2,017
Oakfield Fertilizer Co., Buffalo, N. Y.	Great Value.	Locke.	2,018
Oakfield Fertilizer Co., Buffalo, N. Y.	High farming fertilizer.	Locke.	2,015
Oakfield Fertilizer Co., Buffalo, N. Y.	Potato and tobacco.	Locke.	2,019
Oneonta Fertilizer Co., Oneonta, N. Y.	Economical manure.	Earlville.	1,944
Oneonta Fertilizer Co., Oneonta, N. Y.	Potato manure.	Earlvile.	1,943

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	3.30	8	10	6	
Found.	3.65	7.63	9.88	6.77	$34 00
Below guarantee.		0.37			
Guaranteed.	3.30	8	10	6	35 00
Found.	3.67	8	10	6.04	
Guaranteed.	2.90	......	8	4	28 00
Found.	3.06	4.84	8.61	5.23	
Guaranteed.	3.30	......	22		31 00
Found.	4.15	4.99	23.69		
Guaranteed.	1.65	6	9		26 00
Found.	1.70	7.22	11.54		
Guaranteed.	1.65	8	9	1.08	27 00
Found.	1.94	8.53	8.87	1.24	
Guaranteed.	1.25	7	8	1.90	
Found.	1.72	7.96	8.40	1.87	25 00
Below guarantee.				0.03	
Guaranteed.	0.83	6	7	1.08	24 00
Found.	1.11	6.98	7.70	1.16	
Guaranteed.	1.85	8	9	2.45	
Found.	2.23	7.21	8.88	2.67	29 00
Below guarantee.		0.79			
Guaranteed.	2.50	6	7	4.32	
Found.	2.76	6.70	7.79	3.95	31 00
Below guarantee.				0.37	
Guaranteed.	1.65	5	6	5	
Found.	2.23	8.23	9.84	4.90	30 00
Below guarantee.				0.10	
Guaranteed.	3.70	7.50	8	7	42 00
Found.	3.75	8.27	8.27	7.69	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number
Oneonta Fertilizer Co., Oneonta, N. Y.	Success.	Earlville.	1,942
Pacific Guano Co., New York City.	Nobsque guano.	Oneida.	1,928
Pacific Guano Co., New York City.	Soluble Pacific guano.	Oneida.	1,927
Phipps, Wm. W. & Co., Albion, N. Y.	Dissolved bone.	Albion.	1,977
Phipps, Wm. W. & Co., Albion, N. Y.	Eagle brand ammoniated dissolved bone with potash.	Albion.	1,976
Phipps, Wm. W. & Co., Albion, N. Y.	Eagle brand potato, corn, fruit and vine fertilizer.	Albion.	1,975
Phipps, Wm. W. & Co., Albion, N. Y.	Eagle brand super-phosphate, with potash.	Albion.	1,974
Preston Fertilizer Co., Greenpoint, L. I.	Ammoniated bone super-phosphate.	Queens.	1,825
Preston Fertilizer Co., Greenpoint, L. I.	Potato fertilizer.	Queens.	1,826
Quinnipiac Co., New York City.	Dissolved bone and potash.	Oneida.	1,922
Quinnipiac Co., New York City.	Market garden manure.	Jamaica.	1,808
Quinnipiac Co., New York City.	Mohegan brand.	Oneida.	1,921

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds o water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	0.83	9	11	1	$27 00
Found.	1.99	9.87	10.11	1.67	
Guaranteed.	1.15	8	9	2	28 00
Found.	1.17	8.21	10.79	2.08	
Guaranteed.	2.05	8	10	1.50	
Found.	1.85	8.20	10.41	2.39	32 00
Below guarantee.	0.20				
Guaranteed.		17.10	17.50		
Found.		16.87	17.05		20 00
Below guarantee.		0.23	0.45		
Guaranteed.	0.83	9	11	2	
Found.	0.87	15.60	15.60	1.94	28 00
Below guarantee.				0.06	
Guaranteed.	2.05	8	9	7	
Found.	2.06	8.69	11.56	6.50	36 00
Below guarantee.				0.50	
Guaranteed.		11	13	2	24 00
Found.		13.80	15.63	2.06	
Guaranteed.	2.50	9	......	2	
Found.	2.48	8.40	9.80	5.41	30 00
Below guarantee.	0.02	0.60			
Guaranteed.	3.30	8	......	7	
Found.	2.85	8.16	12.10	6.08	35 00
Below guarantee.	0.45			0.92	
Guaranteed.		10	......	2	25 00
Found.		10.71	13.59	2.22	
Guaranteed.	3.30	8	9	7	
Found.	3.20	8.56	10.52	7.30	35 00
Below guarantee.	0.10				
Guaranteed.	0.83	9	10	3	
Found.	1.34	7.91	10.35	3.15	28 00
Below guarantee.		1.09			

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers and as found by

MANUFACTURERS.	Trade name or brand.	Locality where sample was taken.	Station number.
Quinnipiac Co., New York City.	Potato manure.	Southold.	1,844
Read Fertilizer Co., New York City.	Farmers' friend.	Southold.	1,849
Read Fertilizer Co., New York City.	Farmers' friend superphosphate.	Lyons.	2,006
Read Fertilizer Co., New York City.	High grade farmers' friend.	Canastota.	1,936
Read Fertilizer Co., New York City.	J. H. Devin's fertilizer.	Utica.	1,895
Read Fertilizer Co., New York City.	N. Y. State superphosphate.	Moravia.	1,953
Read Fertilizer Co., New York City.	Practical potato special.	Lyons.	2,005
Read Fertilizer Co., New York City.	Prime wheat fertilizer.	Skaneateles.	2,035
Read Fertilizer Co., New York City.	Standard phosphate.	Moravia. Lyons.	1,952 2,007
Read Fertilizer Co., New York City.	Vegetable and vine fertilizer.	Canastota.	1,935
Reese, John S. & Co., Baltimore, Md.	Concentrated potato special manure.	Oneida.	1,929
Reese, John S. & Co., Baltimore, Md.	Pilgrim fertilizer.	Oneida.	1,930

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	2.50	6	7	5	
Found.	2.80	5.51	9.26	6.62	$33 00
Below guarantee.		0.49			
Guaranteed.	3.30	7	......	7	
Found.	3.37	6.64	7.43	7.80	33 00
Below guarantee.		0.36			
Guaranteed.	2.05	9	11	2	
Found.	2.36	8.87	9.52	2.28	30 00
Below guarantee.		0.13			
Guaranteed.	3.30	5	......	10	
Found.	3.41	5.11	6.77	9.74	......
Below guarantee.				0.26	
Guaranteed.	2.50	7	......	2	
Found.	2.39	7.68	8.65	2.55	23 00
Below guarantee.	0.11				
Guaranteed.	1.25	9	11	2	25 00
Found.	1.41	9.18	10.48	2.31	
Guaranteed.	0.83	4	5	8	
Found.	1.16	4.90	5.38	7.04	30 00
Below guarantee.				0.96	
Guaranteed.	1.65	8	9	4	
Found.	1.87	8.31	8.91	3.76	29 00
Below guarantee.				0.24	
Guaranteed.	0.83	8	10	4	25 00
Found.	1.15	8.15	9.15	4.10	26 00
Guaranteed.	1.65	6	7	8	
Found.	2.12	5.47	9.96	8.20	......
Below guarantee.		0.53			
Guaranteed.	2.90	6	7	7.50	
Found.	2.25	8.47	9.76	8.01	36 00
Below guarantee.	0.67				
Guaranteed.				3	
Found.	1.25	6.50	......	2.92	29 00
	1.52	7.65	8.67		
Below guarantee.				0.08	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Shoemaker & Co., Philadelphia, Pa.	Swift-sure bone meal.	Riverhead.	1,867
Shoemaker & Co., Philadelphia, Pa.	Swift-sure superphosphate for potatoes.	Riverhead.	1,866
Standard Fertilizer Co., Boston, Mass.	"A" brand.	Oneida.	1,920
Standard Fertilizer Co., Boston, Mass.	Bone and potash.	Oneida.	1,915
Standard Fertilizer Co., Boston, Mass.	Complete manure.	Bridgehampton. Oneida.	1,883 1,917
Standard Fertilizer Co., Boston, Mass.	Empire State.	Oneida.	1,919
Standard Fertilizer Co., Boston, Mass.	Hop special.	Oneida.	1,918
Standard Fertilizer Co., Boston, Mass.	Potato and tobacco fertilizer.	Bridgehampton. Oneida.	1,882 1,916
Standard Fertilizer Co., Boston, Mass.	Standard fertilizer.	Oneida.	1,913
Standard Fertilizer Co., Boston, Mass.	Standard guano.	Oneida.	1,914
Stappenbeck, H., Utica, N. Y.	Bone superphosphate.	Utica.	1,894
Swift & Co., Chicago, Ill.	Ground steamed bone.	Oneida.	1,933

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Result expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds o water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	4.10	......	20		
Found.	5.79	7.76	22.04		$32 00
Guaranteed.	2.50	8	......	5	
Found.	2.75	8.46	14.19	7.14	33 00
Guaranteed.	0.83	7	9	1	
Found.	1.07	7.50	8.69	2.93	24 00
Guaranteed.		9	12	2.50	
Feund.		9.59	12 22	2.54	23 00
Guaranteed.	3.30	8	9	7	
Found.	3.22	8.02	10.28	7.69	38 00 38 00
Below guarantee.	0.08				
Guaranteed.	0.83	4	10	8	
Found.	1.65	6.71	6.94	10.25	33 00
Guaranteed.	1.65	8	9	4.30	
Found.	2.23	5.97	9.10	7.34	32 00
Below guarantee.		2.03			
Guaranteed.	2.05	8	9	3	36 00
Found.	2.24	8.81	10.72	3.25	35 00
Guaranteed.	2 05	8	10	2	
Found.	2.13	7.66	10.24	2.71	31 00
Below guarantee.		0.34			
Guaranteed.	1.00	8	10	2	
Found.	0.87	8.02	9.62	2.87	27 00
Below guarantee.	0.13				
Guaranteed.	2.05	10	......	2	
Found.	2.01	11.74	13.57	2.36	25 00
Below guarantee.	0.04				
Guaranteed.	3.30	......	24		
Found.	3.29	6.76	25.61		30 00
Below guarantee.	0.01				

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers and found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Swift & Co., Chicago, Ill.	Pure bone tankage.	Albion.	1,981
Swift & Co., Chicago, Ill.	Pure raw bone meal.	Oneida. Albion.	1,932 1,982
Tavender Soap Co., Utica, N.Y.	Concentrated tankage.	Utica.	1,899
Thomas, I. P. & Son Co., Philadelphia, Pa.	Farmers' choice bone phosphate.	Jamaica.	1,810
Thomas, I. P. & Son Co., Philadelphia, Pa.	Normal bone phosphate.	Jamaica.	1,809
Thomas, I. P. & Son Co., Philadelphia, Pa.	Potato manure.	Jamaica. Greenport.	1,811 1,838
Thomas, I. P. & Son Co., Philadelphia, Pa.	Tip top raw bone superphosphate.	Greenport.	1,839
Thompson & Edwards Fertilizer Co., Chicago, Ill.	Blood and bone animal guano.	Lockport.	1,967
Thompson & Edwards Fertilizer Co., Chicago, Ill.	Pure fine ground bone.	Lockport.	1,966
Thompson & Edwards Fertilizer Co., Chicago, Ill.	Vegetable and potato grower.	Lockport.	1,968
Tuthill, E. & Co., Promised Land, N. Y.	Ground scrap.	Greenport.	1,857
Tuthill, E. & Co., Promised Land, N. Y.	No. 1 fertilizer.	Northville.	1,868

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	4.95	......	17		
Found.	6.31	6.53	16.85		$31 00
Below guarantee.			0.15		
Guaranteed.	3.70	......	23		30 00
Found.	4.05	5.37	25.42		33 00
Guaranteed.	4.10	2	8	2	
Found.	1.07	0.95	3.40	1.07	25 00
Below guarantee.	3.03	1.05	4.60	0.93	
Guaranteed.	1.65	9.50	......	2	
Found.	1.37	9.25	11.14	3.22	32 00
Below guarantee.	0.28	0.25			
Guaranteed.	1	8.50	......	1.50	
Found.	0.98	9.25	10.49	2.39	28 00
Below guarantee.	0.04				
Guaranteed.	2.50	9	......	6	35 00
Found.	2.60	10.26	11.24	6.47	36 00
Guaranteed.	2.50	10	......	2.75	
Found.	3.04	9.33	11.23	3.94	36 00
Below guarantee.		0.67			
Guaranteed.	5.35	......	10		
Found.	2.11	5.03	16.75		27 00
Below guarantee.	3.24				
Guaranteed.	2.50	......	22		
Found.	2.67	6.22	19.76		27 00
Below guarantee.			2.24		
Guaranteed	2.50	6	14	3.25	
Found.	1.40	4.10	14.81	2.85	32 00
Below guarantee.	1.10	1.90		0.40	
Guaranteed.	8.20	......	6		27 00
Found.	8.55	3.66	6.28		
Guaranteed.	4.10	8	......	10	
Found.	3.86	8.15	9.15	9.74	32 00
Below guarantee.	0.24			0.26	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Tuthill, E. & Co., Promised Land, N. Y.	Special fertilizer.	Greenport.	1,856
Tuthill, E. & Co., Promised Land, N. Y.	Webb's potato fertilizer.	New Suffolk.	1,878
Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Cabbage manure.	Flatbush. Hollis.	1,795 1,820
Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Potato manure.	Flatbush. Hollis.	1,794 1,819
Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Special potato manure.	Southold.	1,847
Walker Fertilizer Co., Clifton Springs, N. Y.	Ammoniated phosphate.	Albion.	1,984
Walker Fertilizing Co., Clifton Springs, N. Y.	Potato and vegetable grower.	Albion.	1,983
Wheeler, M. E. & Co., Rutland, Vt.	Grass and oats fertilizer.	Oneida.	1,924
Wheeler, M. E. & Co., Rutland, Vt.	High grade corn fertilizer.	Oneida.	1,923
Wheeler, M. E. & Co., Rutland, Vt.	High grade potato manure.	Oneida.	1,925
Williams & Clark Fertilizer Co., New York City.	Americus brand high grade special.	Flatlands. Jamaica.	1,789 1,806
Williams & Clark Fertilizer Co., New YorkCty.	Potato phosphate.	Jamaica. Southold.	1,807 1,845

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	4.10	8	......	10	
Found.	4.49	6.21	8.26	11.55	$28 00
Below guarantee.		1.79			
Guaranteed.	3.30	7	......	8	
Found.	4.00	6.36	7.79	9.09	29 00
Below guarantee.		0.64			
Guaranteed.	3.30	7	9	5	36 00
Found.	3.63	8.46	10	5.28	35 00
Guaranteed.	3.30	6	9	9	36 00
Found.	3.40	6.53	7.19	9.04	35 00
Guaranteed.	2.05	6	......	6	31 00
Found	2.18	7.37	8.58	7.15	
Guaranteed	1.65	8	......	1	
Found.	1.65	7.87	9.84	1.51	24 00
Below guarantee.		0.13			
Guaranteed.	2.50	6	......	7	
Found.	2.34	5.54	8.06	6.32	28 00
Below guarantee.	0.16	0.46		0.68	
Guaranteed.		10	......	2	26 00
Found.		10.92	14.03	2.11	
Guaranteed.	1.65	8	......	2	32 00
Found.	1.86	8.12	10.78	2.37	
Guaranteed.	2.05	8	9	3.75	32 00
Found.	1.97	9.11	10.54	4.73	
Below guarantee.	0.08				
Guaranteed.	3.75	7	8	7	34 00
Found.	2.97	7	9.84	6.99	40 00
Below guarantee.	0.75				
Guaranteed.	2.50	6	7	6	
Found.	2.72	5.85	9.20	7.33	34 00 33 00
Below guarantee.		0.15			

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Zell Guano Co., Baltimore, Md.	Dissolved bone phosphate.	Canandaigua.	1,992
Zell Guano Co., Baltimore, Md.	Electric phosphate.	Canandaigua.	1,991
Zell Guano Co., Baltimore, Md.	Hop manure.	Canandaigua.	1,993
Zell Guano Co., Baltimore, Md.	Potato grower.	Moravia.	1,956
Zell Guano Co., Baltimore, Md.	Special compound for vegetables.	Canandaigua.	1,994
Not given.	Animal fertilizer, "A" brand.	Greenport.	1,835
Not given.	Animal fertilizer, "B" brand.	Greenport.	1,836
Not given.	Animal fertilizer, "C" brand.	Greenport.	1,837
Not given.	Carpenter's special fertilizer for cabbage.	Jamaica.	1,813
Not given.	Carpenter's special fertilizer for peas and beans.	Jamaica.	1,812
Not given.	Carpenter's special fertilizer for potatoes.	Jamaica.	1,890
Not given.	Grain, special No. 1.	Honeoye Falls.	1,938

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of ni-trogen in 100 pounds of fer-tilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phos-phoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail sell-ng price per ton.
Guaranteed.		13	15		$20 00
Found.		15.51	16.48		
Guaranteed.		10	12	2	22 00
Found.		12.11	14.99	2.44	
Guaranteed.		10	12	8	26 00
Found.		12.66	13.54	7.34	
Below guarantee.				0.66	
Guaranteed.	0.83	8	10	4	24 00
Found.	1.02	8.62	10.51	7.08	
Guaranteed.	2.50	8	10	4	35 00
Found.	3.16	9.28	10.05	5.72	
Guaranteed.	2.90	......	10	7	36 00
Found.	2.91	8.56	13.26	8.25	
Guaranteed.	3.70	......	10	5	36 00
Found.	3.09	8.56	13.52	6.19	
Below guarantee.	0.61				
Guaranteed.	4.10	......	8	10	36 00
Found.	3.19	5.82	10.87	9.42	
Below guarantee.	0.91			0.58	
Guaranteed.	4.50	5	......	6.50	35 00
Found.	3.34	8.02	10.43	7.18	
Below guarantee.	1.16				
Guaranteed.	2.50	8	10	2	30 00
Found.	2.51	10.20	13.36	2.60	
Guaranteed.	3.70	7	......	6.50	35 00
Found.	3.19	9.57	12.29	6.77	
Below guarantee.	0.51				
Guaranteed.	0.83	9	......	4	26 00
Found.	0.79	8.60	9.67	4.91	
Below guarantee.	0.04	0.40			

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Not given.	Grain special No. 2.	Honeoye Falls	1,989
Not given.	Special potato manure.	Honeoye Falls.	1,990
Not given.	Star raw bone superphosphate.	East Williston.	1,829
Not given.	The Victor special formula.	Cutchogue.	1,873

LECTED IN NEW YORK STATE DURING THE SPRING OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 lbs. of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	0.84	7	......	5	$26 00
Found.	1.02	7.77	9.34	6.89	
Guaranteed.	2.50	7	......	7	
Found.	2.17	6.73	8.41	8.09	36 00
Below guarantee.	0.33	0.27			
Guaranteed.	3 30	......	8	10	
Found.	3.13	3.24	9.05	4.33	33.00
Below guarantee.	0.17			5.67	
Guaranteed.	3.30	10	......	8	
Found.	3.04	10.29	10.29	8.72	35 00
Below guarantee.	0.26				

XVI. Analyses of Fertilizers Collected During the Fall of 1895.

SUMMARY OF RESULTS OF ANALYSIS OF FERTILIZERS COLLECTED DURING THE FALL OF 1895.

During the fall of 1895, there were collected 288 samples of commercial fertilizers, representing 182 different brands.

Of these 182 different brands, 133 contained nitrogen varying in amount from 0.10 to 5 per cent. The average of all the guarantee-analyses was 1.60 per cent. of nitrogen, while the average amount found by the Station analysis was 1.75 per cent.

There were 181 brands which contained available phosphoric acid, varying in amount from 5.56 to 16.81 per cent. The average amount of available phosphoric acid found by Station analysis exceeded the average guarantee-analysis by 0.85 per cent., the average of all the guarantee-analyses being 9.12 per cent. and the average actually found being 9.97 per cent.

There were 153 brands which contained potash, varying from 0.55 to 49.02 per cent. The average amount of potash found by our analysis exceeded the average guarantee-analysis by 0.33 per cent., the average of all the guarantee-analyses being 2.75 per cent., and the average actually found being 3.08 per cent.

The retail price of the brands analyzed varied from $16 to $48 a ton and averaged $26.70.

Of the 182 different brands collected, 76 were below the manufacturer's guarantee-analysis in one or more constituents, in amounts varying from 0.01 to 2.91 per cent.

The amount of nitrogen was below the guarantee-analysis of the manufacturer in 27 brands, the deficiency varying from 0.01 to 1.15 per cent. and averaging 0.18 per cent. In 24 of the 27 brands, the deficiency was not greater than 0.25 per cent.; in 1 brand, it was over 0.25 and below 0.50 per cent.; in 1 brand, it was over 0.50 and below 1 per cent.; in 1 brand, the deficiency was slightly over 1 per cent.

The amount of phosphoric acid was below the manufacturer's guarantee-analysis in 33 brands, the deficiency varying from 0.02 to 2.91 per cent. and averaging 0.58 per cent. In 14 of the 33 brands, the deficiency was less than 0.25 per cent.; in 10 cases, it was above 0.25 and below 0.50 per cent.; in 2 brands, it was above 0.50 and below 1 per cent.; in 2 brands, the deficiency was above 1 and below 2 per cent.; in 3 brands, it was above 2 and below 3 per cent.

The amount of potash was below the manufacturer's guarantee-analysis in 30 different brands, the deficiency varying from 0.01 to 1.55 per cent. and averaging 0.43 per cent. In 14 of the 30 brands, the deficiency was below 0.25 per cent.; in 5 brands, it was above 0.25 and below 0.50 per cent.; in 7 brands, it was above 0.50 and below 1 per cent.; in 4 brands, the deficiency was above 1 and below 2 per cent.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Alafia River M. L. Co., Syracuse, N. Y.	Florida ground bone and potash.	Johnsonburg.	2,252
Allentown Manufacturing Co., Allentown, Pa.	Complete bone phosphate.	Fayette.	2,114
Allentown Manufacturing Co., Allentown, Pa.	Lehigh phosphate.	Fayette.	2,113
Bowker Fertilizer Co., Boston and New York.	Acid phosphate.	Le Roy. Wyoming.	2,185 2,204
Bowker Fertilizer Co., Boston and New York.	Alkaline bone.	Romulus.	2,053
Bowker Fertilizer Co., Boston and New York.	Ammoniated dissolved bone.	Waterloo. Moravia. Warsaw.	2,051 2,132 2,190
Bowker Fertilizer Co., Boston and New York.	Farm and garden phosphate.	Le Roy.	2,171
Bowker Fertilizer Co., Boston and New York.	Fresh ground bone.	Warsaw.	2,188
Bowker Fertilizer Co., Boston and New York.	Hill and drill.	MacDougall. Binghamton. Warsaw.	2,062 2,143 2,187
Bowker Fertilizer Co., Boston and New York.	Kinne's selected fertilizers.	Ovid.	2,070
Bowker Fertilizer Co., Boston and New York.	Lawn and garden dressing.	Binghamton. Batavia.	2,144 2,260
Bowker Fertillzer Co., Boston and New York.	Stockbridge manure for flowers and small fruits.	Syracuse.	2,097

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.		......	16	3.50	
Found.		5.60	18.20	2.91	$24 00
Below guarantee.				0.59	
Guaranteed.	1.65	12	16	2	
Found.	1.40	9.09	15.54	2.23	33 00
Below guarantee.	0.25	2.91			
Guaranteed.	0.80	7	8	2	
Found.	0.74	9.77	14.47	0.55	27 00
Below guarantee.	0.06			1.45	
Guaranteed.		11	13		22 00
Found.		13.44	15.79		
Guaranteed.		11	12	1	
Found.		10.91	16.22	1.19	24 00
Below guarantee.		0.09			
Guaranteed.	1.50	8	10	2	
Found.	1.26	8.53	14	2.07	29 00
					28 00
Below guarantee.	0.24				
Guaranteed.	1.60	8	......	2	
Found.	1.43	7.87	13.81	1.93	27 00
Below guarantee.	0.17	0.13		0.07	
Guaranteed.	2.50	5	18		
Found.	2.60	13.28	19.46		
Guaranteed.	2	8	10	2	30 00
Found.	2	8.39	11.55	2.54	35 00
					30 00
Guaranteed.	1	9	11	2.50	
Found.	0.94	9.70	13.80	2.60	23 00
Below guarantee.	0.06				
Guaranteed.	3.25	6	8	5	
Found.	3.75	7.91	9.47	4.95	48 00
Below guarantee.				0.05	
Guaranteed.	2.50	6	7	4	42 00
Found.	2.66	10.64	12.80	5.38	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bowker Fertilizer Co., Boston and New York.	Stockbridge special.	Batavia.	2,259
Bowker Fertilizer Co., Boston and New York.	Sure crop.	Waterloo. Farmer. Batavia.	2,052 2,072 2,257
Bowker Fertilizer Co., Boston and New York.	Tecumseh O I O bone phosphate.	Warsaw.	2,189
Bowker Fertilizer Co., Boston and New York.	Tobacco grower.	Syracuse.	2,099
Bowker Fertilizer Co., Boston and New York.	Tobacco phosphate.	Syracuse.	2,098
Bradley Fertilizer Co., Boston, Mass.	Acid phosphate.	Warsaw.	2,196
Bradley Fertilizer Co., Boston, Mass.	Alkaline bone.	Geneva.	2,036
Bradley Fertilizer Co., Boston, Mass.	Ammoniated dissolved bone.	Waterloo. Warsaw.	2,042 2,194
Bradley Fertilizer Co., Boston, Mass.	Dissolved bone.	Warsaw.	2,195
Bradley, Fertilizer Co., Boston, Mass.	Farmers' new method.	Geneva. Le Roy. Warsaw.	2,038 2,181 2,192
Bradley Fertilizer Co., Boston, Mass.	Fruit and vine.	Geneva.	2,039
Bradley Fertilizer Co., Boston, Mass.	Niagara phosphate.	Waterloo. Attica.	2,041 2,242

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	3.25	6	8	7	
Found.	3.70	7.57	10.96	6.97	$40 00
Below guarantee.				0.03	
Guaranteed.	0.75				
Found.	0.68	8	10	1	26 00
		9.50	12.32	1.07	24 00
Below guarantee.	0.07				26 00
Guaranteed.		7	9		
Found		14.34	14.87		
Guaranteed.	2.50	7	9	4	42 00
Found.	2.71	9.88	12.93	4.24	
Guaranteed.	1.25	8	9	1.10	35 00
Found.	1.37	9.40	11.34	1.37	
Guaranteed.		10	11		20 00
Found.		11.89	12.50		
Guaranteed.		11	12	2.45	
Found.		10.69	13.76	2.96	25 00
Below guarantee.		0.31			
Guaranteed.	1.65	7	8	1	
Found.	1.61	7.96	10.67	1.48	......
Below guarantee.	0.04				30 00
Guaranteed.		12	13		22 00
Found.		12.44	14.93		
Guaranteed.	0.80	8	10	2.15	28 00
Found.	1.09	8.71	10.31	2.28	24 00
					28 00
Guaranteed.	2.05	8	10	5.40	
Found.	2.15	8.31	12.59	4.20	39 00
Below guarantee.				1.20	
Guaranteed.	0.80	7	8	1.10	......
Found.	0.81	7.34	10.19	1.28	23 00

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bradley Fertilizer Co., Boston, Mass.	Patent superphosphate of lime.	Geneva. Le Roy. Warsaw.	2,037 2,180 2,193
Bradley Fertilizer Co., Boston, Mass.	Sea fowl guano.	Attica.	2,243
Chemical Co. of Canton, Baltimore, Md.	Baker's special wheat and grass.	Groton. Perry.	2,141 2,230
Chemical Co. of Canton, Baltimore, Md.	Resurgam guano.	Perry.	2,228
Clark's Cove Fertilizer Co., Boston and New York.	Alkaline bone.	Perry.	2,213
Clark's Cove Fertilizer Co., Boston and New York.	Atlas bone phosphate.	Perry.	2,214
Clark's Cove Fertilizer Co., Boston and New York.	Bay State.	MacDougall.	2,109
Clark's Cove Fertilizer Co., Boston and New York.	Defiance complete manure.	Union Springs. East Avon.	2,121 2,291
Clark's Cove Fertilizer Co., Boston and New York.	Great Planet "A" manure.	Owego.	2,159
Clark's Cove Fertilizer Co., Boston and New York.	King Philip alkaline guano.	MacDougall.	2,108
Clark's Cove Fertilizer Co., Boston and New York.	Potato phosphate.	Owego. East Avon.	2,158 2,292
Clark's Cove Fertilizer Co., Boston and New York.	Triumph bone and potash.	Union Springs.	2,122

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	2.05	8	10	1.50	$31 00
Found.	2.05	8.90	11.85	2.02	27 00
					32 00
Guaranteed.	2.05	8	10	1.50	28 00
Found.	2.22	8.48	10.95	1.56	
Guaranteed.	0.80	9	11	2	
Found.	0.99	10.29	12.86	1.81	26 00
					25 00
Below guarantee.				0.19	
Guaranteed.	1.25	8	------	2	
Found.	1.50	9.03	11.98	1.92	26 00
Below guarantee.				0.08	
Guaranteed.	1	8	9	2	24 00
Found.	1.06	8.49	10.59	2.39	
Guaranteed.		13	14		16 00
Found.		13.31	14.43		
Guaranteed.	2.45	9	10	2	
Found.	2.36	9.56	11.55	2.15	31 00
Below guarantee.	0.09				
Guaranteed.	0.80	6	8	2	26 00
Found.	1.02	9.63	12.27	2.64	25 00
Guaranteed.	3.30	8	9	7	
Found.	3.36	8.50	10.03	6.31	42 00
Below guarantee.				0.69	
Guaranteed.	1.25	6	7	3	27 00
Found.	1.35	6.12	8.40	3.19	
Guaranteed.	2.45	6	7	5	36 00
Found	2.77	6.73	9.60	5.27	35 00
Guaranteed.		10	11	2	23 00
Found.		11.56	13.62	2.48	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
E. Frank Coe Co., New York.	Alkaline bone.	Aurora. Warsaw. Daws.	2,118 2,197 2,287
E. Frank Coe Co., New York.	Dissolved bone and potash.	MacDougall. Daws.	2,110 2,289
E. Frank Coe Co., New York.	Matchless grain fertilizer.	Aurora. Warsaw. Daws.	2,119 2,198 2,288
E. Frank Coe Co., New York.	Ralston's Knickerbocker phosphate.	Aurora.	2,117
E. Frank Coe Co., New York.	Soluble bone.	MacDougall.	2,112
E. Frank Coe Co., New York.	Standard grade ammoniated bone superphosphate.	MacDougall.	2,111
E. Frank Coe Co., New York.	XXV ammoniated bone superphosphate.	Aurora. Warsaw.	2,120 2,199
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Ammoniated bone superphosphate.	Cato. Elba.	2,124 2,266
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Ammoniated practical super-phosphate.	Perry. Elba.	2,225 2,273
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Ammoniated wheat and corn phosphate.	West Fayette. Le Roy. Perry.	2,065 2,169 2,223
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Bone black.	Batavia.	2,261
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Cereal phosphate.	Lima.	2,306

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	1	9	11	1.85	$26 00
Found.	1.14	10.53	12.98	2.11	26 00
					25 00
Guaranteed.		12	15	2.50	
Found.		12.08	14.33	2.11	24 00
					22 00
Below guarantee.				0.39	
Guaranteed.	0.65	11	12	1	
Found.	0.87	10.85	14.06	1.15	24 00
					24 00
Below guarantee.		0.15			23 00
Guaranteed.	1.50	8	9	1.35	27 00
Found.	1.71	10.45	12.76	1.38	
Guaranteed.		13	15		
Found.		12.98	15.12		17 00
Below guarantee.		0.02			
Guaranteed.	1.60	8	8	1.35	29 00
Found.	1.73	10.35	12.29	1.35	
Guaranteed.	1	8	9	1	24 00
Found.	1.26	11.60	13.62	1.18	24 00
Guaranteed.	2.90	10	11	1.08	
Found.	2.73	10.81	11.26	1.45	31 00
					30 00
Below guarantee.	0.17				
Guaranteed.	0.82	8	8	1	25 00
Found.	1.05	8.95	10.90	1.42	24 00
Guaranteed.	2	10	11	1.60	
Found.	1.82	11.02	12.21	1.98	30 00
					28 00
Below guarantee.	0.18				28 00
Guaranteed.		16	......		20 50
Found.		16.81	16.81		
Guaranteed.	0.83	8	8	3.24	
Found.	1.10	7.35	11.38	5.67	25 00
Below guarantee.		0.65			

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Crocker Fertilizer and Chemical Co. Buffalo, N. Y.	Crocker's phosphate.	Geneseo.	2,317
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Muriate of potash.	Batavia.	2,262
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	New rival ammoniated super-phosphate.	West Fayette. Le Roy. Perry.	2,063 2,168 2,224
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Potato, hop and tobacco phosphate.	Elba.	2,272
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Special potato manure.	Perry.	2,227
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Universal grain grower.	West Fayette.	2,064
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Vegetable bone super-phosphate.	Perry.	2,226
Farmers' Fertilizer Co., Syracuse, N. Y.	Phœnix.	Attica.	2,238
Farmers' Fertilizer Co., Syracuse, N. Y.	Soluble bone.	Attica.	2,237
Farmers' Fertilizer Co., Syracuse, N. Y.	Standard ammoniated bone-phosphate.	Syracuse.	2,086
Farmers' Fertilizer Co., Syracuse, N. Y.	Standard special formula.	Syracuse.	2,087
Florida Manufacturing Co., Syracuse, N. Y.	Florida ground bone and potash.	Syracuse. Attica.	2,088 2,236

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	1.23	10	11	1.76	$28 00
Found.	1.38	10.14	12.35	1.92	
Guaranteed.				......	43 00
Found.				49.02	
Guaranteed.	1.20	10	11	1.60	28 00 25 00 26 00
Found.	1.36	10.14	12.21	1.86	
Guaranteed.	2	10	11	3.20	30 00
Found.	2.18	10.29	11.41	3.40	
Guaranteed.	3.70	8	9	5.40	38 00
Found.	3.45	8.36	8.67	6.59	
Below guarantee.	0.25				
Guaranteed.	0.82	7	8	2.70	26 00
Found.	0.99	6.64	10.22	3.11	
Below guarantee.		0.36			
Guaranteed.	5	6	7	5.94	40 00
Found.	5	6.16	6.91	6.84	
Guaranteed.	1.25	6	......	1.60	23 00
Found.	0.10	6.97	7.17	2.81	
Below guarantee.	1.15				
Guaranteed.		6	7.50	1	21 00
Found.		6.37	6.56	2.89	
Guaranteed.	0.80	9	11	3.25	
Found.	0.79	8 12	11.34	4.10	
Below guarantee.	0.01	0.88			
Guaranteed.	0.80	8	10	2.15	
Found.	0.72	7.97	10.45	2.32	
Below guarantee.	0.08	0.03			
Guaranteed.		......	16	3.25	
Found.		13.77	14.43	4.08	...... 20 00
Below guarantee.			1.57		

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Great Eastern Fertilizer Co., New York.	English wheat grower.	Elba. Oakfield.	2,268 2,286
Great Eastern Fertilizer Co., New York.	Oats, buckwheat and seed fertilizer.	Avon.	2,314
Great Eastern Fertilizer Co., New York.	Pure fine ground bone.	Syracuse.	2,094
Great Eastern Fertilizer Co., New York.	Soluble bone and potash.	Syracuse.	2,091
Great Eastern Fertilizer Co., New York.	Vegetable, vine and tobacco fertilizer.	Syracuse. Avon.	2,093 2,313
Great Eastern Fertilizer Co., New York.	Wheat special.	Syracuse. Attica. Oakfield.	2,092 2,247 2,284
George L. Harding, Binghamton, N. Y.	Special potato manure.	Binghamton.	2,145
S. M. Hess & Bros., Philadelphia, Pa.	Keystone dissolved bone phosphate.	Le Roy. East Avon. Batavia.	2,164 2,296 2,274
C. C. Hicks, Penn Yan, N. Y.	C. C. H. soluble bone.	Penn Yan.	2,332
C. C. Hicks, Penn Yan, N. Y.	Standard guano.	Penn Yan.	2,321
C. C. Hicks, Penn Yan, N. Y.	Yates county fertilizer.	Penn Yan.	2,323
F. N. Isham, Avon, N. Y.	Eureka.	Avon.	2,312

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	0.82	8	9	2	
Found.	0.95	8.10	11.80	1.82	$23 00 23 00
Below guarantee.				0.18	
Guaranteed.	0.80	8	9	4	28 00
Found.	0.80	8.33	9.66	4.18	
Guaranteed.	1.65	......	22		
Found.	1.38	13.23	28.03		......
Below guarantee.	0.27				
Guaranteed.		10	......	2.15	
Found.		9.73	12.24	2.01	......
Below guarantee.		0.27		0.14	
Guaranteed.	2.05	8	9	3.25	......
Found.	2.28	8.43	9.51	3.49	30 00
Guaranteed.	1.65	8	9	2	......
Found.	1.72	8.48	9.80	2.03	26 00 25 00
Guaranteed.	3.10	6.25	11	4.50	30 00
Found.	3.62	7.97	11.68	5.40	
Guaranteed.	0.80	9	11	1	25 00 26 00
Found.	1.10	11.95	13.23	1.10	26 00
Guaranteed.		14	15		16 00
Found.		15.32	16.10		
Guaranteed.	1.25	10	11	3	
Found.	1.39	11.86	13.14	2.66	25 00
Below guarantee.				0.34	
Guaranteed.	0.80	9	11	3	25 00
Found.	1.01	9.12	11.67	3.21	
Guaranteed.		10	11	3.50	
Found.		12.95	13.20	3.23	21 00
Below guarantee.				0.27	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Lazaretto Guano Co., Baltimore, Md.	Alkaline dissolved bone phosphate.	Romulus.	2,068
Lazaretto Guano Co., Baltimore, Md.	Dissolved bone phosphate.	Romulus. Lima.	2,067 2,307
Lazaretto Guano Co., Baltimore, Md.	Kinne's selected Fertilizer.	Ovid.	2,071
Lazaretto Guano Co., Baltimore, Md.	New York Standard No. 1.	Romulus.	2,069
Liebig Manufacturing Co., Carteret, N. J.	Dissolved bone.	Moravia.	2,123
Liebig Manufacturing Co., Carteret, N. J.	F. and F. bone and potash.	Moravia.	2,131
Liebig Manufacturing Co., Carteret, N. J.	High-grade bone and potash.	Moravia.	2,130
Lister Agricultural Chemical Works, Newark, N. J.	Ammoniated dissolved bone phosphate.	West Fayette. Syracuse. Batavia.	2,059 2,095 2,255
Lister Agricultural Chemical Works, Newark, N. J.	Animal bone and potash.	West Fayette.	2,061
Lister Agricultural Chemical Works, Newark, N. J.	Dissolved bone black.	Le Roy.	2,167
Lister Agricultural Chemical Works, Newark, N. J.	Perfect fertilizer.	Le Roy. Elba.	2,165 2,267
Lister Agricultural Chemical Works, Newark, N. J.	Standard pure bone.	Fowlerville.	2,316

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.		13	14	3	$19 00
Found.		15.70	15.70	3.07	
Guaranteed.		14	15		17 50
Found.		16.16	16.79		18 00
Guaranteed.	1	9	10	2.50	23 00
Found.	1.01	10.02	10.96	2.60	
Guaranteed.	1.65	9	10	2	24 00
Found.	1.76	10.10	11.74	2.40	
Guaranteed.		14	......		18 00
Found.		14.59	15.79		
Guaranteed.		13	......	5	24 00
Found.		14.16	15.40	5.08	
Guaranteed.		10	......	5	
Found.		9.86	13.07	6.68	22 00
Below guarantee.		0.14			
Guaranteed.	1.81	9	11	1.50	30 00
Found.	1.70	8.61	12.02	1.80	28 00
Below guarantee.	0.11	0.39			28 00
Guaranteed.		10	11	3	25 00
Found.		10.29	11.60	3.44	
Guaranteed.		13	......		
Found.		12.58	14.41		22 00
Below guarantee.		0.42			
Guaranteed.	1.24	9.50	11.50	1.50	
Found.	1.41	8.81	12.62	2.21	25 00
Below guarantee.		0.69			24 00
Guaranteed.	1.65	10	12	1.30	
Found.	2.21	9.95	12.26	2.01	30 00
Below guarantee.		0.05			

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Lister Agricultural Chemical Works, Newark, N. J.	U. S. phosphate.	Attica.	2,240
Lister Agricultural Chemical Works, Newark, N. J.	Success.	West Fayette. Syracuse. Batavia.	2,060 2,096 2,256
Frederick Ludlam, New York.	A. B. F. brand.	Magee. Wyoming.	2,050 2,206
Frederick Ludlam, New York.	Cereal brand.	Magee. Farmer. Wyoming.	2,049 2,014 2,207
Frederick Ludlam, New York.	Sickle brand.	Farmer. Magee.	2,075 2,048
Michigan Carbon Works, Detroit, Mich.	Homestead bone-black.	Cato. East Pembroke. Le Roy.	2,128 2,269 2,179
Michigan Carbon Works, Detroit, Mich.	Homestead potato grower.	Freeville.	2,142
Miller Fertilizer Co., Baltimore, Md.	Seneca county special.	MacDougall.	2,058
Milsom Rendering and Fertilizing Company, Buffalo, N. Y.	Bean special.	Elba.	2,265
Milsom Rendering and Fertilizing Company, Buffalo, N. Y.	Buffalo fertilizer.	Waterloo. Perry. East Avon.	2,045 2,216 2,293
Milsom Rendering and Fertilizing Company, Buffalo, N. Y.	Buffalo guano.	Romulus. Perry.	2,054 2,218
Milsom Rendering and Fertilizing Company, Buffalo, N. Y.	Cyclone bone-meal.	Perry. Attica.	2,215 2,235

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	1.32	7	8	2	
Found.	1.37	6.68	9.67	2.74	$25 00
Below guarantee.		0.32			
Guaranteed.	1.24	9.50 9.29	11.50	2	28 00 27 00
Found.	1.61		12.21	2.18	26 00
		0.21			
Guaranteed.	1.65	8	10	2	
Found.	1.00	7.93	14.03	1.80	30 00 28 00
Below guarantee.	0.65	0.07		0.20	
Guaranteed.	0.80	8	10	1	27 00 24 00
Found.	0.97	10.11	14.89	1.21	25 00
Guaranteed.		10 12.61	12	1	22 00
Found.			17.28	1.10	24 00
Guaranteed.	1.85	8 9.46	......	1.50	27 00 28 00
Found.	2.45		9.85	2.01	27 00
Guaranteed.	1.35	8	......	3.50	34 00
Found.	2.11	10.18	10.90	3.91	
Guaranteed.	0.80	10	12	4	
Found.	0.80	10.63	11.99	3.90	27 00
Below guarantee.				0.10	
Guaranteed.	0.80	10	11	4	
Found.	1.09	9.84	10.79	4.04	24 00
Below guarantee.		0.16			
Guaranteed.	1.80	9	10	1.50	30 00
Found.	1.84	8.57	10.14	1.21	24 00 27 00
Below guarantee.		0.43		0.29	
Guaranteed.	0.80	10 9.70	11	1	
Found.	0.90		11.22	1.16	
		0.30			
Guaranteed.	1.65	......	22		28 00
Found.	3.90	11.56	23.26		30 00

RESULT OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Potato, hop and tobacco phosphate.	Waterloo. Attica. East Avon.	2,047 2,233 2,297
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Vegetable bone.	Attica.	2,234
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Wheat, oats and barley phosphate.	Waterloo. Perry. Alexander.	2,045 2,217 2,245
Niagara Fertilizer Co., Buffalo, N. Y.	Wheat and corn producer.	Waterloo.	2,044
Oakfield Fertilizer Co., Buffalo, N. Y.	Domestic.	Sempronius. Oakfield.	2,137 2,278
Oakfield Fertilizer Co., Buffalo, N. Y.	Golden sheaf.	Sempronius. Oakfield.	2,136 2,279
Oakfield Fertilizer Co., Buffalo, N. Y.	Great value.	Sempronius. Oakfield.	2,135 2,280
Oakfield Fertilizer Co., Buffalo, N. Y.	High farming.	Oakfield.	2,277
Oakfield Fertilizer Co., Buffalo, N. Y.	Potato and tobacco fertilizer.	Sempronius. Oakfield.	2,134 2,282
Oakfield Fertilizer Co., Buffalo, N. Y.	Standard fertilizer.	Oakfield.	2,276
Oakfield Fertilizer Co., Buffalo, N. Y.	Special hop A.	Oakfield.	2,281
Oakfield Fertilizer Co., Buffalo, N. Y.	Special wheat manure.	Oakfield.	2,283

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	2.05	8	9	4	$32 00
Found.	1.98	8.93	10.82	3.93	26 00
Below guarantee.	0.07			0.07	31 00
Guaranteed.	4.10	8	9	5	30 00
Found.	4.31	8.54	9.33	5.95	
Guaranteed.	1.25	9	10	2	27 00
Found.	1.53	8.97	10.24	2.47	22 00
Below guarantee.		0.03			23 00
Guaranteed.	1.23	8	9	2.16	26 00
Found.	1.46	8.12	10.62	2.75	
Guaranteed.	1.65	8	9	1.08	......
Found.	1.91	9.03	10.16	1.54	27 00
Guaranteed.	1.25	7	8	1.90	......
Found.	1.50	8.15	8.84	2.07	25 00
Guaranteed.	0.80	6	7	1.08	......
Found.	1.14	6.99	7.27	1.48	23 00
Guaranteed.	1.85	8	9	2.45	29 00
Found.	2.11	9.27	9.84	2.54	
Guaranteed.	2.50	6	7	4.32	......
Found.	2.71	6.79	7.27	4.64	31 00
Guaranteed.	2.50	10	11	1.62	31 00
Found.	2.71	11.17	11.66	1.63	
Guaranteed.	0.82	6	6	6.50	28 00
Found.	0.83	7.04	8.70	6.79	
Guaranteed.	4.10	9.50	10	6	
Found.	3.89	9.76	10.78	5.41	38 00
Below guarantee.	0.21			0.59	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Pacific Guano Co., New York.	Ammoniated dissolved bone.	Warsaw.	2,191
Pacific Guano Co., New York.	Dissolved bone and potash.	Le Roy.	2,172
A. Peterson, Penfield, N. Y.	Penfield standard fertilizer.	Penfield.	2,163
Moro Phillips Chemical Co., Philadelphia, Pa.	Farmers' phosphate.	Lima.	2,300
Moro Phillips Chemical Co., Philadelphia, Pa.	Guaranteed guano.	Willow Creek.	2,116
Moro Phillips Chemical Co., Philadelphia, Pa.	New Jersey potato manure.	Cato. Lima.	2,126 2,304
Moro Phillips Chemical Co., Philadelphia, Pa.	Soluble bone phosphate.	Willow Creek.	2,115
Moro Phillips Chemical Co., Philadelphia, Pa.	Special fertilizer.	Cato.	2,125
Moro Phillips Chemical Co., Philadelphia, Pa.	Special formula.	Mt. Morris.	2,320
Moro Phillips Chemical Co., Philadelphia, Pa.	Standard phosphate.	Lima.	2,302
Pottstown Iron Co., Pottstown, Pa.	Odorless phosphate.	Lima.	2,301
Quinnipiac Co., New York.	Ammoniated dissolved bone.	Flemingville. Le Roy. Wyoming.	2,161 2,174 2,202

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	2	9	10	2	
Found.	1.97	8.75	12.62	2.15	$30 00
Below guarantee.	0.03	0.25			
Guaranteed.		10	11	2	
Found.		12.55	13.94	1.24	18 00
Below guarantee.				0.76	
Guaranteed.	2.50	8	12	4	30 00
Found.	2.70	11.06	14.41	5.26	
Guaranteed.	0.80	7	8	1	20 00
Found.	1.10	9.17	10.37	1.64	
Guaranteed.	1.25	9.25	10.25	1.40	
Found.	1.09	9.50	10.19	1.88	25 00
Below guarantee.	0.16				
Guaranteed.	1.65	6	7	9	30 00
Found.	2.06	7.87	8.81	11.32	32 00
Guaranteed.		14	15		19 00
Found.		14.99	15.38		
Guaranteed.	1.85	9	10	4.75	
Found.	2.01	8.69	9.65	5.25	28 00
Below guarantee.		0.31			
Guaranteed.	0.80	10	......	2.45	25 00
Found.	0.80	11	11.81	4.37	
Guaranteed.	1	9	11	2.50	
Found.	1.17	6.56	7.86	1.17	24 00
Below guarantee.		2.44		1.33	
Guaranteed.		......	20		18 00
Found.		5.73	20.94		
Guaranteed.	1.64	9	10	2	32 00 27 00
Found.	2.31	9.86	13.50	2.12	26 00

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Quinnipiac Co., New York.	Climax.	Oakwood. Wyoming.	2,104 2,200
Quinnipiac Co., New York.	Dissolved bone and potash.	Oakwood.	2,106
Quinnipiac Co., New York.	Fish bone and potash.	Oakwood. Flemingville. Wyoming.	2,107 2,160 2,201
Quinnipiac Co., New York.	Mohawk.	Oakwood.	2,103
Quinnipiac Co., New York.	Nobsque guano.	Le Roy.	2,177
Quinnipac Co., New York.	Pacific guano, bone and potash.	Le Roy.	2,176
Quinnipac Co., New York.	Potato manure.	Oswego.	2,154
Quinnipac Co., New York.	Potato phosphate.	Oswego. Flemingville.	2,153 2,162
Quinnipac Co., New York.	Quinnipiac phosphate.	Wyoming.	2,203
Quinnipac Co., New York.	Soluble dissolved bone.	Oakwood.	2,105
Read Fertilizer Co., New York.	Acid phosphate.	Syracuse.	2,089
Read Fertilizer Co., New York.	Dissolved bone phosphate.	Syracuse.	2,084

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	1	8	9	2	
Found.	1.40	7.97	10.94	2.28	$27 00
					24 00
Below guarantee.		0.03			
Guaranteed.		10	11	2	24 00
Found.		10.47	13.18	2.15	
Guaranteed.	1.65	9	10	1	30 00
Found.	2.08	9.20	13 65	1.40	31 00
					25 00
Guaranteed	0.80	7	8	1	25 00
Found.	1.26	8.27	10.07	1.46	
Guaranteed.	1.40	8	9	2	25 00
Found.	1.52	8.67	11.98	2.20	
Guaranteed.	1.65	9	10	1	22 00
Found.	1.87	10.52	12.44	2.63	
Guaranteed.	2.50	6	7	5	37 00
Found.	2.64	6.33	9.24	5.25	
Guaranteed.	2.05	8	9	3	35 00
Found.	2.25	8.91	12.42	3.28	35 00
Guaranteed.	2 50	......	10	2	28 00
Found.	2.65	10.20	12.75	2.50	
Guaranteed.		12	13		20 00
Found.		14.52	15.11		
Guaranteed.		10	12		17 00
Found.		10.13	11.31		
Guaranteed.		12	14		20 00
Found.		10.80	13.96		
Below guarantee.		1.20			

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Read Fertilizer Co., New York.	Farmers' friend.	Syracuse. Lima.	2,079 2,299
Read Fertilizer Co., New York.	Leader guano.	Syracuse. Wyoming.	2,080 2,212
Read Fertilizer Co., New York.	N.Y. State superphosphate.	Syracuse.	2,081
Read Fertilizer Co., New York.	Prime wheat fertilizer.	Syracuse. Wyoming.	2,282 2,211
Read Fertilizer Co., New York.	Pure ground bone.	Syracuse.	2,085
Read Fertilizer Co., New York.	Samson fertilizer.	Syracuse.	2,083
Read Fertilizer Co., New York.	Soluble bone.	Syracuse.	2,090
Read Fertilizer Co., New York.	Standard phosphate.	Syracuse. Lima. Wyoming.	2,078 2,298 2,210
John S. Reese & Co., Baltimore, Md.	Challenge crop grower.	Niles. Johnsonburg.	2,138 2,249
John S. Reese & Co., Baltimore, Md.	Crown bone and potash phosphate.	Niles. Johnsonburg.	2,139 2,248
John S. Reese & Co., Baltimore, Md.	Elm bone phosphate.	Niles.	2,140
John S. Reese & Co., Baltimore, Md.	Pilgrim.	Owego. Perry.	2,152 2,221

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	2.05	9	11	2	$30 00
Found.	2.22	10.16	11.45	2.11	28 00
Guaranteed.	0.80	7	8	2	25 00
Found.	1.06	8.13	9.12	3.94	24 00
Guaranteed.	1.35	9	11	2	28 00
Found.	1.48	9.22	10.41	2.25	
Guaranteed.	1.65	8	9	4	28 00
Found.	1.74	8.37	9.56	4.09	29 00
Guaranteed.	2.05	......	22		
Found.	1.80	14.72	29.92		32 00
Below guarantee.	0.25				
Guaranteed.	2.50	8	9	5	
Found.	2.47	8.11	9.20	5.78	35 00
Below guarantee.	0.03				
Guaranteed.		16	17		
Found.		13.96	18.06		24 00
Below guarantee.		2.04			
Guaranteed.	0.82	8	10	4	28 00
Found.	0.99	8.44	9.60	3.99	26 00
Below guarantee.				0.01	27 00
Guaranteed.	0.80	8.50	11.25	2	25 00
Found.	0.96	8.87	11.52	2.96	27 00
Guaranteed.		12	13	2	
Found.		14.24	15.79	1.70	23 00
Below guarantee.				0.30	24 00
Guaranteed.		14	17		18 00
Found.		15.16	16.90		
Guaranteed.	1.25	6.50	7.50	3	
Found.	1.20	8.49	13.96	3.55	30 00
Below guarantee.	0.05				26 00

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number
John S. Reese & Co., Baltimore, Md.	Potato special manure.	Johnsonburg.	2,250
John S. Reese & Co., Baltimore, Md.	Potato phosphate.	Oswego.	2,151
John S. Reese & Co., Baltimore, Md.	Special alkaline phosphate.	Perry.	2,220
Springfield Fertilizer Co., Springfield, O.	Atlas bone phosphate.	Binghamton.	2,149
Springfield Fertilizer Co., Springfield, O.	Globe bone phosphate.	Binghamton.	2,148
Springfield Fertilizer Co., Springfield, O.	Soluble bone phosphate.	Binghamton.	2,150
Standard Guano Co., Boston, Mass.	Standard guano.	Corfu.	2,275
Standard Fertilizer Co., Boston, Mass.	W. E. Lowe's wheat, oats and barley fertilizer.	Geneseo.	2,318
I. P. Thomas & Son Co., Philadelphia, Pa.	Alkaline bone.	Marcellus.	2,100
I. P. Thomas & Son Co., Philadelphia, Pa.	Improved superphosphate.	Binghamton.	2,146
I. P. Thomas & Son Co., Philadelphia, Pa.	Potato and tomato manure.	Binghamton.	2,147
I. P. Thomas & Son Co., Philadelphia, Pa.	Wheat and grass compound.	Marcellus.	2,101

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	2.90	6.50	......	7.50	
Found.	3.42	5.56	7.76	9.54	$35 00
Below guarantee.		0.94			
Guaranteed.	2.05	8.50	9.50	6	
Found.	2.47	9.73	10.92	5.19	35 00
Below guarantee.				0.81	
Guaranteed.		10	12	1	20 00
Found.		13.58	14.94	1.01	
Guaranteed.	1.65	8	......	2.15	34 00
Found.	1.77	9.23	10.94	2.33	
Guaranteed.	2.05	10	......	2	36 00
Found.	2.17	11.02	13.58	2.84	
Guaranteed.	1	6.50	7.50	3	
Found.	1.02	7.05	8.62	2.47	30 00
Below guarantee.				0.53	
Guaranteed.	1	8	10	2	26 00
Found.	1.24	8.17	10.37	2.22	
Guaranteed.		10	......	3.25	22 00
Found.		11.03	12.11	3 27	
Guaranteed.		10	......	1.50	
Found.		12.16	13.87	1.42	23 00
Below guarantee.				0.08	
Guaranteed.	0.42	12	14		25 00
Found.	0.51	12.09	15.53		
Guaranteed.	1	9	10.50	6	36 00
Found.	1.31	11.15	13.54	6	
Guaranteed.	0.80	10	11	1	26 00
Found.	1.14	10.70	12.38	1.29	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number
Tygert-Allen Co., Philadelphia, Pa.	Yearsley's acidulated phosphate.	Owego.	2,157
Tygert-Allen Co., Philadelphia, Pa.	Yearsley's standard.	East Avon.	2,294
Walker Fertilizer Co., Clifton Springs, N. Y.	Economical bone phosphate.	Owego.	2,156
Walker Fertilizer Co., Clifton Springs, N. Y.	Ontario.	Le Roy.	2,178
Walker Fertilizer Co., Clifton Springs, N. Y.	Pure ground bone.	Le Roy.	2,186
Walker Fertilizer Co., Clifton Springs, N. Y.	Victoria bone.	Owego.	2,155
Williams & Clark Fertilizer Co., New York.	Americus ammoniated superphosphate.	Avon.	2,308
Williams & Clark Fertilizer Co., New York.	Americus special potato.	Avon.	2,309
Williams & Clark Fertilizer Co., New York.	Genesee valley special.	Avon.	2,311
Williams & Clark Fertilizer Co., New York.	Royal bone phosphate.	Le Roy.	2,175
Williams & Clark Fertilizer Co., New York.	Universal ammoniated dissolved bone.	Johnsonburg. Avon.	2,251 2,310
Wheeler, M. E. & Co., Rutland, Vt.	Electrical dissolved bone fertilizer.	Trumansburg.	2,077
Wheeler, M. E. & Co., Rutland, Vt.	Grass and oats fertilizer.	Trumansburg.	2,076

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs. of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.		12	......		$20 00
Found.		15.78	16.15		
Guaranteed.		12	......		19 00
Found.		13.80	15.10		
Guaranteed.	0.80	11	13	1	28 00
Found.	0.85	10.57	12.22	1.59	
Below guarantee.		0.43			
Guaranteed.		10	......	4	22 00
Found.		9.70	11.11	3.98	
Below guarantee.		0.30		0.02	
Guaranteed.	3.70	......	21		28 00
Found.	4.38	6.29	21.22		
Guaranteed.	0.80	8	10	1.50	24 00
Found.	0.85	8.30	9.90	1.86	
Guaranteed.	2.45	9	10	2	29 00
Found.	2.43	9.43	11.68	2.17	
Below guarantee.	0.02				
Guaranteed.	2.45	6	7	5	35 00
Found.	2.76	7.21	10.73	5.55	
Guaranteed.		10	11	5	26 00
Found.		10.99	12.61	3.45	
Below guarantee.				1.55	
Guaranteed.	1	7	8	2	26 00
Found.	1.42	7.49	12.08	2.12	
Guaranteed.	1.65	8	10	2	29 00
Found.	1.83	9.86	13.46	2.29	27 00
Guaranteed.		13	15		22 00
Found.		12.91	14.12		
Below guarantee.		0.09			
Guaranteed.		11	13	2	24 00
Found.		11.47	14.39	2.55	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

Composition of fertilizers as guaranteed by manufacturers, and as found by

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Wheeler, M. E. & Co., New York.	Royal wheat grower.	Romulus. Wyoming.	2,066 2,205
Zell Guano Co., Baltimore, Md.	Dissolved bone phosphate.	Cato.	2,129
Zell Guano Co., Baltimore, Md.	Economizer.	Mac Dougall.	2,056
Zell Guano Co., Baltimore, Md.	Fruit tree invigorator.	Mac Dougall.	2,055
Zell Guano Co., Baltimore, Md.	Genesee fertilizer.	Mac Dougall.	2,057
Zell Guano Co., Baltimore, Md.	Special potato fertilizer.	Fowlerville.	2,315
Zell Guano Co., Baltimore, Md.	Wilson's special No. 1.	Le Roy.	2,182
Zell Guano Co., Baltimore, Md.	Wilson's special No. 2.	Le Roy.	2,184
Zell Guano Co., Baltimore, Md.	Wilson's special No. 3.	Le Roy.	2,183
Not given.	Grain special No. 1.	Lima.	2,305
Not given.	Grain special No. 2.	Lima.	2,303
Not given.	Special fertilizer.	Geneseo.	2,319

LECTED IN NEW YORK STATE DURING THE FALL OF 1895.

chemical analysis at this Station. Results expressed in parts per hundred.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 lbs of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Retail selling price per ton.
Guaranteed.	0.80	8	9	2	$23 00
Found.	1.04	9.53	10.49	2.09	
Guaranteed.		14	15		18 00
Found.		14.80	16.12		
Guaranteed.	0.80	9	11	1	26 00
Found.	1.01	10.60	12.93	2.17	
Guaranteed.		10	12	8	26 00
Found.		11.17	12.97	9.15	
Guaranteed.	2.05	8	10	2	
Found.	1.99	10.61	12.23	2.39	30 00
Below guarantee.	0.06				
Guaranteed.	3.25	6	8	8	
Found.	3·21	7.52	10 95	8.13	40 00
Below guarantee.	0.04				
Guaranteed.	0.80	8	10	4	23 00
Found.	0.80	9.10	12.59	4.29	
Guaranteed.		10	12	4	
Found.		9.88	12.86	4.45	21 00
Below guarantee.		0.12			
Guaranteed.		14	15		17 00
Found.		14.29	15.71		
Guaranteed.	0.80	9	10.25	4	
Found.	0.86	9.01	11.55	3.45	26 00
Below guarantee.				0.55	
Guaranteed.	0.80	8	10.50	4	
Found.	1.10	7.40	9.46	6.62	26 00
Below guarantee.		60			
Guaranteed.	1	9	11	2.50	
Found.	1.39	7.05	14.35	1.98	24 00
Below guarantee.		1.95		0.52	

XVI. Gifts to the Station.

Almond.

United States Division of Pomology, Washington, D. C., hard shell sweet.

Apples.

March 28. Erwin Lord, Pompanoosuc, Vt., twelve cions each of Alice, Old Garden, Lombard, Erwin Lord, Windsor, Hazen Pippin, Houghton Sweet and Lord crab.

April 4. United States Pomologist, Washington, D. C., cions of Albemarle, Newby and Perry.

April 19. M. F. Pierson, Seneca Castle, N. Y., cions of Princess Louise.

April 22. O. W. Rich, Atlantic, Iowa, cions of Soulard crab.

April 25. J. V. Cotta, Nursery, Ill., two cions each of Ficke and Milwaukee.

April 27. United States Pomologist, Washington, D. C., two cions of Baxter.

April 27. Ellwanger & Barry, Rochester, N. Y., one Barry.

January 5. George H. Andrews, Clarkson, N. Y., cions of Monroe.

April 8. Amos Daniels, Chittenango, N. Y., cions of Wheeler, Nos. 3, 9, 33, 36, 38, 41, 43 and 44. October 5, cions of Nos. 45 to 79 inclusive.

November 26. Charles Hand, Mountainville, Orange county, N. Y., cions of Barton.

Apricot.

April 27. The Lovett Co., Little Silver, N. J., two each of Bongoume and Hubbard.

March —. Prof. T. Minami, Sapporo Agriculture College, Japan, Anzu.

Bean.

March 20. W. A. Burpee & Co., Philadelphia, Pa., Dwarf Golden Wax, Best of All, Saddle Back Wax, New Stringless Green Pod Bush, New Champion Bush, Round Yellow Six Weeks, Improved Rust-Proof Golden Wax, Kidney Wax, New Prolific German Wax, New Black Eye Wax.

March 3. A. N. Jones, Newark, N. Y., Jones No. 71, Wax Bush.

Beet.

March 2. W. A. Burpee & Co., Philadelphia, Pa., Early Blood Red Turnip, Danish Improved Sugar, Dark Stinson, Early Egyptian.

Blackberry.

April 26. Thompson's Sons, Rio Vista, Va., Maxwell.

April 11. E. A. Riehl, Alton, Ill., Piasa.

Broccoli.

March 22. Charles Schwake, 404 East Thirty-fourth street, New York, N. Y., San Isadore.

Carrot.

March 20. W. A. Burpee & Co., Philadelphia, Pa., Improved Long Orange, New Forcing No. 1387, Danvers or Half Long Orange, Early Scarlet Horn, New Extra Dark Moss-curled Parsley

Cauliflower.

March 20. W. A. Burpee & Co., Philadelphia, Pa., Best Early.

Celery.

March 22. Charles Schwake, 404 East Thirty-fourth street, New York, N. Y., De Candolle, F. E. Rudman & Brother, 132 North Clinton street, Rochester, N. Y., Golden Heart.

Cherry.

April 4. United States Pomologist, Washington, D. C., cions of Esel Kirsche, Rupp and White Bigarreau.

April 10. Starke Brothers, Louisiana, Mo., one tree of Abesse d'Oignies.

August 7. United States Department of Agriculture, Division of Pomology, Washington, D. C., No. 9211 seedling cherry buds.

August 1. United States Department of Agriculture, Division of Pomology, Washington, D. C., Esel Kirsche buds.

August 8. United States Department of Agriculture, Division of Pomology, Washington, D. C., Rupp buds.

August 9. G. H. Andrews, Clarkson, N. Y., Yellow Waif buds.

August 10. W. F. Heikes, manager Huntsville Nursery, Huntsville, Ala., two trees Esel Kirsche.

November 11. W. & T. Smith, Geneva, N. Y., per Edward Smith, two trees each of the following varieties on Mahaleb stock: Black Tartarean, Coe Transparent, Dyehouse, Early Richmond or Kentish, English Morello, Governor Wood, Late Duke, Montmorency, Napoleon; and two trees each of the following varieties on Mazzard stock: Black Tartarean, Coe Transparent, Dyehouse, English Morrello, Montmorency, Napoleon.

CORN.

March 2. W. A. Burpee & Co., Philadelphia, Pa., Early Fordhook.

CUCUMBER.

March 20. W. A. Burpee, Philadelphia, Pa., Fordhook Improved White Spine, Early Green Prolific, Early Russian, New Improved Chicago Pickle.

March 22. Charles Schwake, 404 East Thirty-fourth street, New York, N. Y., White Japanese Climbing.

CURRANT.

March 17. Geo. Coote, Corvallis, Oregon, cuttings native Oregon black currant.

April 26. D. Brandt, Bremen, Ohio, Yellow Utah.

October 28. R. B. Whyte, Ottawa, Canada, Moore Ruby.

November 2. S. D. Willard, Geneva, N. Y., five Moore Ruby, five White Imperial.

November 11. W. & T. Smith, Geneva, N. Y., per Edward Smith, five Gondouin. November 19, five Cherry and five Versaillaise.

November 20. E. Y. Teas, Irvington, Ind., five one-year plants of Knight's Improved.

November 27. Albertson & Hobbs, Bridgeport, Ind., one plant of Albertson & Hobbs, No. 1.

DEWBERRY.

March 26. J. W. Austin, Pilot Point, Denton Co., Texas, six plants, Austin Improved.

April 22. C. C. Maynard, Kincaid, Kansas, six Maynard.

ENDIVE.

March 22. Charles Schwake, 404 E. Thirty-fourth street, New York, N. Y., Sant Angelo.

Gooseberry.

April 19. Storrs Harrison Co., Painesville, O., one Carmen.

April 27. The Lovett Co., Little Silver, N. J., two Oregon Jumbo.

May 1. R. B. Whyte, Ottawa, Canada, London, Cossack, Hairy Green, Green Ocean, Lofty.

Grape.

March 18. Geo. Coote, Corvallis, Oregon, cuttings of native grape.

April 1. A. F. Rice, Griswoldsville, Ga., Superb, one three-year vine.

April 5. J. R. Johnson, Dallas, Texas, one Columbian.

April 13. T. V. Munson, Denison, Texas, two each of Presley (formerly Pres. Lyon), Eumedel, R. W. Munson, Long John, Gold Coin, Chambrill, Bell, W. B. Munson.

April 15. T. S. Hubbard Co., Fredonia, N. Y., two each of Brilliant, Eaton, (Rog. 14) Gaertner.

April 19. P. R. DeMuth, Connellsville, Pa., three vines Helen Keller.

May 1. H. M. Woodward, 717 Napoleon St., Rockford, Ill., two Regal.

May 1. J. A. Putnam & Son, Fredonia, N. Y., two Lucile.

May 18. Prof. John Craig, Experiment Farm, Ottawa, Canada, two Emerald. J. E. Lord, Pompanoosuc, Vt., two cuttings of Lord Favorite.

Kohlrabi.

March 22. Charles Schwake, 404 East Thirty-fourth St., New York, N. Y., Giant of Modica.

Lettuce.

March 2. W. A. Burpee & Co., Philadelphia, Pa., Dwarf White Heart, New Cabbage, No. 3835.

March 22. Charles Schwake, 404 East Thirty-fourth St., New York, N. Y., Albano, Genezzans.

October 28. A. Luther, Leeds, Jackson Co., Mo., Luther, one packet forcing lettuce.

F. E. Rudman & Brother, 132 N. Clinton St., Rochester, N. Y., Keene, forcing lettuce, one packet. Big Boston, forcing lettuce, one packet.

MISCELLANEOUS.

February 1. John J. McGowan, Forest Home, N. Y., one No. 7 McGowan nozzle.

March 18. George Coote, Horticulturist, Experiment Station, Corvallis, Oregon, Thimble Berry, native Oregon species; native Oregon Rose plants.

March 22. J. H. Gregory & Son, Marblehead, Mass., several packets of seeds.

March 26. Frost & Co., Rochester, N. Y., Polygonum Sagalinese two small roots (Sacaline).

March —. Prof. T. Minami, Sapporo Agricultural College, Japan, No. 7 Chestnut, cultivated; No. 8 Chestnut, wild; No. 9 Walnut, wild.

April 18. C. Schaefer, Rutlidge, Helidon, Queensland, Australia, seeds as follows: Grass (Paspalum Galmarra), Bailey; the Russell river grass; Cyas Media (one fruit); Bunya Pine, one seed; Cassia Brewsteri, F. & M., several seeds; Mezoneurum Brachycarpum; Vitex, var lignum vitæ, two fruits; Lance Wood? (three nuts); Parkinsonia Aculeata, commonly called Jerusalem Thorn or Bird of Paradise Tree, several seeds; a native Raspberry of Queensland, several fruits; Vitis Opaca, F. & M., seeds.

April 24. C. E. Brown, Yarmouth, Nova Scotia, Rhubarb, Carlton Club, received through G. H Hicks, assistant botanist, Washington, D. C.

July 26. John G. Schumaker, 189 Montague street, Brooklyn, N. Y., one-horse power vineyard sprayer.

April 27. Ellwanger & Barry, Rochester, N. Y., one Rosa Setigera.

April 27. The Lovett Co., Little Silver, N. J., quince, two Fuller.

May 4. A. Blanc & Co., Philadelphia, Pa., two Stanley berry, Rubus Capenses; one Spiræa, Anthony Waterer; one Golden Mayberry, one Logan berry, May 20.

May 24. C. W. Ward, Queens, N. Y., Carnations, twelve plants each, William Scott, Storm King, Stuarts.

MUSKMELON.

March 20. W. A. Burpee & Co., Philadelphia, Pa., Melrose, Tip Top, Nutmeg, Cannon Ball, Acme or Baltimore.

OKRA.

March 20. W. A. Burpee & Co., Philadelphia, Pa., New Lady Finger.

ONION.

March 20. W. A. Burpee & Co., Philadelphia, Pa., White Globe, New Gigantic Gibralter, New Queen, Red Globe, Yellow Globe Danvers, Yellow Dutch, Giant Yellow Rocca.

PEACH.

April 30. The Rogers Nursery Co., Moorestown, N. J., two Blood, Dwarf Japan.

May 4. W. W. Hilborn, Leamington, Ontario, Canada, two Tyhurst.

August 7. United States Department of Agriculture, Division of Pomology, Washington, D. C., York Pearl.

September 27. H. Wiard, Syracuse, N. Y., buds of Wiard.

October —. R. G. Chase Co., Geneva, N. Y., Chase (*Chase's Early Free*), three trees.

November 27. A. Pullen, Milford, Delaware, one year trees on peach roots; five each of Capt. Eads, Conkling, Champion, Crosbey, Elberta, Globe, Hill's Chili, Hynes' Surprise, Lemon Free, Sneed, Susquehanna; two each of Columbia, Alexander, Amsden June, Beer's Smock, Bishop's Early, Chinese Free, Crawford's Early, Crawford's Late, Early Rivers, Foster, Hale's Early, Mountain Rose, Moore's Favorite, Old Mixon Free, Picquett' Late, Prize, Redcheek Melocoton, Reeves' Favorite, Salway, Stevens' Rareripe, Stump the World, Wager, Wheatland, Yellow St. John.

Five June buds of Triumph on peach roots.

PEAR.

March —. Professor T. Minami, Sapporo Agricultural College, Japan, No. 1 cions Taihei, No. 2 cions Koga, No. 3 cions Kinriu.

April 10. Stark Brothers, Louisiana, Mo., one Koonce.

April 27. Ellwanger & Barry, Rochester, N. Y., Dorset, Lady Clapp, Oliver des Serres, Bon Chretien Fred. Baudry, Madam Heminway.

September 18. T. G. Clark, Tyre, Seneca county, N. Y., buds of Seneca.

November 2. J. T. Macomber, Adams, Vt., Grand Isle, Dr. Hoskins.

PEAS.

March 20. W. A. Burpee & Co., Philadelphia, Pa., Echo, Renown.

April 18. Delano Moore, Presque Isle, Aroostook county, Me., one packet Maud S.

PEPPER.

March 22. Charles Schwake, 404 East Thirty-fourth street, New York, N. Y., Elephant's Trunk, Columbus.

PLUM.

March —. Professor T. Minami, Sapporo Agricultural College, Japan, Hadankyo, yellow long; Hadankyo, yellow round.

March 4. Luther Burbank, Santa Rosa, Calif., Giant Prune and Wickson Plum.

April 4. United States Pomologist, Washington, D. C., Yellow Aubert, Moldovka, Hungarian.

April 10. Howard E. Merrill, Geneva, N. Y., five General Hand on Myrobolan stock.

April 10. Stark Brothers, Louisiana, Mo., one each of Chabot and Gold, and April 20, one Splendor prune.

April 27. Ellwanger & Barry, Rochester, N. Y., two Dunlap on Myrobolan.

April 27. Van Dusen Nursery Co., Geneva, N. Y., five General Hand on Horse, and 100 Horse plum stock.

April 27. J. F. Hunt, Kendaia, N. Y., two Hunt's No. 1 on Myrobolan stock.

May 14. S. D. Willard, Geneva, N. Y., two Willard plum on peach roots, and 100 Myrobolan plum stock.

April 9. R. G. Chase, Geneva, N. Y., 100 Mariana stock.

August 4. C. L. Watrous, Des Moines, Iowa, buds of following varieties: Rockford, Wood, Baker or Stoddard, Wayland.

August 9. T. C. Maxwell & Brothers, Geneva, N. Y., Early Rivers buds.

August 10. M. F. Pierson, Seneca Castle, N. Y., Miller's Superb buds.

August 24. Stark Brothers Company, Louisiana, Mo., buds of Red June, a Japanese sort.

PUMPKIN.

March 2. W. A. Burpee & Co., Philadelphia, Pa., Winter Luxury.

RADISH.

March 20. W. A. Burpee & Co., Philadelphia, Pa., Golden Dresden, New Bright Breakfast, New White Forcing, French Breakfast, Earliest Carmine Olive-shaped, Extra Early Scarlet Turnip, White Tipped Scarlet Turnip.

RASPBERRY.

March 18. George Coote, Horticulturist, Experiment Station, Corvallis, Oregon, Black Cap Native.

April 17. W. C. Gault, Ruggles, Ohio, six Gault.

April 20. Slaymaker & Son, Dover, Del., twelve Miller.

April 19. Storrs Harrison Co., Painesville, Ohio, one Gault.

April 25. Albertson & Hobbs, Bridgeport, Ind., six Wade.

April 26. W. D. Barns & Son, Middlehope, N. Y., five of Red variety grown in vicinity of Middlehope, and six each of Cromwell and Palmer.

April 27. Ellwanger & Barry, Rochester, N. Y., six Thomson Early.

April 27. C. G. Velie, Marlboro, N. Y., six Marlboro.

April 27. The Lovett Co., Little Silver, N. J., Conrath, All Summer.

April 27. Birdseye & Son, Hopewell, N. Y., Shaffer's Collossal, from one year and two year bushes; Ohio, from one year, two year and four year bushes; Gregg, from one year and three year bushes; Tyler, from one year, two year and three year bushes.

May 1. I. F. Street, West Middleton, Ind., Telataugh.

May 1. R. B. Whyte, Ottawa, Canada, Seedling Reds, No. 6, 7, 13 and 17.

November 9. C. H. Koch, Middlehope, N. Y., six No. 1 Red, six No. 2 Viking.

November 13. S. H. Loomis, Geneva, N. Y., Geneva Pride.

November 15. R. B. Whyte, Ottawa, Canada, Whyte No. 6, 7, 13 and 17.

May 4. A. Blanc & Co., Philadelphia, Pa., one Strawberry-raspberry.

October 23. W. C. Gault, Ruggles, Ohio, six black Gault.

SQUASH.

March 20. W. A. Burpee & Co., Philadelphia, Pa., Hubbard.

STRAWBERRY.

March 18. George Coote, Horticulturist, Experiment Station, Corvallis, Oregon, native species from coast of Pacific Yaguina Bay, Lincoln county, and one from foot hills, Coast Range, Willamette Valley.

April 10. R. S. Cole, Harmans, Md., 25 Tubbs.

April 10. Slaymaker & Son, Dover, Del., strawberry seedlings Nos. 1, 5, 8, 9, 12 and 25.

April 21. M. Crawford, Cuyahoga Falls, Ohio, William Belt, Staples, Margaret.

April 24. Slaymaker & Son, Dover, Del., 25 Thompson (*Lady Thompson*).

April 25. W. D. Barnes & Son, Middlehope, N. Y., 25 Thompson (*Lady Thompson*).

April 26. Thompson's Sons, Rio Vista, Va., 12 Earliest, 12 America, 12 Edith, 12 Thompson No. 101, 12 Enormous, 12 Thompson No. 100.

April 27. Ellwanger & Barry, Rochester, N. Y., 25 Williams.

April 27. Birdseye & Son, Hopewell, N. Y., 25 Canada Wilson.

April 29. E. B. Stevenson, Lowville, Ontario, Canada, 25 Maple Bank.

April 29. D. B. Garvin & Son, Wheeling, W. Va., unnamed strawberry.

May 1. E. J. Hull, Olyphant, Pa., Hulls No. 3.

May 3. W. F. Allen, Jr., Salisbury, Md., 12 Allen.

May 1. W. F. Allen, Jr., Salisbury, Md., Enormous, Bissel, Columbian.

May 1. H. S. & A. J. See, Geneva, Pa., 12 each of See Nos. 5, 4 and 3.

May 17. E. J. Hull, Olyphant, Pa., Hull's No. 4.

TOMATO.

March 20. W. A. Burpee & Co., Philadelphia, Pa., Fordhook First.

February 5. West Virginia Station, F. William Rane, Horticulturist, Rane's Seedling.

February 5. Hoover & Moore, Antler's, Garfield county, Colo., Seedlings Nos. 1, 2, and 3.

October 29. F. Chatfield, Sennett, Cayuga county, N. Y., Early Forcing, Eureka.

Turnip.

March 20. W. A. Burpee & Co., Philadelphia, Pa., New Kashmye.

XVIII. Newspapers and Periodicals Presented to the Station.

Acker & Gartenbau Zeitung, Milwaukee, Wis.
Agricultural Epitomist, Indianapolis, Ind.
Agricultural South, Atlanta, Ga.
Albany Weekly Journal, Albany, N. Y.
Allegan Gazette, Allegan, Mich.
American Agriculturist, New York, N. Y.
American Cultivator, Boston, Mass.
American Dairyman, New York, N. Y.
American Grange Bulletin and Scientific Farmer, Cincinnati, Ohio.
American Grocer, New York, N. Y.
American Horticulturist, Wichita, Kans.
American Stock Keeper, Boston, Mass.
American Veterinary Review, New York, N. Y.
Baltimore Weekly Sun, Baltimore, Md.
Canadian Entomologist, Fort Hope, Canada.
Canadian Horticulturist, Toronto, Canada.
Clover Leaf, South Bend, Ind.
Country Gentleman, Albany, N. Y.
Dairy World, London, England.
De Ruyter Gleaner, De Ruyter, N. Y.
Detroit Free Press, Detroit, Mich.
Every Week, Angelica, N. Y.
Farm and Dairy, Ames, Iowa.
Farm and Fireside, Philadelphia, Pa.
Farm and Home, Springfield, Mass.
Farmer and Trucker, Berkley, Va.
Farmers' Advocate, London, Canada.
Farmers' Guide, Huntington, Ind.
Farmers' Home, Dayton, Ohio.
Farmers' Magazine, Springfield, Ill.
Farm Journal, Philadelphia, Pa.

Farm Life, Rochester, N. Y.
Farm Poultry, Boston, Mass.
Farm, Stock and Home, Minneapolis, Minn.
Fruit, Dunkirk, N. Y.
Geneva Gazette, Geneva, N. Y.
Gleanings in Bee Culture, Medina, Ohio.
Grange Visitor, Charlotte, Mich.
Hoard's Dairyman, Fort Atkinson, Wis.
Homestead, Des Moines, Iowa.
Horticultural Gleaner, Austin, Tex.
Horticultural Visitor, Kinmundy, Ill.
Industrial American, Lexington, Ky.
Iowa Weather Crop Service Review, Des Moines, Iowa.
Ithaca Democrat, Ithaca, N. Y.
Jersey Bulletin, Indianapolis, Ind.
Ladies' Home Companion, Philadelphia, Pa.
Live Stock Journal, London, England.
Long Island Farmer, Jamaica, N. Y.
Louisiana Planter and Sugar Manufacturer, New Orleans, La.
Market Garden, Minneapolis, Minn.
Maryland Farmer, Baltimore, Md.
Mirror and Farmer, Manchester, N. H.
Montana Fruit Grower, Missoula, Mont.
Monthly Weather Review, Washington, D. C.
National Dairyman, Kansas City, Mo.
National Nurseryman, Rochester, N. Y.
Nebraska Bee-Keeper, York, Neb.
Nebraska Farmer, Lincoln, Neb.
New England Farmer, Boston, Mass.
New York Farm and Fireside, Springfield, Ill.
New York Farmer, Port Jervis, N. Y.
Northwest Pacific Farmer, Portland, Oregon.
Oregon Agriculturist, Portland, Oregon.
Peninsula Farmer, Federalsburg, Md.
Poultry Monthly, Albany, N. Y.
Practical Farmer, Philadelphia, Pa.
Prairie Farmer, Chicago, Ill.
Progressive South, Richmond, Va.
Southern Cultivator, Atlanta, Ga.
Southern Planter, Richmond, Va.

Southern States, Baltimore, Md.
Sugar Beet, Philadelphia, Pa.
Sugar Planters' Journal, New Orleans, La.
Utah Church and Farm, Salt Lake City, Utah.
Vermont Farmers' Advocate, Burlington, Vt.
Village Record, West Chester, Pa.
Western Plowman, Moline, Ill.

XIX. Rules of the Station Governing Gratuitous Chemical Analysis for Private Persons.

The idea prevails to a greater or less extent that this Station employs its chemists for the purpose of making chemical analysis of any and all materials sent here by any one residing in this State. This is a mistake. Our chemists are employed mainly to do the analytical work which our regular investigations necessitate. The work thus called for is very extensive, probably greater than that done at any other experiment station in the United States. We make annually about 25,000 chemical determinations in connection with our regular investigations. These investigations are planned so as to benefit the largest possible number of farmers. We have, therefore, to exercise care, in order to prevent work for individuals from interfering with the work which is done for the farmers in the State at large. When we consider that there are nearly 400,000 farmers in this state, it can easily be seen that, if chemical work was done for any considerable number of individual farmers, our regular work would be completely stopped with our present force of chemists. It is hoped that in the near future we can make arrangements to do promptly a larger amount of chemical analysis for individuals. There is a feeling on the part of some that they pay taxes to support this Station and that, therefore, they have the right to ask to have chemical work done for them gratuitously. When we consider that each farmer of the State pays less on an average than one cent a year toward the support of our entire work, and that requests for chemical work call for time and materials which cost the State many times that sum, it can be clearly seen how little ground the individual has for claiming the right to demand special work for himself. Many requests for chemical work are to satisfy mere curiosity and the work, if done,

16

would do nobody any good. Others are entirely foreign to agricultural interests and often of a purely private commercial character.

In order that there may be a clear understanding in regard to this matter, the Board of Control has considered it necessary to make the following rules.

Rule I.—Chemical work that does not relate directly to agricultural matters can not be undertaken at all.

Rule II.—Before sending to the Station samples of anything for analysis, private parties should first state the nature of the work they wish to have done and the reasons for having it done. Information can then be given as to the advisability of doing the work. All such work, if done at all, is done gratuitously, and the Station must, in every case, decide whether the importance of the work is sufficient to justify the expenditure of time and materials that may be required. Undoubtedly, many who ask the Station to make gratuitous analyses for them do not fully understand the large amount of time a satisfactory analysis of almost any substance requires and do not realize to what extent compliance with their wishes would interfere with our regular work.

Rule III.—In deciding what chemical work it can or can not do, the Station always plans to consult the benefit of the greatest number. Preference will always be given to the work promising information that is for the benefit of the larger number of individuals.

Rule IV.—Any chemical work which is for private commercial interests can not be undertaken. Such work properly belongs to a private professional analyist, and the State should not be asked to do such work.

Rule V.—A complete analysis of any soil or mineral can not be undertaken except in rare cases. Analysis of water must generally be regarded as foreign to our work. Analysis in suspected cases of poisoning, adulteration of drugs, etc., can not be undertaken here.

Rule VI.—The determination of fat in milk will be undertaken at any time. In such cases the milk should be sent to the Station as quickly as possible; a small amount of potassium bichromate may be added as a preservative. An examination of foods for animals will be undertaken when circumstances justify and our regular work permits.

Rule VII.— The analysis of commercial fertilizers and fertilizing materials for private parties will be undertaken only on the following conditions: (1) The brand of fertilizer must be one that has not been collected and analyzed by the Station within one year. (2) The fertilizer must be sampled in accordance with instructions furnished by this Station. (3) Blanks describing the fertilizer must be filled out; these will be furnished on application. (4) The samples must be taken by consumers from stock of present season and from lots of not less than one ton. (5) All such work for private parties can be done only after the regular Station work in carrying out the provisions of the State Fertilizer Law is completed each season. Hence, analyses for single individuals may be under the necessity of waiting some months for a report, since the regular work of the Station in carrying out the provisions of the Fertilizer Law can not under any circumstances be interrupted or delayed.

REPORT

OF THE

HORTICULTURIST.

S. A. BEACH, Horticulturist.

WENDELL PADDOCK, Assistant Horticulturist.

REPORT OF THE HORTICULTURIST.

By S. A. BEACH, Horticulturist.
WENDELL PADDOCK, Assistant.

Horticultural investigations at this Station in 1895, weie conducted chiefly along the following lines:

1. Testing fruits.

2. Origination of new fruits for the purpose of securing improved sorts.

3. Investigation of several subjects pertaining to forcing vegetables.

4. Comparison of different lines of treatment in combating some plant diseases of economic importance.

Some attention has been given to a comparison of new spraying devices with those already on the market. A report on this subject was given in the annual report for 1894, and in Bulletin 74, so it is proposed to defer a further report till next season.

Considerable time has been devoted to station correspondence on horticultural topics, to preparing the annual report and various bulletins, and to addresses on horticultural subjects, which were given in various parts of the state. The Horticulturist addressed the Western New York Horticultural Society, Rochester; Grange organizations at Lodi, Brockport, Billsborough and Stanley; Farmers' Clubs at Hall's Corners and Clarence Center, and Farmers' Institutes at Medina, Penn Yan, Penfield, Albion, Pittsford, Skaneateles, Wellsburg and Horseheads. Exhibits of fruit were made at the State fair, and at various county or district fairs.

The following bulletins on horticultural topics were issued in 1895:

No. 84. Spraying pear and apple orchards in 1894.*

No. 86. Treatment of common diseases and insects injurious to fruits and vegetables.

---

* The texts of this bulletin was published in the annual report for 1894. The text of the other bulletins appear, with few alterations, in this report.

No. 88. I. Forcing lettuce in pots.
II. Mushrooms as a greenhouse crop.
No. 91. I. A new strawberry.
II. Notes on strawberries, raspberries, blackberries and dewberries.
No. 95. Currants.

In all this work Mr. Paddock has constantly rendered such willing and trustworthy assistance that it is a pleasure to here make acknowledgment of his faithfulness and efficiency. He has continued the investigations of the previous year with raspberry anthracnose. The bulletin on the treatment of diseases and insects injurious to fruits and vegetables, and the strawberry, raspberry and blackberry bulletins issued during the year, are chiefly his work. During the year he has addressed the following meetings: Farmers' meetings at Southhampton, Mattituck, Southold, Huntington and Port Jefferson in Suffolk county; Minneola, Queens county; Thiells and Suffern in Rockland county; Newburg, Orange county; Brewster, Putnam county; Mount Kisco and White Plains, Westchester county; West Bloomfield, Ontario county, and a Grange meeting at Manchester, Ontario county.

SPECIAL WORK IN THE SECOND JUDICIAL DEPARTMENT.

In addition to other work the Horticulturist has had, as in 1894, the general direction of the special investigations in the second judicial department, subject to the director's approval. This department includes Long Island, Staten Island and the counties of Rockland, Orange, Dutchess, Putnam and Westchester.

During the winter of 1895, a series of twelve Farmers' Meetings were held, reaching localities in six counties. At these meetings addresses were given by members of the Station staff and other specialists. Agricultural or horticultural topics of local interest were discussed. A stereopticon was employed in illustrating the different forms of insects and fungus diseases, spraying machinery, etc. In most places these meetings were well attended and were generally considered instructive and valuable, as well as interesting. Informal meetings were held in several localities during the summer, at which topics pertaining to injurions insects and plant diseases were discussed by members of the Station staff.

The Entomological investigations have been carried on by Mr. V. H. Lowe and Mr. F. A. Sirrine, and Mr. C. F. Stewart has given his attention to the study of plant diseases and remedial treatment for the same. Detailed accounts of the work of these specialists are found in their annual reports published in this volume. An account of Mr. Paddock's experiments in treating leaf blight and fruit rot of cherries in Orange county is combined with a report of similar treatment of plum orchards at Geneva by the Horticulturist.

A co-operative field test of different brands of commercial fertilizers for potatoes was conducted in Suffolk county by Dr. Van Slyke and the results of the test were published in Bulletin 93.

Two circulars designed to give information about destructive insects were issued so as to call attention to these pests just before they were expected to appear. Circular No. 1, by F. A. Sirrine, treated of the cabbage maggot and No. 2, by V. H. Lowe, treated of the corn worm. Circular No. 3 issued to the press May 15, 1895, gave a brief account of the progress of the work. Besides these circulars the following bulletins were issued:

Bulletin 86, by S. A. Beach and W. Paddock, on Treatment of Injurious Insects and Fungous Diseases.

Bulletin 87, by F. A. Sirrine, on The San Jose or Pernicious Scale.

Bulletin 93, by Dr. L. L. Van Slyke, on Comparative Field-Test of Commercial Fertilizers used in raising potatoes.

I. TESTING FRUITS.

In testing fruits a systematic record is kept for each variety showing for each year the time of blossoming, the period of marketable condition and the yield. Descriptions are made of the fruit its keeping qualities are noted, especially in case of winter fruits, and other features of interest or importance are noticed such as the habit of growth, liability to disease, condition of the plants, etc.

These records are useful not only in determining the merits of new varieties as compared with old standard sorts, but the notes on the period of blossoming are also valuable in helping to decide what varieties may be used for planting with other desirable varieties that set fruit imperfectly or not at all when standing alone. It is well known that strawberry growers must mingle imperfect flowering varieties with perfect flowering varieties in order to secure proper fertilization of the blossoms. It has recently been shown at this Station that some kinds of grapes likewise need to be mingled in planting. For a more complete discussion of this subject the reader is referred to the article on "Fertilization of Flowers in Orchards and Vineyards" in the annual report of this Station for 1894.

Published descriptions of the varieties, accounts of their origin and introduction, reports as to their value in other localities and other observations of interest are kept on slips of paper arranged in alphabetical order after the manner of a card index so as to be readily accessible for reference. The results of the tests of blackberries, dewberries, raspberries and strawberries are issued each year. This season a bulletin on currants has been published and it is proposed to prepare bulletins of gooseberries, grapes, stone fruits and pomaceous fruits as fast as the time available for this purpose permits.

Collections of fruits true to name are annually exhibited at the State Fair and at various county or district fairs throughout the State. These exhibitions are of considerable educational value in that they give opportunity to examine the fruit of many new or little known varieties and to compare them with standard sorts grown under similar conditions.

Some idea of the extent to which the testing of fruits is carried on at the Station may be formed from the following statement of the number of varieties of the different fruits that were grown and fruited here during 1895. These figures are exclusive of varieties received for fall planting, Station seedlings, novelties like the Stanley berry and Mayberry, and fruits that are little grown, such as mulberries and huckleberries.

TABLE I. NUMBER OF VARIETIES OF FRUITS GROWN AND NUMBER FRUITED AT THIS STATION IN 1895.

KIND OF FRUIT.	Number fruited.	Number grown.
Pomaceous Fruits.		
Apples	210	427
Crab apples	23	30
Pears	38	102
Quinces	5	10
Stone Fruits.		
Almond	....	1
Apricots	11	20
Cherries	22	43
Nectarines	....	2
Peaches	49	111
Plums	119	204
Small Fruits.		
Grapes	200	234
Currants	36	40
Gooseberries	197	219
Blackberries	24	39
Dewberries	4	6
Raspberries	74	88
Strawberries	91	138
Total	1,103	1,714

APPLES AND CRAB APPLES.

The varieties of apples and crab apples thus far received for testing at this Station, with few exceptions, have been top-worked on young bearing trees of Baldwin or Rhode Island Greening. In a few cases they were worked on some other variety. In several instances root grafted or budded trees of the variety to be tested were planted. Many old varieties have been admitted to the orchard for the sake of comparison with new or little known sorts.

Grafting into the orchard varieties which were received for testing was commenced in 1883, and additions have been made in succeeding years till at present there are four hundred and twenty-seven kinds of apples and thirty kinds of crab apples growing at the Station, a total of four hundred and fifty-seven kinds.

Many of the kinds first introduced are now bearing from a few fruits to five or six bushels or more per tree. Two hundred and ten kinds of apples and twenty-three kinds of crab apples fruited here in 1895, making the total number fruited that year two hundred and thirty-two. Notes on a few of these varieties are given below, based on their records at this Station. Some of them may do better elsewhere than they have done here; others may not do so well. This report is not put forth as a final statement of the merits of these fruits, but simply shows their records thus far at this Station.

Notes on Varieties.

In the following pages synonyms and temporary designations of unnamed sorts are printed in italics.

Aunt Ginnie.— *From Ellwanger & Barry, Rochester, N. Y.*, 1883.— Tree a moderately vigorous, upright grower. Fruit medium to large, oblate, slightly conic, obscurely ribbed; skin yellow, nearly overlaid with streaks and splashes of bright red; cavity broad and deep, heavily russetted; stem medium; calyx small, nearly closed; basin shallow, broad and corrugated. Flesh white, coarse, sub-acid, aromatic, good in flavor and quality; core very large. Season, October. It was top-worked on a young bearing tree in 1883 and bore its first fruit four years later. In several succeeding seasons it gave a light yield. Its first fairly good crop was produced this season, when it bore two bushels.

Downing Winter Maiden Blush.—*Cions from E. M. Buechly, Greenville, Ohio*, 1887. It bore its first fruit last season. Fruit large, roundish, slightly oblate; skin pale greenish yellow with a blush where exposed, and sprinkled with numerous white dots; stem short and thick, set in a medium cavity; calyx closed; basin broad, shallow and slightly corrugated. Flesh white, firm and crisp, moderately juicy, fine grained, mild sub-acid; quality good. Season, November to late winter. Tree moderately vigorous, upright.

Golden White.—A Russian apple received from T. H. Hoskins, Newport, Vermont, in 1888. It was top-worked on a young bearing tree and bore its first fruit six years later. Its growth has been weak so far. Fruit medium size, oblate inclined to conic, ribbed and peculiarly flattened at the base; color greenish yellow tinted and streaked with bright red in the sun, sprinkled with many large light dots; calyx half open; basin large, irregular and corrugated; stem small, inserted in a small and shallow cavity; flesh white with a faint salmon tinge; moderately juicy, sub-acid, quality fair, season September.

Heidorn.—A Russian apple received from T. H. Hoskins, Newport, Vermont, in 1888, and topworked on a bearing tree. It bore its first fruit this season. Fruit medium size, roundish oblate, slightly conic; skin of an unattractive dull purplish-red color. Calyx closed, set in a shallow corrugated basin; stem short; cavity deep and narrow. Flesh white, fine grained, sweet, poor to fair in flavor and quality. Season first of August here, but said to be a September apple in northern Vermont. The tree is a slow grower and only moderately vigorous.

Jacobs.—*Jacobs' Winter Sweet.* Received from Charles S. Jacobs, Medford, Mass., in 1888, with whom it originated. It was top-worked on a young bearing tree and bore its first fruit five years later. Tree a good vigorous grower of spreading habit. Fruit, medium to very large, roundish oblate; skin light yellowish green, with numerous large greenish dots; occasionally specimens are seen with a faint blush. Stem small; cavity broad, deep, and slightly russeted; basin rather broad and deep; calyx small, half open. Flesh white, crisp, sweet, rather coarse; quality good. Season November to late winter. The indications are that it will be productive and a valuable acquisition to the list of winter sweet apples. Yield this season five bushels.

Jonathan Buler.—*From Benjamin Buckman, Farmingdale, Illinois*, 1889.—It was top-worked on a bearing tree, and yielded its first fruit five years later. Fruit above medium size, oblate; skin light greenish-yellow, mottled and splashed with dark red, or sometimes reddish brown, and dotted with numerous small brown dots; stem small, inserted in a very broad, shallow, slightly russeted cavity; basin broad and deep, slightly irregular; calyx medium, open. Flesh white, mildly sweet, moderately juicy, fair quality. When cooked it keeps its shape like a sweet apple. Season, November and December, but like Fameuse, carefully handled specimens may be kept through the winter. See nothing in it to make it worthy of dissemination in this State. The tree is a free grower, vigorous, and somewhat spreading.

Landsberger Reinette.—Cions received from T. H. Hoskins, Newport, Vermont, in 1888, and top-worked on a bearing tree. It bore its first fruit in 1894, and in 1895 gave a large yield for so young a tree. Fruit medium to large, conic or oblate-conic; skin smooth, yellow, dull red on the exposed side washed and striped with dull carmine; stem medium; cavity deep and russeted; calyx open; basin wide, rather shallow and corrugated. Flesh nearly white, rather fine grained, mild sub acid, good quality for desert use, but too mild for cooking purposes. Its season may be said to begin with October, but like Fameuse, specimens may be kept till spring, though not in the best condition. Tree vigorous, inclined to be spreading.

Northwestern Greening.—*From George J. Kellogg, Janesville, Wisconsin*, 1888.— Yielded its first fruit in 1894, and gave a good yield in 1895. Tree a free grower, inclined to spread. Fruit medium to large, oblate inclined to conic; skin pale yellow when ripe; stem medium, inserted in a deep cavity; calyx closed, set in an abrupt, moderately shallow basin. Flesh rather coarse, juicy, aromatic, mild sub-acid, good flavor and fair quality. Keeps in good condition until March. Has not enough acidity to be as desirable for culinary use as other varieties of its season.

Ornament de Table.—*From Benjamin Buckman, Farmingdale, Illinois*, 1889.— It was top-worked on a bearing tree, and produced its first fruit in 1894. Tree vigorous, spreading. Fruit medium size or above, roundish oblate, attractive in appearance; skin yellow, sprinkled with russet and light dots, and streaked and blushed in the sun with light red; stem small, set in a moderately deep, symmetrical, russeted cavity; basin broad, rather abrupt, moderately deep; calyx closed; flesh nearly white, rather coarse, tender, mildly sweet; quality good. Season, October to February. As a desert fruit it is not as desirable as some other varieties of the same season.

Prolific Sweeting.—A Russian variety received from T. H. Hoskins, Newport, Vermont. Fruit medium or above, roundish oblate; skin pale yellow, sprinkled with whitish dots and russet specks. Stem medium set in a deep cavity. Calyx closed with segments reflexed; basin wide, shallow and corrugated. Flesh white, fine grained, mildly sweet. Season August. Topworked in 1888, it bore its first fruit in 1895. Tree moderately vigorous and upright.

Rome Beauty.—*Faust's Rome Beauty.*—This variety was first received here in 1883. In 1889 it was received under the name of Faust's Rome Beauty. The tree is vigorous, spreading, begins to bear young and is very productive. Fruit attractive in color, medium or above, roundish-conical. Skin yellow, striped and shaded with red and sprinkled with light dots. Flesh tender, sprightly, sub-acid, good in flavor and quality. When cooked at its prime it is nearly equal to Northern Spy in flavor and quality and has a fine color. It cooks evenly and quickly. Season November to March.

Smelling.—A Russian apple received from T. H. Hoskins, Newport, Vermont, in 1888, and topworked on a bearing tree. It bore its first fruit five years later. Fruit medium to large, oblong conic, obscurely ribbed; skin greenish yellow, largely covered with dark red and splashed with carmine, and sparingly dotted with small, light dots. Stem slender, scarcely projecting from the narrow, very deep, slightly russeted cavity; basin abrupt, moderately wide, corrugated; calyx half open. Flesh rather coarse, sub-acid, good flavor and quality. Season August. A handsome apple. The tree has as yet made only a weak growth.

Switzer.—A German variety received from T. H. Hoskins, Newport, Vermont, in 1888. Tree vigorous, spreading. Fruit medium size, roundish oblate. Skin pale yellow, at first nearly white, and beautifully blushed with light red, making it very attractive in appearance. Calyx closed; basin shallow, sometimes corrugated. Stem short, set in a narrow, shallow cavity. Flesh white, fine-grained, tender, moderately juicy, mild sub-acid, good to very good in flavor and quality. Desirable either for dessert or culinary use.

It was topworked on a young bearing tree in 1888, produced its first specimens of fruit in 1894 and in 1895 gave a large yield for so young a tree. Prof. Budd* calls it a hardy tree for cold climates and reports that when grown in northern localities, if carefully handled, it may be kept till winter.

Stump.—Top grafted in 1883, it produced its first fruit seven years later. Tree vigorous, upright grower. Fruit medium size, roundish conic; skin pale yellow, beautifully striped and shaded with red; flesh firm, crisp, tender, sub-acid, mild in flavor. Season last of August and first of September. It begins to ripen a few days later than Chenango Strawberry. The fruit is borne on short spurs close to the limbs. Tree productive. One of the handsomest late summer or early fall apples.

Williams (Favorite).—A dessert fruit that should be more widely known. Its symmetrical form and deep red color make it an attractive apple in market. It is also desirable for home use, as it is good in flavor and quality. The tree makes moderate growth and is a good bearer.

* Bulletin Iowa Agricultural College, Revised list of Fruits, &c., 1885 : 12, and Bulletin on Notes on Apples &c., 1890 : 18.

Yield of Apples and Crab Apples in 1895.—The following tabulated statement of the yield of apples and crab apples in Station orchard No. 2, in 1895, permits of a comparison of the yield for this year with the yield in former years as given in previous annual reports. It also permits of a comparison of the different varieties as to their yield in 1895. The statement shows which of these trees were planted and which were grafted on bearing stock, and gives the orchard age of each. The varieties have not all been planted or grafted the same length of time and some have been bearing for several years while others are just beginning to bear. For this reason the orchard age is given so that a more correct comparison of the varieties may be made, and the yield is not given in bushels but is stated by using the adjectives few, fair, good, large, or very large as the case may be.

TABLE II, SHOWING (1) YIELD IN 1895; (2) NUMBER OF YEARS SINCE EACH VARIETY WAS TOP-WORKED ON A YOUNG BEARING TREE, OR SINCE IT WAS PLANTED, AND (3) SEASON OF RIPENING AT GENEVA.

NOTE.—The following abbreviations are used to denote the season of ripening: E. S., for early summer; S., for summer; E. F., for early fall; F., for fall; E. W., for early winter; W., for winter, and L. W., for late winter. Synonyms are printed in italics.

NAME.	Yield in 1895.	ORCHARD AGE. Top-worked on bearing tree.	Planted.	Season at Geneva.
Acuba-leaf Reinette	Very large	12	....	E. W.
Alexander	Few	12	....	F.
American Newtown Pippin, see Green Newtown Pippin	......	....	....	......
Amos Jackson	Fair	6	....	E. W.
Ananarnoe	Few	11	....	F.
Andrews Winter	Large	6	....	L. W.
Aport Oriental	Large	7	....	F.
Aporta, see Alexander	......	....	....	......
Arabian	Few	7	....	S.
Astravaskoe, see Ostrakoff	......	....	....	......
August	Very large	7	....	S.
Aunt Ginnie	Good	12	....	F.
Aurora, see Twenty Ounce	......	....	....	......
Autumn Streaked	Good	7	....	F.
Baltimore Pippin, see Ben Davis	......	....	....	......
Baltimore Red, see Ben Davis	......	....	....	......
Baltimore Red Streak, see Ben Davis	......	....	....	......
Belborodooskoe	Fair	....	11	S.
Belle de Boskoop	Large	7	....	E. W.
Belle Fleur, see Yellow Bellflower	......	....	....	......
Bell's Early, see Sops of Wine	......	....	....	......
Ben Davis	Very large	12	....	L. W.
Benninger	Very large	6	....	E. F.
Bennington, see Sops of Wine	......	....	....	......
Benoni	Few	7	....	E. F.
Boston Russet, see Roxbury Russet	......	....	....	......
Brooke's Pippin, see Green Newtown Pippin	......	....	....	......

TABLE SHOWING THE YIELD OF APPLES, ETC., IN 1895 — (*Continued*).

NAME.	Yield in 1895.	Orchard Age. Top-worked on bearing tree.	Orchard Age. Planted.	Season at Geneva.
Brownlee Russet	Few	12	....	L. W.
Buckingham	Fair	7	....	L. W.
Buckley, see Chenango Strawberry	....	....	....	......
Byer's Best, see Buckingham	....	....	....	......
Carolina Red Streak, see Ben Davis	....	....	....	......
Cayuga Red Streak, see Twenty Ounce	....	....	....	......
Canada Baldwin	Fair	7	....	L. W.
Canada Reinette	Fair	7	....	L. W.
Chenango Strawberry	Very large	12	....	S.
Coleman, see Twenty Ounce	....	....	....	......
Colton	Fair	7	....	S.
Coon Red	Fair	6	....	L. W.
Cooper Market	Very large	12	....	L. W.
Cooper's Redling, see Cooper Market	....	....	....	......
Count Orloff, see Groscœ Selenka Gruner	....	....	....	......
Cox Pomona	Good	12	....	E. F.
Czar Thorn	Good	....	11	E. F.
Delaware	Fair	7	....	E. W.
Delaware Winter, see Delaware	....	....	....	......
Delaware Red Winter, see Delaware	....	....	....	......
Dickinson	Good	7	....	L. W.
Disharoon	Few	6	....	E. W.
Dodge's Early Red, see Sops of Wine	....	....	....	......
Downing Winter Maiden Blush	Fair	8	....	W.
Duchess of Oldenburg, see Oldenburg	....	....	....	......
Dudley Winter	Few	3	....	E. F.
Duncan	Good	6	....	L. W.
Early French Reinette, see Early Harvest	....	....	....	......
Early Harvest	Fair	12	....	E. S.
Early Ripe	Very large	7	....	E. S.
Early Strawberry	Few	12	....	E S..

TABLE SHOWING THE YIELD OF APPLES, ETC., IN 1895 — (*Continued*).

NAME.	Yield in 1895.	Orchard Age. Top-worked on bearing tree.	Orchard Age. Planted.	Season at Geneva.
Edgar Red Streak	Good	7	....	L. W.
Edwards	Good	6	....	L. W.
Elgin Pippin	Good	6	....	E. F.
Emperor Alexander, see Alexander	....	....	....	......
English Golden, see Golden Russet	....	....	....	......
English Golden Russet, see Golden Russet	....	....	....	......
English Pippin	Few	7	....	F.
Enormous	Fair	7	....	E. S.
Ernest Pippin, see Ohio Pippin	....	....	....	......
Esopus Spitzenburg	Few	12	....	W.
Everbearing	Large	6	....	F.
Ewalt	Few	7	....	W.
Falix	Few	6	....	F.
Fallawater	Very large	12	....	E. W.
Fall Pippin	Very large	12	....	F.
Fall Queen, see Haas	....	....	....	......
Fall Queen, see Buckingham	....	....	....	......
Fall Wine	Large	12	....	F.
Fameuse	Fair	12	....	F.
Family	Good	6	....	E. F.
Farris	Good	6	....	E. W.
Faust's Rome Beauty, see Rome Beauty	....	....	....	......
Ferdinand	Few	6	....	W.
Flory	Very large	7	....	F.
Frank, see Chenango Strawberry	....	....	....	......
French Pippin	Few	5	....	......
Gardener's Apple, see Mother	....	....	....	......
Gideon	Large	7	....	F.
Gideon, No. 7	Very large	7	....	S.
Gideon, No. 30	Few	7	....	S.
Gideon Sweet	Few	7	....	......
Gillett's Seedling, see Rome Beauty	....	....	....	......
Glass Green	Large	7	....	E. S.
Golden Russet	Good	12	....	L. W.
Golden Sweet	Good	12	....	E. F.
Golden White	Few	7	....	E. F.

TABLE SHOWING THE YIELD OF APPLES, ETC., IN 1895 — (*Continued*).

NAME.	Yield in 1895.	ORCHARD AGE. Top-worked on bearing tree.	ORCHARD AGE. Planted.	Season at Geneva.
Gracie	Few	7	....	E. F.
Grandmother	Large	7	....	F.
Grand Sultan	Few	12	....	E. S.
Gravenstein	Fair	12	....	F.
Gray Apple, see Pomme Grise	....	....	....	......
Green Newtown Pippin	Fair	12	....	L. W.
Green Winter Pippin, see Green Newtown Pippin	....	....	....	......
Green Vandevere, see Vandevere	....	....	....	......
Grimes Golden	Good	7	....	E. W.
Groskœ Selenka Gruner	Few	12	....	E. S.
Gros Pomier, see Haas	....	....	....	......
Haas	Good	12	....	E. W.
Hartford Rose	Large	7	....	F.
Haskell	Large	7	....	F.
Heidorn	Few	7	....	S.
Hicks	Very large	6	....	E. S.
Holland	Very large	7	....	E. W.
Hominy, see Sops of Wine	....	....	....	......
Hass or *Horse*, see Haas	....	....	....	......
Howard Aport	Fair	7	....	E. F.
Hower or *House*, see Fall Wine	....	....	....	......
Howe's Russet, see Roxbury Russet	....	....	....	......
Hurlbut	Fair	12	....	E.W.
Hurlbut Stripe, see Hurlbut	....	....	....	......
Jackson Apple, see Chenango Strawberry	....	....	....	......
Jacobs	Very large	7	....	W.
Jacobs Winter Sweet, see Jacobs.	....	....	....	......
Jenniton, see Ralls Genet	....	....	....	......
Janette, see Ralls Genet	....	....	....	......
Jersey Sweeting	Large	12	....	S.
Jewett Fine Red	Fair	7	....	W.
Jonathan	Large	7	....	W.
Jonathan Buler	Fair	6	....	L. F.
Juicy Krimtartar	Fair	7	....	F.
July Apple, see Primate	....	....	....	......
July Pippin, see Early Harvest	....	....	....	......

TABLE SHOWING THE YIELD OF APPLES, ETC., IN 1895 — (*Continued*).

NAME.	Yield in 1895.	Orchard age. Top-worked on bearing tree.	Orchard age. Planted.	Season at Geneva.
Kalkidouskœ	Few	....	11	F.
Kansas Greening	Few	6	....	.....
Kansas Keeper	Few	6	....	.....
Karabowka	Few	12	....	S.
Kentucky Pippin, see Ben Davis	....	....	....	.....
Kentucky Queen, see Buckingham	....	....	....	.....
Keswick	Large	12	....	E. F.
King Apple, see Tompkins King	....	....	....	.....
King of Tompkins County, see Tompkins King	....	....	....	.....
Kittageskee	Large	5	....	W.
Lady Henniker	Few	12	....	W.
Lady's Blush, see Maiden Blush	....	....	....	.....
Landon	Few	7	....	L. W.
Landsberger Reinette	Very large	7	....	F.
Lankford	Large	7	....	L. W.
Large Yellow Bough, see Sweet Bough	....	....	....	.....
Large White Juneating, see Early Harvest	....	....	....	.....
Late Duchess	Fair	7	....	S.
Letitz Beauty	Few	5	....	S.
Lima, see Twenty Ounce	....	....	....	.....
Longfield	Very large	7	....	F.
Lord Nelson	Good	7	....	.....
Lou	Very large	7	....	S.
Lyman's Pumpkin Sweet, see Pumpkin Sweet,	....	....	....	.....
Magog Red Streak	Fair	7	....	W.
Maiden Blush	Large	12	....	F.
Maiden Blush	Good	5	....	F.
Mann	Good	7	....	L. W.
Marietta Russet, see Roxbury Russet	....	....	....	.....
Maryland Queen, see Haas	....	....	....	.....
McIntosh Red	Large	7	....	E. W.
McMahan White	Very large	7	....	W.
Melon	Few	12	....	W.

TABLE SHOWING THE YIELD OF APPLES, ETC., IN 1895 — (*Continued*).

NAME.	Yield in 1895.	Orchard Age. Top-worked on bearing tree.	Orchard Age. Planted.	Season at Geneva.
Melonen	Fair	7	....	S.
Menagere	Fair	12	....	E. W.
Michigan Beauty, see Shiawasse Beauty	.....	....	....	.....
Milding	Large	7	....	W.
Milligen	Fair	7	....	W.
Missouri Pippin	Fair	7	....	E. F.
Molly Whopper, see Fallawater	.....	....	....	.....
Monmouth	Very large	12	....	L. W.
Moon	Few	6	....	.....
Moore Sweet	Few	5	....	W.
Morgan's Favorite, see Twenty Ounce	.....	....	....	.....
Moshier	Fair	7	....	F.
Mother	Few	12	....	E. W.
Mountain Pippin, see Fallawater	.....	....	....	.....
Musk Spice, see Fall Wine	.....	....	....	.....
Mzensk	Large	7	....	F.
Nelson	Good	6	....	L. W.
Never Fail, see Ralls Genet	.....	....	....	.....
New Brunswick, see Oldenburg	.....	....	....	.....
Newman Seedling	Large	5	....	L. W.
Newtown Pippin, see Green Newtown Pippin	.....	....	....	.....
New York Pippin, see Ben. Davis	.....	....	....	.....
Nodhead, see Jewett Fine Red	.....	....	....	.....
North American Best, see Primate	.....	....	....	.....
Northern Spy	Few	12	....	L. W.
North Star, see Dudley Winter	.....	....	....	.....
Northwestern Greening	Large	7	....	L. W.
Norton's Melon, see Melon	.....	....	....	.....
No. 21 Voronesh, see Yellow Calville	.....	....	....	.....
No. 199	Large	7	....	E. F.
No. 228 *Dept*, see Vochins Crimean	.....	....	....	.....
No. 238	Very large	7	....	E. S.
Occident	Fair	12	....	L. W.
Ohio Pippin	Large	7	....	.....
Ohio Wine, see Fall Wine	.....	....	....	.....

TABLE SHOWING THE YIELD OF APPLES, ETC., IN 1895 — (*Continued.*)

NAME.	Yield in 1895.	Orchard Age. Top-worked on bearing tree.	Orchard Age. Planted.	Season at Geneva.
Olive	Fair	6	....	......
Ontario	Few	12	....	L. W.
Ornament de Table	Fair	6	....	F.
Ostrakoff	Fair	11	....	E. F.
Palmer's Greening, see Washington	....	....	....	......
Parry White	Very large	6	....	E. F.
Parry White	Large	....	6	E. F.
Peck Pleasant	Good	12	....	E. W.
Peter	Very large	7	....	F.
Petersburgh Pippin, see Green Newtown Pippin	....	....	....	......
Pewaukee	Good	12	....	W.
Pound, see Fallawater	....	....	....	......
Pound Sweet (Red)	Very large	7	....	F.
Pound Sweet, see Pumpkin Sweet	....	....	....	......
Powers, see Primate	....	....	....	......
Pride of Texas	Fair	6	....	L. W.
Primate	Large	12	....	E. S.
Prince's Harvest, see Early Harvest	....	....	....	......
Prolific Sweeting	Fair	7	....	E. F.
Prussian, see Twenty Ounce	....	....	....	......
Pumpkin Russet	Very large	12	....	F.
Pumpkin Sweet	Very large	12	....	F.
Putnam Russet, see Roxbury Russet	....	....	....	......
Queen Ann, see Mother	....	....	....	......
Queen, see Buckingham	....	....	....	......
Ralls Genet	Few	12	....	W.
Rambo	Good	12	....	E. W.
Red Astrichan	Few	12	....	E. S.
Red Beitigheimer	Large	12	....	E. F.
Red Cheek Pippin, see Monmouth	....	....	....	......
Red Juneating, see Early Strawberry	....	....	....	......
Red Pippin, see Ben Davis	....	....	....	......
Red Russet	Few	12	....	L. W.
Red Transparent	Fair	....	11	E. S.
Red Vandervere, see Vandervere	....	....	....	......
Reinette a feuille d' Acuba, see Acuba-Leaf Reinette	....	....	....	......

TABLE SHOWING THE YIELD OF APPLES, ETC., IN 1895 — (*Continued*).

NAME.	Yield in 1895.	Orchard Age. Top-worked on bearing tree.	Orchard Age. Planted.	Season at Geneva.
Reinette de Caux	Few	12	....	W.
Repka	Fair	....	11	S.
Rhode Island Greening	Very large	12	....	W.
Rhodes Orange	Large	6	....	L. F.
Rome Beauty	Very large	12	....	W.
Romna	Very large	7	....	E. F.
Ronk	Few	5	....	......
Roxbury Russet	Very large	12	....	W.
Saint Lawrence	Very large	12	....	F.
Saint Peters	Fair	7	....	S.
Salome	Fair	7	....	L. W.
Sassafras Sweet, see Haskell	....	....	....	......
Scott Winter	Fair	7	....	L. W.
Sharp	Very large	6	....	L. F.
Shiawasse Beauty	Few	7	....	E. W.
Small Admirable	Very large	12	....	E. W.
Smelling	Fair	7	....	S.
Smith Cider	Very large	7	....	W.
Sops of Wine	Large	12	....	F.
Stanard	Very large	6	....	W.
Stark	Very large	7	....	L. W.
Stump	Very large	12	....	F ...
Sugar Barbel	Large	7	....	F ...
Summer Red Calville	Few	7	....	S.
Summer Rose	Few	7	....	S.
Sutton	Very large	12	....	W.
Sutton Beauty, see Sutton	....	....	....	......
Swaar	Few	7	....	W.
Sweet Bough	Very large	7	....	S.
Swenker	Few	5	....	......
Switzer	Very large	7	....	S.
Talman Sweet	Fair	12	....	W.
Thaler, see Yellow Transparent	....	....	....	......
Titovka	Fair	12	....	F.
Tobias Pippin	Fair	7	....	E. W.
Tompkins King	Good	12	....	E. W.
Tufts	Fair	12	....	E. F.
Twenty Ounce	Large	12	....	F.
Vandevere	Good	12	....	W.

TABLE SHOWING THE YIELD OF APPLES ETC., IN 1895 — (*Continued*).

NAME.	Yield in 1895.	Orchard Age. Top-worked on bearing tree.	Orchard Age. Planted.	Season at Geneva.
Van Hoy No Core	Good	6	....	L. W.
Vochins Crimean	Very large	7	....	E. S.
Wagener	Few	12	....	W.
Walbridge, see Edgar Red Streak	....	....	....	......
Wallace Howard	Few	6	....	......
Washington, see Sops of Wine	....	....	....	......
Washington Royal	Large	7	....	L. W.
Washington Strawberry	Very large	7	....	E. F.
Watermelon, see Melon	....	....	....	......
Wealthy	Large	7	....	F.
Western Beauty	Fair	7	....	W.
Wheeler No. 13	Few	3	....	......
White Canada Pippin	Few	5	....	E. W.
White Doctor	Large	6	....	L. W.
White Pigeon	Very large	7	....	S.
White Pippin	Good	12	....	S.
White Vandevere, see Vandevere	....	....	....	......
Williams' Early, see Williams	....	....	....	......
Williams (Favorite)	Good	12	....	E. S.
William Prince	Large	6	....	S.
Williams' Red, see Williams	....	....	....	......
Wine Apple, see Twenty Ounce	....	....	....	......
Wine Rubets	Few	7	....	S.
Winesap	Large	12	....	W.
Winter Blush, see Fallawater	....	....	....	......
Winter Queen, see Buckingham	....	....	....	......
Wolf River	Few	7	....	F.
Workarœ	Few	....	11	S.
Yellow Bellflower	Large	12	....	W.
Yellow Calville	Very large	7	....	S.
Yellow Forest	Good	7	....	L. W.
Yellow Transparent	Very large	7	....	E. S.
Yopp Favorite	Few	6	....	L. F.
York Imperial	Very large	7	....	L. W.

Seven varieties which fruited are not included in the above list because they were borne on older trees. Including these the total number of apples fruited in 1895 is 210.

TABLE SHOWING THE YIELD OF APPLES, ETC., IN 1895 — (*Concluded*).

NAME.	Yield in 1895.	Orchard Age. Top-worked on bearing tree.	Orchard Age. Planted.	Season at Geneva.
CRAB APPLES.				
Blood Red	Fair	7	....	F.
Cherry Red	Fair	6	....	S.
Chicago	Very large	7	....	W.
Coral	Few	12	....	E. W.
Dartmouth	Good	7	....	S.
Excelsior	Large	7	....	E. F.
Gideon No. 2	Very large	7	....	F.
Gideon No. 3	Large	7	....	F.
Hyslop	Large	12	....	F.
Lady	Very large	7	....	L. F.
Large Yellow Siberian	Fair	7	....	E. F.
Marengo	Large	7	....	F.
Martha	Fair	7	....	F.
Minnesota	Few	7	....	E. F.
Montreal Beauty	Few	7	....	......
Oblong	Large	12	....	F.
Paul Imperial	Very large	7	....	E. F.
Picta Striata	Very large	7	....	E. F.
Red Siberian	Large	7	....	E. F.
September	Very large	7	....	F.
Transcendant	Few	12	....	E. F.
Van Wyck	Few	7	....	S.
Whitney (*Whitney No.* 20)	Large	12	....	S.

Total number of crab apples fruited, twenty-three.

PEARS.

List of pears in Station orchards in 1895, not including Station seedlings.

Angouleme.
Anjou.
Anna Nellis.
Ansault.
Arkansas Mammoth.
Assomption.
Autumn Bergmot.
Ayer No. 1.
Bartlett.
Bartseckel.
Bessemianka.
Bezi de la Motte.
Bon Chrétien Fred Baudry.
Bordeaux.
Bosc.
Boussock.
Brandywine.
Brignais.
B. S. Fox.
Buffum.
Centennial.
Chinese Sand.
Cincincis.
Clapp Beauty.
Clapp Favorite.
Clairgeau.
Cocklin.
Cole.
Colonel Wilder.
Columbia.
Comet.
Comice.
Congress.
Craig.
Crow Choice.
Daimyo.
Dana Hovey.
Dearborn Seedling.
Delices de Louvenjal.
Dewey Premium.
Directeur Alphande.
Dix.
Dr. Farley.
Dr. Reder.
Dorset.
Dula.
Early Bergamot.
Early Harvest.
Easter Beurre.
Ellis.
E. No. 47.
Exeitier.
Fitzwater.
Flat Bergamot.
Flemish Beauty.
Fondante de Bihorel.
Fortunée Boisselot.
Frederic Clapp.
Gakovsky.
Gans.
Gansel Seckel.
Garber.
Giffard.
Goodale.
Hosenschenck.
Howell.
Idaho.
Japan.
Japan Golden Russet.
Jaques Molet.
Jones.
Josephine of Malines.
Kieffer.
Kingsessing.
Kinsman.
Koonce.
Kurskaya.
Lady Clapp.
Lamartine.
Late Bartlett.
Lawrence.
Lawson.
Le Conte.
Limbertwig.
Lincoln.
Lincoln Coreless.
Little Gem.
Longworth No 1.

Lucrative.
Lucy Duke.
Macomber No. 6.
Madam Appert.
Madam Heminway.
Madam Millet.
Madam Treyve.
Madam Von Siebold.
Manning Elizabeth.
Marie Benoist.
Marshall.
Maurice Desportes.
Miriam.
Mount Vernon.
Nickerson.
No. 439.
Old Crassane.
Oliver Des Serres.
Ontario.
Osband Summer.
Passans du Portugal.
P. Barry.
Peffer.
Peffer No. 3.
Pitmaston Duchess.
Pound
President Drouard.
Ravenwood.
Raymond of Montlaur.
Refreshing.
Reliance.
Ritson.
Rutter.
Saint Crispin.
Seckel.
Seneca.
Sheldon.
Shull
Souvenir d'Esperen.
Superfin.
Theresa Appert.
Tyson.
Urbaniste.
Van Cott.
Vermont Beauty.
Victor.
White Doyenné.
Wilder Early.
Winter Bartlett.
Winter Nellis.
Youngken Favorite.
Zuckerbirn.

Total 140

QUINCES.

List of quinces in Station orchards in 1895 :

Borgeat.
Champion.
D'Alger.
Fuller.
Meeche Prolific.
Missouri Mammoth.
Rea.
Santa Rosa.
Sweet Winter.
Van Deman.

Total 10

APRICOTS.

In 1884, apricots were first planted at this Station for the purpose of comparing the different varieties. They were set in a fertile, rather heavy clay loam, retentive of moisture and imperfectly drained. It is generally conceded that the first essential to successful apricot culture is a thoroughly drained soil and probably the location of this first planting of apricots is partly accountable for the fact that not one of the nineteen varieties then planted lived more than seven years. But the trouble has not been wholly due to the soil, for after the drains were put in good working order other trees died because of the imperfect union of stock and cion. Death of trees from this cause is more frequent with apricots than with any other orchard fruits with which I am acquainted.

For several years after 1884, efforts were made to fill the vacant places as fast as the trees died, and even to extend the area of the planting somewhat, but in the location first chosen the results have not been encouraging. As previously stated none of the first planting are alive to-day except the Black or Purple apricot, and this does not belong to the same species as the common apricot. The Russian apricots belong to the same species as the common apricots. The claim has been made that they are hardier than the common apricots and the experience with them at this Station tends to support this claim. In 1888 and 1889, several varieties of Russian apricots were planted and they have done better than the common apricots planted in the same orchard under similiar soil conditions and subject to similar care. Plums in the same orchard have been longer lived and much more fruitful than apricots growing under similar conditions, thus furnishing another illustration of the fact that not all locations in which plums succeed are suitable for apricots.

By consulting the following tables a comparison may be made of the average length of life of common apricots, Russian apricots and plums which have been planted in orchard No. 4, during the six years from 1884 to 1889, inclusive. In these lists no account is taken of the trees which died within a year after they were set because they never became fully established, neither is any account taken of those which were removed on account of accidental injury.

COMMON APRICOTS. (*Prunus Armeniaca.*)

WHEN PLANTED.	Number planted.	Average years actually lived.	Average years possible to live to 1895.	Total years actually lived.	Total years possible to live to 1895.
1884	15	4.13	12	62	165
1885	2	5.50	11	11	20
1886	9	5.22	10	47	81
1888	4	4.25	8	17	28
Total	30	....	....	137	294

Average years actually lived	4.56
Average years possible to live	9.80
Per cent. of possible years actually lived	47

RUSSIAN APRICOTS. (*Prunus Armeniaca.*)

WHEN PLANTED.	Number planted.	Average years actually lived.	Average years possible to live to 1895.	Total years actually lived.	Total years possible to live to 1895.
1888	5	6.20	8	31	35
1889	3	5.66	7	17	18
Total	8	....	....	48	53

Average years actually lived	6.00
Average years possible to live	6.63
Per cent. of possible years actually lived	91

COMMON PLUMS. (*Prunus Domestica.*)

WHEN PLANTED.	Number planted.	Average years actually lived.	Average years possible to live to 1895.	Total years actually lived.	Total years possible to live to 1895.
1884	17	10.76	12	183	204
1885	14	11.00	11	154	154
1888	32	8.00	8	256	256
1889	5	7.00	7	35	35
Total	68	....	....	628	649

Average years actually lived	9.24
Average years possible to live	9.54
Per cent. of possible years actually lived	97

In this case the Russian apricots have been nearly twice as reliable under the existing conditions as the common apricots have, for they have lived 91 per cent. of their possible time, while the common apricots have lived but 47 per cent. of their possible time. The plums have lived 97 per cent. of their possible time, showing a very small mortality, although the list of varieties planted contains some that are commonly considered not very hardy. The tables show that in 1888 a planting of both common and Russian apricots was made. Up to the present time the common apricots which were planted in 1888 have lived 61 per cent. of their possible time while the Russians have lived 94 per cent. of their possible time.

The total number of common apricot trees which were planted in Station orchard No. 4 from 1884 to 1889, excepting those that died within a year after they were planted and those that were accidentally injured, is thirty, of which three still live. Making the same exceptions the number of Russian apricots planted during this period is eight, of which six are still living; and the number of common plums is sixty-eight, of which sixty-five are still alive.

PRODUCTIVENESS.

The Russian apricots have given as large or larger yields than the common apricots so far as tested here. The following is a statement of the yield of the surviving trees in 1895 when they bore their first crop. Some of the trees have borne a few fruits in previous years and five pounds were borne by Early Moorpark in 1893.

NAME.	When planted.	Yield in pounds in 1895.
COMMON APRICOTS.		
Early Moorpark	1886	15
Large Early	1886	10
Shipleys	1888	0
RUSSIAN APRICOTS.		
Alexander	1888	45
Budd	1888	20
Catharine	1888	20
Gibb	1888	10
Golden Russian	1889	45
Golden Russian	1889	30

None of the Russian apricots that we have tested compare favorably with the common apricots either in appearance or quality. They generally rank from small to medium in size. In habit of growth the trees are much like the common kinds, but the leaves are narrower, as may be seen by comparing plates II and III with plate IV. Should they prove hardier than the common apricots they will be desirable for home use in localities where better kinds do not thrive, for they ripen before the early peaches and give a pleasing variety to the list of mid-summer fruits. It is not to be expected, however, that they will ever be of much commercial value.

The best in quality of the kinds fruited here in 1895 is the Gibb, but, as shown above, the tree bore a light crop and on this account it may have developed finer fruit than it would have done had the tree borne as heavy a crop as did the others. Descriptions of the apricots that fruited here in 1895 are given below.

Alexander.—A Russian variety. Tree a vigorous upright grower; new shoots quite red, leaves with globose glands. Fruit small, slightly oblong; suture is somewhat obscure and extends half round;

skin light yellow; flesh slightly darker than the skin, not firm, very juicy, sweet but not sprightly. Stone medium size. Season last of July.

Black or Purple.—An old variety quite distinct from the common apricots and belonging to the species *prunus dasycarpa*. (See plate I.) Tree not as free a grower as the other sorts; young shoots more slender; leaves narrower. Fruit medium size, nearly round; skin dull reddish purple in the sun, covered with a slight down. Flesh a deep red toward the outside, but tinged with yellow next the pit, to which it adheres somewhat; juicy; inferior to common apricots in quality. Season middle of August.

Budd.—*J. L. Budd.* A Russian variety. Tree upright, vigorous. Fruit small, oval, slightly flattened, sides unequal, suture deep, extending half-round; skin golden yellow, tinged with red on the exposed side; flesh bright orange, darker than the skin, juicy, fibrous and coarse; pit comparatively large. Moderately productive this year. Season first of August.

Catherine.— A Russian variety. Tree an upright, vigorous grower. Fruit small, nearly round; suture half-round and ends in a small point at the apex. (See plate 2). Skin light orange color when fully ripe, splashed with red on the exposed side; flesh darker than the skin, a fine bright orange color, juicy, sweet and melting but somewhat stringy. Quality good for a Russian. Pit large. Season, first of August.

Early Moorpark.— (See illustration, figure 1.) This is one of the old varieties that is much esteemed. Tree vigorous and productive. Fruit of good size and excellent quality. Ripens here about the middle of July.

Gibb.— A Russian variety; vigorous, upright. Leaves have globose glands. Fruit below medium, roundish with obtuse apex; suture somewhat obscure, extending half round. (See plate 3.) Skin very light yellow. Flesh yellowish, juicy, moderately firm, nearly sweet, good quality and does not adhere to the medium sized stone. Season, last of July.

Golden Russian.— Tree a good grower. Leaves have few globose glands. Fruit below medium, roundish, slightly obovate; suture not deep, extending half round, skin light greenish yellow with fine bloom. Flesh golden yellow, tender, very juicy, rather coarse, semi-cling. Pit rather large. Ripens here about August 1st.

Plate A. Figure 1.— Early Moorpark Apricot.

PLATE I.— Black Apricot.

PLATE II.—Catherine Apricot

PLATE III.—Gibb Apricot.

Plate IV.—Large Early Apricot.

Golden Russian.— Received here as Golden Russian, but is not identical with the variety above described. Tree a strong grower, upright. Fruit below medium, roundish oval with decided suture from base to apex, usually extending a little beyond the apex. Skin nearly smooth, orange colored. Flesh deep orange, juicy, sweet, moderately firm, rather coarse and stringy, fine flavored. Pit rather large and free.

Large Early.— One of the standard sorts of common apricots. Fruit highly colored, orange with bright red cheek. Flesh sweet and excellent. Freestone. Ripened this season the last of July. Plate IV is reproduced from a life size photograph of this variety.

List of Apricots Grown at the Station in 1895.

COMMON APRICOTS.

De Coulange.
Early Moorpark.
Harris.
Large Early.
Oullin Early.
Shense, (*Acme*).
Shipley (*Blenheim*).
Smith Triumph.
Victor.
Uvadale

Total.................................... 10

RUSSIAN APRICOTS.

Alexander.
Budd, (*J. L. Budd*).
Catharine.
Gibb.
Golden Russian.
Golden Russian.

Total 6

JAPAN APRICOTS.

Bougoume.
Hubbard.
Japan.

Total.................................... 3

Prunus dasycarpum.

Black, (*Purple*).

Total	1
Total of all varieties	20

THE LUTOVKA CHERRY.

In July, 1895, the following circular was issued to all names on the Bulletin list of this Station:

Among the new or little known cherries received at this Station in recent years, the Lutovka is one of the most promising of the late sour varieties. It was imported from Europe about twelve years ago by Prof. Budd of Ames, Iowa, who says it is much grown in Poland and in Silesia, as a road-side tree. It was first planted at the Station in 1888. So far as observed, it is not catalogued by any nurseryman in this state, although it is grown to some extent in western nurseries. It appears to be worthy of extended trial as a late sour cherry. Buds will be distributed to persons in this state who make written requests for them immediately. The requests will be filled in the order they are received as long as the supply lasts. Of course but a few buds can be given to each person. Buds will be sent out soon after the tenth of August. Applications received after the present supply is exhausted will be placed on file and the buds sent next year.

DESCRIPTION.—Tree of Morello type, a vigorous grower, young branches rather slender; fruit firm, good quality, sprightly acid, as large as English Morello or larger, more nearly round, very similar to that variety in color, but the flesh is not so dark as that of English Morello; clings tenaciously to the long stem. So far as tested here the tree has proved to be very productive, ripening its fruit as late as, or later than, the English Morello.

Address

N. Y. AGRICULTURAL EXPERIMENT STATION,
Geneva, N. Y.

In response to this circular so many requests were received for cions that the supply was soon exhausted. The names of applicants from this State who could not be supplied with cions in 1895 have been placed on file and it is expected to mail them cions in August, 1896.

GRAPES.

Some of the newer varieties of grapes which have fruited in the Station vineyards are described below; comment is also made on a few older and better known grapes, and references are given to the reports of varieties which have been noted in previous publications of this Station.

The botanical classification of a variety is indicated by an itali cized abbreviation of the name of the species to which it belongs.*

A hybrid is indicated by an "X" separating the names of the species of which it is the offspring; thus *vin.* X. *Lab.* indicates a hybrid of *vinifera* fertilized by *Labrusca*. When it is known to which of the two species the female parent belongs, this parent is named first.

When a hybrid is more closely related to one species than to any other this relationship is indicated by an "X" following the name of the species to which it is most closely related; thus "*Lab.* X" shows that the hybrid is most closely related to the *Labrusca* species.

The names of the species represented in a hybrid are also frequently given in parentheses following the name of the hybrid; thus, Bailey (*Lab.*, *Lin.*, *vulp.*), indicates that the three species named are represented in the parentage of this variety; Brighton *Lab.* X (*Lab.*, *Vin.*), indicates that Brighton is a hybrid of *Labrusca* and *vinifera*, with more of *Labrusca* than of *vinifera* blood.

Synonyms are printed in italics and inclosed in parentheses.

Alexander Winter.—*From S. R. Alexander, Bellefontaine, Ohio*, 1892. Vine vigorous. Bunch medium size, imperfectly filled and containing many small seedless berries clearly indicating imperfect fertilization of the flowers. The fully developed berries are medium to large in size, reddish purple with lilac bloom. Pulp tender, sweet, excellent in flavor and quality. It has been tested as to its self fertility and the results show that it is capable of setting some fruit of itself but that it can not be relied on to form perfect clusters when standing alone. Even when standing in a mixed vineyard it has failed to set perfect clusters. It was briefly noticed in the report of this Station, 1892: 613.

Alice.—*From Ward D. Gunn, Cedar Hill, Ulster Co., N. Y.*, 1889. This variety was noticed in the report of the Station for 1892: 613 and 1893: 617. The report now given is based on observations of the past four years at this Station.

Vine vigorous and moderately productive. Clusters medium or above, moderately compact, shouldered. The different clusters are apt to vary considerably in time of ripening. Begins to ripen about with Concord and may be kept into winter. Berries are not very uniform in size but vary from small to medium or above and are pale

*The following abbreviations are used, viz.: *Lab.* for *Labrusca*, L., the wild Fox grape; *vin.* for *vinifera*, L., the cultivated grape of Europe; *Lin.* for *Lincecumii*, Buck., the Post-oak grape of Texas; *Bourq.* for *Bourquiniana*, Mun., and *rup.* for *rupestris*, Scheele, the Rock or Sand grape of Western Mississippi Valley and Texas.

red with lilac bloom. Skin rather thick and tough. Pulp juicy, somewhat vinous, tender, good quality and good flavor, slightly foxy. It is self fertile and capable of setting fruit satisfactorily when standing alone. It bears a marked resemblance to Diana in foliage, habit and fruit.

This variety is now being introduced by Mr. Fred E. Young, Rochester, N. Y.

America.—*Lin.* X *rup. From T. V. Munson, Denison, Texas.* 1892. Clusters medium to large, shouldered, compact, conical; berries medium size, nearly round; skin thin, purple-black with blue bloom; leaves purplish; fibres remain attached to the pedicle when it is separated from the fruit; pulp tender, breaking, moderately juicy, nearly sweet, vinous, with a pronounced flavor; juice dark purple. Possibly a good wine grape but the highly colored juice is objectionable in a dessert fruit. It bore its first fruit this season. So far as tested here it is not capable of setting fruit when standing alone, but in a vineyard of mixed varieties it has formed an abundance of perfect clusters. Prof. Munson with whom it originated reports that it is perfect in fertilization in Texas. It was briefly noticed in the Station report 1892: 614.

Arkansaw.—*Lab. From Joseph Hart, Fayetteville, Arkansas,* 1893. Cluster medium or above, moderately compact, not shouldered. Berry medium size with little or no bloom, pale dull green mottled or thinly covered with red and spotted with red dots, giving it a unique appearance. Its peculiar color is probably the only character that has brought it into notice. Were its color either red, yellow or purple, it is doubtful if the variety would ever have been propagated. The pulp is rather tough, sweet, foxy, fair in flavor and quality. It appears to be vigorous and productive, but has not been tested long enough to determine these characters.

Bailey.—*Lin.* X (*Lin. Lab. vin.*) Bunch large, long, cylindrical, moderately compact; berries slightly ovate, black with blue bloom; pulp moderately tender, releasing the seeds readily, pure flavored, sprightly, vinous, good quality. Season evidently a little later than Concord, almost as late as Catawba this year. Vine vigorous. Received from T. V. Munson, Denison, Texas, in the fall of 1892, and produced its first fruit this year. See, also, report of this Station for 1892: 614.

Bertha.—*From United States Pomologist, Washington, D. C.,* 1892. Parentage unknown. It bore its first fruit this season.

Vine vigorous; foliage healthy; clusters medium or above, compact; berries medium size; skin pale green color with white bloom; pulp moderately tough, sub-acid; quality fair to good. Since it is fully self-fertile, it can set fruit satisfactorily, even when standing alone.

Big Extra.—*Lin.* X (*Lin., Lab., vin*). A seedling of Post Oak X Triumph, received from T. V. Munson, Denison, Texas, in the spring of 1892. It bore a small amount of fruit this season. Bunch large, compact, cylindrical, slightly shouldered; berry nearly round, dark purple with blue bloom; pulp tender, juicy, and of good quality. Vine vigorous.

Big Hope.—*Lin.* X (*Lin., Lab., vin*). A seedling of Post Oak X Triumph, originated by T. V. Munson, Denison, Texas, and received here in the spring of 1892. It bore its first fruit this season. Bunch medium or above, moderately compact; berries medium, reddish purple with blue bloom; pulp rather firm, moderately tender, releases seeds readily, vinous, good flavor and quality. Ripened this year with, or a little before Catawba.

Brown.—*From W. B. Brown, Newburgh, N. Y.*, 1893. Bunch medium size, moderately compact, cylindrical; berries somewhat oval; it leaves dark purple fibres attached to the pedicle; skin black, with thin blue bloom; pulp moderately tough, good flavor and quality; juice slightly colored. Season early, about with Hartfort or a little earlier. Vine vigorous; foliage healthy. Resembles Hartford in fruit but not in foliage.

Campbell. See **Early Golden.**

Carman.—*Lin.* X (*Lin., Lab., vin*). A seedling of Post Oak X Triumph, originated by T. V. Munson, Denison, Texas. Cluster medium size, cylindrical, rather loose; berry medium or above, nearly round, purplish black with blue bloom; skin thin, tough; juice colored; pulp moderately tender, good flavor and quality, somewhat vinous, nearly sweet. Ripen a little before Catawba. Vine very vigorous and capable of fruiting satisfactorily when standing alone. Foliage good, received here in the spring of 1892 and bore its first fruit in 1895.

Chandler.—*Lab.* A chance seedling received from N. M. Chandler, Ottawa, Kansas, in the spring of 1892. Bunch medium to large, compact; berry medium to large; skin greenish white, tinged with faint yellow, tender, cracks easily; pulp juicy, sweet, vinous, good quality, fair flavor. Vine fairly vigorous, productive, and capable of setting fruit satisfactorily when standing alone. Do not think it worthy of dissemination, at least in this locality.

Colerain.—*Lab.*—*From G. W. Campbell, Delaware, Ohio,* 1892. A seedling of Concord. Bunch medium, conical, moderately compact, attractive; berry medium or above in size, pale green with white bloom; skin thin, tender, with occasional brown punctate dots; pulp sweet, tender, juicy, good quality and flavor, somewhat vinous. A good grape. Vine vigorous, capable of setting fruit satisfactorily when standing alone. Foliage good. Ripened this season about with Worden. Briefly noticed in Station Report 1892: 618.

Cortland.—*Lab. From E. C. Pierson, Waterloo, N. Y.,* 1892. This proves to be identical with Champion. The variety is a seedling of Concord X Hartford that was originated by M. F. Cleary, Cortland, N. Y., about 1863. Mr. Cleary still has the original vine in his possession. He named the variety Cortland. The Bushberg Catalogue, 1895: 102, states that prior to 1873 it had been disseminated in the vicinity of Rochester, N. Y., under the name of Early Champion, and in the vicinity of Montreal it became known as the Beaconsfield. Prior to this it was grown in the vicinity of Binghamton, N. Y., and was propagated and sold by T. S. Hubbard, Fredonia, N. Y., under the name of Tallman. It is capable of setting fruit satisfactorily when standing alone.

Dr. Collier.—(*Big Red*) *Lin.* X, (*Lin. vin., Lab.*). *From T. V. Munson, Denison, Texas, in the fall of* 1892. Clusters medium to large, rather loose, sometimes shouldered. Berries medium or above, reddish purple, with blue boom, leaving red fibres attached to the pedicles; pulp tender, juicy, vinous, nearly sweet, agreeable flavor, good quality; colored juice. Sets fruit imperfectly when self-fertilized and so should be planted with other kinds that blossom with it. Briefly noticed in Station Report, 1892: 620.

Dr. Hexamer.—*Lin.* X, (*Lin., Lab., vin.*). A seedling of Post Oak X Triumph, originated by T. V. Munson, Denison, Texas, and sent to the Station in the fall of 1892. Clusters rather loose and spreading, medium or above in size. Berry medium size; color purple-black with blue bloom. Pulp tender, moderately juicy, nearly sweet, good quality but with strong Post Oak flavor; juice dark red. Much like America in foliage, size, color, flavor and quality of fruit. In mixed vineyards it sets fruit satisfactorily but it can not set fruit when standing alone.

Early Golden.—(*Campbell*). This variety was first named Campbell, but since Mr. George W. Campbell has introduced a new grape under the name Campbell's Early, this one has been renamed by its originator, Professor Munson, and is now called Early Golden. It produces beautiful large clusters of medium sized white berries, but ripens too late for this locality, being somewhat later than Catawba. It is capable of setting fruit satisfactorily when standing alone. See, also, Station report 1892 : 616, and 1893 : 619.

Early Victor.— *From Bush and Son and Meissner, Bushberg, Mo.*, 1893. Vine moderately vigorous; bunch medium or below, compact; berry medium, round, black with blue bloom; red fibres are left with the pedicle when the berry is detached; pulp juicy, mildly sweet, rather tough, releases seeds readily, fair flavor and quality. Ripens about with Moore's Early.

Edmeston No. 1. *Lab.* A Concord seedling originated by D. G. Edmeston, Adrian, Michigan, and received from him in the spring of 1892. Bunch medium size, moderately compact; berry medium to large, dark purple with blue bloom; pulp moderately tough, juicy, vinous, nearly sweet, good quality; vine vigorous; foliage good. Ripened about with Concord this year or a little earlier. Capable of setting fruit satisfactorily when standing alone.

Essex.— (*Roger's No.* 41.) *Lab.* X *vin.* A black grape of good quality, which ripens at about the same season as Concord. Bunch medium size, with large berries. Vine vigorous and productive when planted in a mixed vineyard. The blossoms are not capable of setting fruit of themselves, and therefore should be planted with other varieties that blossom at the same time.

Esther.— *Lab. From G. S. Josselyn, Fredonia, N. Y.*, 1892. A seedling of Concord. Vine a moderate grower, productive. Cluster medium or above, moderately compact; berry medium to large, nearly round; skin thin and tender, somewhat liable to crack, pale yellow covered with thin white bloom and sparsely dotted with brown dots; pulp moderately tough, juicy, sweet, somewhat vinous, very good flavor and quality. It drops from the cluster somewhat. The vine is capable of setting fruit satisfactorily when standing alone.

Rockwood.— *Lab. From George S. Josselyn, Fredonia, N. Y.*, 1892. A seedling of Concord, vigorous and self-fertile. Bunch medium or above, rather long, conic moderately compact, shouldered; berry medium size, round, purple-black with thin blue bloom; pulp nearly sweet, juicy, agreeable flavor, vinous, good to very good quality. Skin thin, moderately tender. Its season is about the same as that of Moore's Early.

Roger's No. 13. *Lab.* X *vin.* Vine unproductive here although it is self-fertile. Clusters rather small and loose or imperfect. Berries have foxy odor and flavor, are medium to large, very dark red, almost black, with blue bloom. Pulp meaty, rather tender, sweet, moderately juicy. Season about with Concord or later. Do not consider it of sufficient value to pay for cultivation.

Rogers No. 24. *Lab.* X *vin.* Vine very vigorous, productive and capable of setting fruit satisfactorily alone. Bunch handsome, large, sometimes well shouldered, moderately compact. Berries have a fine, light red color with lilac bloom. They are large and nearly round. Pulp rather tough, juicy, good quality, nearly sweet but apt to remain acid near the seeds. The pulp does not readily release the seeds. Concord season or later.

Victoria. *Lab. From. T. S. Hubbard Co., Fredonia, N. Y.*, 1892. A seedling of Concord originated by the late T. B. Miner, Linden, Union Co., N. J. Vine fairly vigorous; foliage moderately healthy; cluster medium to large, moderately compact; berry pale greenish yellow with white bloom; skin rather tender; pulp moderately tough, moderately juicy, vinous, good flavor and good quality. Capable of setting fruit satisfactorily alone. Ripened in 1895 a little earlier than Concord.

Wheaton. (*Bourq., Lab.*) A seedling of Delaware, originated by Daniel W. Babcock, Dansville, N. Y. It was received at the Station in the spring of 1892. Bunch small, compact, not shouldered; berries about the size of of Delaware, pale yellow with white bloom; pulp tender, releases the seeds readily, nearly sweet, juicy good flavor and quality. Season about the same as that of Moore's Early. Shows no superior merit as far as tested here. Its small size is against it for a white market grape.

Witt. *Lab.* A seedling of Concord, received at the Station in 1892. It produced its first fruit in 1895. Clusters medium size, moderately compact; berry medium size or above, pale yellow; pulp tender, juicy, vinous, nearly sweet, good flavor and quality. Vine not very vigorous; foliage moderately healthy. Has not as yet shown any points of superiority over well known varieties.

CURRANTS.

Several varieties of currants were planted for testing at this Station as early as 1882, the year that experiment work was inaugurated here. These varieties were all well known standard sorts and included five red, one white and five black kinds. Specimens of the wild currant of the western prairies, *Ribes aureum*, Pursh, sometimes called Missouri Large Fruited, and of the wild currant of our woods that bears dull black fruit and resinous dotted leaves, *Ribes floridum*, L'Her., were also planted. Additions have been made to this collection from time to time till the list of varieties now grown at the Station includes eighteen red, six white and ten black kinds, one kind with red and white striped fruit, three black fruited kinds of the species *Ribes aureum*, Pursh, one of the wild black *Ribes floridum*, Pursh, and one of the Oregon species *Ribes sanguineum*, Pursh ; besides these there are fifty-three Station seedlings, including twelve hybrids, nineteen pure Fay seedlings and twenty-two pure White Grape seedlings, making ninety-three kinds in all.

It is interesting to note that new varieties are constantly being added to the list of currants in cultivation. Previous to 1891 the Station list contained but two kinds that might be classed as new varieties, viz., Fay and Caywood's unnamed white seedling. Since 1891 fifteen additions have been made to the list besides the Station seedlings and all of these fifteen kinds are new, several of them not having been as yet named or introduced.

Currants are grown at this Station on a southern slope with soil consisting of a rather heavy clay loam and clay subsoil. It is well drained by lines of tile about two rods apart. The bushes are set four feet apart in the row and the rows are from six to seven feet apart. In the fall a forkful or two of stable manure is given to each bush, which in the spring is turned under quite shallow, or cultivated in as soon as the ground is fit to work. The ground is cultivated two or three inches deep near the plants and somewhat deeper midway between the rows at the first cultivation, after which shallow cultivation is continued till August, keeping the surface well stirred and free from weeds. In the fall the bushes are pruned by removing the five-year-old canes, the broken branches or those that droop to the ground, and all but one or two of the new shoots of one season's growth. The canes are not always removed after their fifth season's growth, but should they still appear very vigorous and well filled with buds they are permitted to remain longer. No unvarying rule can be followed in pruning, yet it is thought that usually a cane reaches its greatest productiveness during its fourth and fifth seasons. With this treatment the currants have made satisfactory growth and have yielded abundantly each season.

RED CURRANT.

Ribes rubrum, L.

The commonly cultivated red currant is a native of northern Europe and northern Asia. A form of this species is also found in the northern part of the United States and in Canada,* but, so far as I know, this wild American form has no representatives among cultivated varieties. In Europe the cultivation of the currant dates back to the middle ages,† and the cultivated red currants are varieties of European origin or seedlings of them which have been produced in this country.

DESCRIPTION OF VARIETIES.

NOTE.—Italics are used to designate synonyms and unnamed seedlings.

Cherry.— Bush vigorous, stocky and compact in nursery. The young plants are upright but with age they tend to become more spreading. It has a tendency to grow a single stalk and does not sucker as freely as do most other kinds. There is also a noticeable tendency to have imperfect buds at or near the end of shoots, especially on bearing plants. Sometimes two or three joints near the end of the shoot have no buds. This is one feature that distinguishes the Cherry from the Versaillaise. It bears its fruit quite close to the wood on short stemmed clusters so that it usually costs more to pick this than it does other varieties. The clusters are rather short, about two inches long.

The fruit frequently varies from small to large in the same cluster but averages large. It is not so uniform in size as Fay. The color is a fine, bright red, much like that of Red Dutch. Berry thin-skinned, juicy and fine flavored. On account of its attractive color and large size it sells well for dessert use and it is also liked at canneries. It is generally conceded to be one of the most productive of the large currants. Season early.

Eclipse.—*From H. S. Anderson, Union Springs, N. Y.*, 1892. Bush a vigorous, upright grower. Bunches medium length, two and a half to three inches long. (See Plate V, figure 2.) Fruit varies from small to large. It has comparatively mild acid pulp for a red currant. Color good, somewhat lighter than Fay. It is not yet in full bearing here so that we are not prepared to say how productive it is.

---

*Torrey and Gray, Fl. N. Amer. 1, 150. †De Candolle. Origin of Cultivated Plants, 277.

Fay.—Bush vigorous but not quite as strong a grower as Cherry Its canes are somewhat spreading and not always strong enough to remain upright when weighted with fruit. The clusters vary from two and a half to four inches long. The cluster stems are long, leaving enough room between the wood and the fruit to make it easy to gather. (See plate V, figure 4.) The berries vary from medium to very large, averaging large. They are quite uniform in size, of a good color, darker than Red Dutch. Pulp less acid than that of Cherry. It has not been so productive at this Station as have Cherry, Victoria, London Red or Prince Albert. Its average yield for the last three seasons has been four and seven-tenths pounds per bush.

This variety is said to be a seedling of Cherry or Victoria that originated in 1868 with Lincoln Fay, Portland, Chautauqua Co., N. Y. It was introduced about twelve years ago and is now quite generally known. Its clusters are long and attractive, filled with large fruit, making it desirable for market where there is a demand for currants for dessert use. It is liked at canning factories for making jelly or jam on account of its large size, thin skin and rich, juicy pulp, but it is more profitable to grow other more prolific sorts, such as Prince Albert, for this purpose.

Gloire de Sablons.—Bush upright, vigorous, but only moderately productive. Bunches short. Fruit small. Remarkable only for the color of the fruit which is white, striped or splashed with red.

London Red.—*Short Bunched Red.* Bush vigorous, upright and very productive. Clusters short with a very short stem. (See plate VI, figure 6.) Fruit medium to large, nearly the same color as Red Dutch and similar to it in quality. During the last three years it has ranked second in average yield per bush among the varieties in full bearing at this Station.

Mills No. 20. *From C. Mills, Fair Mount, N. Y.*, 1891. Bush vigorous, somewhat spreading. Bunches medium length, two to three inches long. (See plate V, figure 3.) Fruit medium to large, more uniform in size than Cherry. Color fine, lighter than Cherry and darker than Prince Albert. Pulp not quite so acid as that of Red Dutch. It ranked second in productiveness this year but it has not been tested here long enough to justify a general report as to its productiveness. Mr. Mills reports that it is a seedling of Versaillaise crossed by Red Dutch.

Mills No. 22. From Chas. Mills, Fair Mount, N. Y., 1893. Mr. Mills reports that this is a seedling of Versaillaise crossed by Red Dutch. The bush is moderately vigorous, somewhat spreading. Clusters two and a half to three inches long. (See plate VII, figure 9.) Fruit has a good color, lighter red than Fay. Berries are usually large, but vary from small to very large. Pulp less acid than that of Red Dutch. The variety has not been fruited here long enough to justify a report as to its productiveness, but it appears to be very productive.

Mills No. 28. From Chas. Mills, Fair Mount, N. Y., 1893. Mr. Mills reports that this is a seedling of Versallaise crossed by Red Dutch. The bush is moderately vigorous, somewhat spreading. Clusters good size, three to three and a half inches long. Fruit medium size, dark red color, mild flavored. It has not been fruited here long enough to justify a report as to its productiveness.

Mills No. 29. From Chas. Mills, Fair Mount, N. Y., 1893. Mr. Mills reports that this is a seedling of Versallaise crossed by Red Dutch. Bush a vigorous upright grower. Clusters short. Fruit averages large but varies from small to large. Somewhat darker than Mills 22 but brighter and better in color than that variety. Good flavor, excellent quality. Has not fruited here long enough to justify a report as to its productiveness.

North Star.—*From Jewell Nursery Co., Lake City, Minn. and E. Moody & Sons, Lockport, N. Y.*, 1892. Bush vigorous, upright or somewhat spreading. Bunches medium length, (see plate VI, figure 7), color good, much like that of London Red or Red Dutch. Fruit will probably average large with good cultivation but varies from small to large. Pulp comparatively mild acid. It has not been tested here long enough to justify a report as to its productiveness.

Prince Albert.— Bush vigorous, even more upright than Red Dutch. Of all the varieties that are in full bearing here, this has given the largest average yield per bush during the last three years, though one year it took second rank, being exceeded in yield by London Red. Prince Albert has long been valued as a late variety. It is well liked at canneries because of its good size, thin skin and large percentage of highly flavored juice. Bunches short to medium in length. (See Plate VII, figure 12.) Fruit medium to large, rather pale red, making it less attractive in color than Fay. The young plants make a rather slow, short growth but with age the bush becomes strong and upright. On account of the slow growth of the young plants some prefer to propagate them by mound layering.

Red Cross, *Moore No. 23.—From Jacob Moore, Attica, N. Y.*, 1893. Mr. Moore states that this is a cross of Cherry by White Grape. Bush vigorous, upright. Bunch medium length. (See Plate VI, figure 8.) Fruit medium to very large, averaging large. Color good, somewhat lighter than Cherry. More acid than White Grape but milder than Cherry. Season somewhat later than Cherry. Has not been fruited here long enough to justify a report as to its productiveness. Green's Nursery Co., Rochester, N. Y., now controls this variety.

Red Dutch.— This is one of the old well-known standard sorts. Bush a strong grower, rather tall, upright, with comparatively slender shoots. Clusters about three inches long. Fruit has a fine, dark red color and sprightly acid flavor. Berries vary from small to large but average medium. Productive.

Ruby Castle. From F. Ford & Son, Ravenna, O., 1892. This variety was obtained from Canada several years ago by Messrs. Ford & Son, under the name, Ruby Castle, which it now appears is a corruption of Raby Castle, which is one of the synonyms of Victoria. Ruby Castle is a strong, upright grower, like Victoria, with clusters two and a half to three inches long; similar to Victoria in size and color. (See Plate VII, figure 10.) The buds are shaped like Victoria and have the same chracteristic bluish gray color. I should call the two identical.

Storrs & Harrison Co. No. 1.—From Storrs & Harrison Co., Painesville, O., Nov., 1892. Bush moderately vigorous, upright. Bunches medium size, two to three inches long. Berries small to medium or above, averaging below medium. Much like Red Dutch in color but with less acid pulp than that variety. The variety has not been tested here long enough to justify a report as to its productiveness.

Versaillaise.—A vigorous, somewhat spreading grower. It is so similar to Cherry in wood, habit of growth and character of fruit that many hold that the two varieties are identical. As grown here, the Versaillaise is less productive than Cherry and is inclined to have a longer bunch (see Plate V, figure 1), and rather darker red fruit. The tendency of the shoots to "go blind," that that is, to lack either the terminal buds or buds near the terminal is not so marked with it as with Cherry.

Victoria.—This is one of the most valuable of medium sized currants. The bush is one of the strongest growers we have, upright and very productive. The buds have a peculiar bluish-gray color, quite characteristic of this variety, as is also the cluster of well formed buds at the end of the shoot. Foliage rather pale green. The fruit has a bright red color, and is medium or above in size. Clusters good medium length (see Plate VI, figure 5), pulp rather mild acid. The fruit is late in coloring and will keep on the bushes in good condition later than either Cherry or Red Dutch.

Wilder.—*From F. Ford & Sons, Ravenna, O.*, 1892. Bush vigorous, upright. Fruit medium to very large, averaging large. Not so uniform in size as Fay. (See Plate VII, figure 2.) Fine color, somewhat lighter than Fay, and remains bright and attractive till very late in the season. Flavor mild for a red currant. Quality good. It has not been fruited here long enough to justify a report as to its productiveness.

This is a seedling of the Versaillaise. It originated about eighteen years ago with E. Y. Teas, Irvington, Ind., by whom it was named and disseminated to a limited extent as the Wilder, Mr. Teas' stock was then purchased by Mr. S. D. Willard, Geneva. N. Y., and the variety was then catalogued as President Wilder.

DISCUSSION OF VARIETIES.

The yields of the red currants at this Station that are in full bearing may be compared by consulting the following table, which shows the average yield per plant in pounds for the last three seasons combined:

Name.	Average yield per plant.
Cherry	5.15
Fay	4.70
Gloire des Sablons	2.07
London Red	7.14
Prince Albert	8.86
Victoria	6.25

It appears from this table that, for this locality at least, the Cherry is superior to Fay in productiveness and it still holds its place as one of the most desirable of the large fruited red currants for the commercial grower. Fay yields the longer bunches, more uniformly large fruit, and its fruit is more easily picked than Cherry, but it does not make as satisfactory a bush nor give as satisfactory a yield. Both these varieties need to be marketed comparatively early. They will not remain on the bushes in good condition for shipping as late as will Victoria, Prince Albert or Wilder. As to the comparative value of different varieties for jam and jelly, Curtice Brothers Co., Rochester, N. Y., who operate a very extensive establishment for preserving and canning fruits, write us that Cherry currant is preferred for jam because it is thin skinned and juicy; but not so for jelly making, for the reason that it is necessary to evaporate away more of its juice to produce jelly than it is with some other varieties. The currant that is preferable, they say, is the largest one that has a thin skin and is filled with rich juice or pulp, and they believe this is true of Fay and Prince Albert above other varieties.

London Red, also called Short Bunched Red, is objectionable, on account of its short clusters and fruit close to the wood, but has the merit of being one of the most productive of the red kinds that have been tested here. It ripens about with Red Dutch. The Red Dutch was not included in the above list because the bushes under test were unsatisfactory. It is one of the best of the mid-season, medium-sized red currants.

Prince Albert and Victoria are both valued as productive late currants. The former when well grown will pass for a large currant. The fruit is paler and less attractive than Cherry. Victoria is a good late currant, but it ranks only medium in size.

Several of the apparently desirable newer varieties under test here have not been fruited sufficiently long to justify a report as to their yield.

WHITE CURRANT.

Ribes rubrum, L.

The commonly cultivated white currants belong to the same species as do the red varieties. They are grown chiefly for home use as the market demand for them is quite limited. The following is a list of the white currants in full bearing at this Station during the last three years, together with a statement of the average number of pounds per bush yielded during that time. There were five bushes each of Champion, White Grape and White Dutch and but one bush of Caywood Seedling:

Name.	Average yield per plant in pounds.
Caywood Seedling	4.65
Champion	5.00
White Dutch	6.19
White Grape	5.77

In 1893 the bushes of White Grape were not in as good condition as could be desired. The average yield per bush for these varieties in 1894 and 1895 combined is:

Name.	Yield per plant in pounds.
Caywood Seedling	4.88
Champion	3.09
White Dutch	5.59
White Grape	6.86

DESCRIPTION OF VARIETIES.

Caywood Seedling.—From A. J. Caywood & Son, Marlboro, N. Y., 1888. Bush a moderate grower with spreading or drooping branches; very productive. Fruit more acid than White Grape, good quality and attractive in appearance, being translucent, tinged with very pale greenish yellow. Bunches medium size, about two and a half inches long. Berries medium to large, averaging large. (See Plate VIII, figure 14.)

Champion.— Bush very tall, vigorous, upright. Bunches medium length. Berries a shade lighter in color than White Dutch, not uniform in size, varying from small to large and averaging medium or below. Flavor mild. Inferior to White Dutch in productiveness, appearance, flavor and quality.

Marvin Seedling.—From D. S. Marvin, Watertown, N. Y., 1892. Bush a moderately vigorous, upright grower. Bunches above medium length, running from two and a half to three inches long. It is one of the largest white currants, the berries averaging larger than White Grape. Pulp mild, but more acid than White Grape. Color much like that of White Grape. It has not fruited long enough here to justify a report as to its productiveness. This variety is now controlled by J. C. Vaughan, Chicago, Ill.

White Dutch.—This is an old, well-known standard variety. Bush a vigorous, upright grower and very productive. Bunches usually from two to three inches long. (See Plate VIII, figure 15.) Fruit not uniform, varying from small to large, but averaging

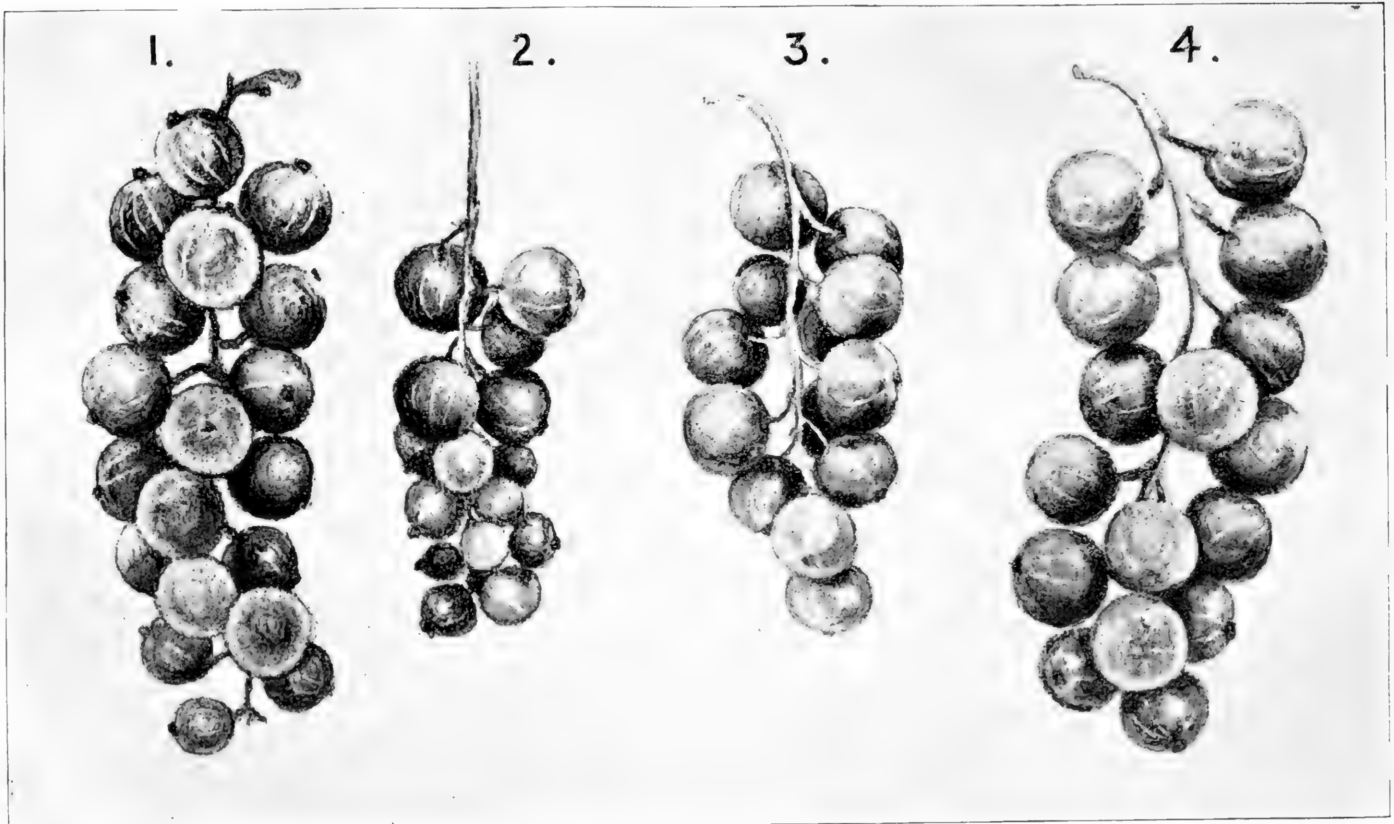


PLATE V.—Versaillaise. 2. Eclipse. 3 *Mills No. 20.* 4. Fay.

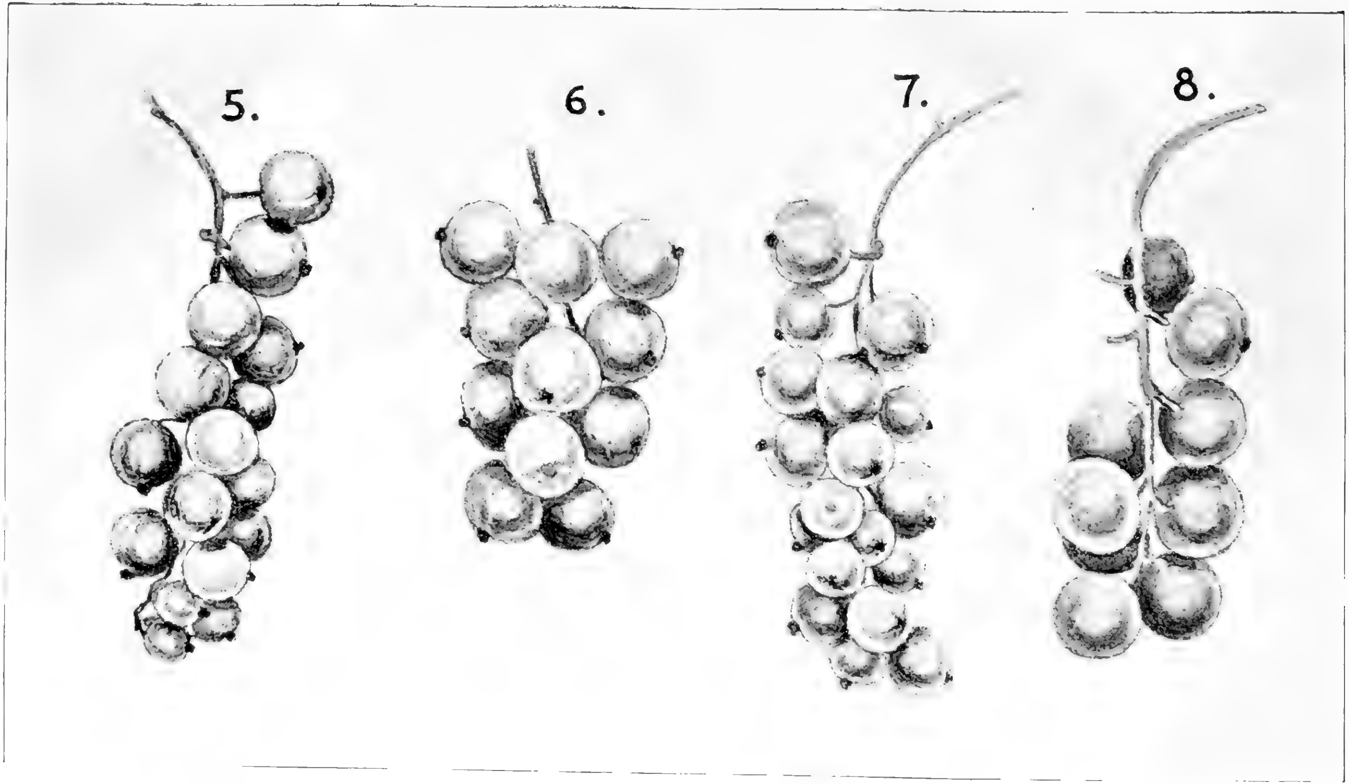


PLATE VI.—5. Victoria. 6. London Red. 7. North Star. 8. Red Cross.

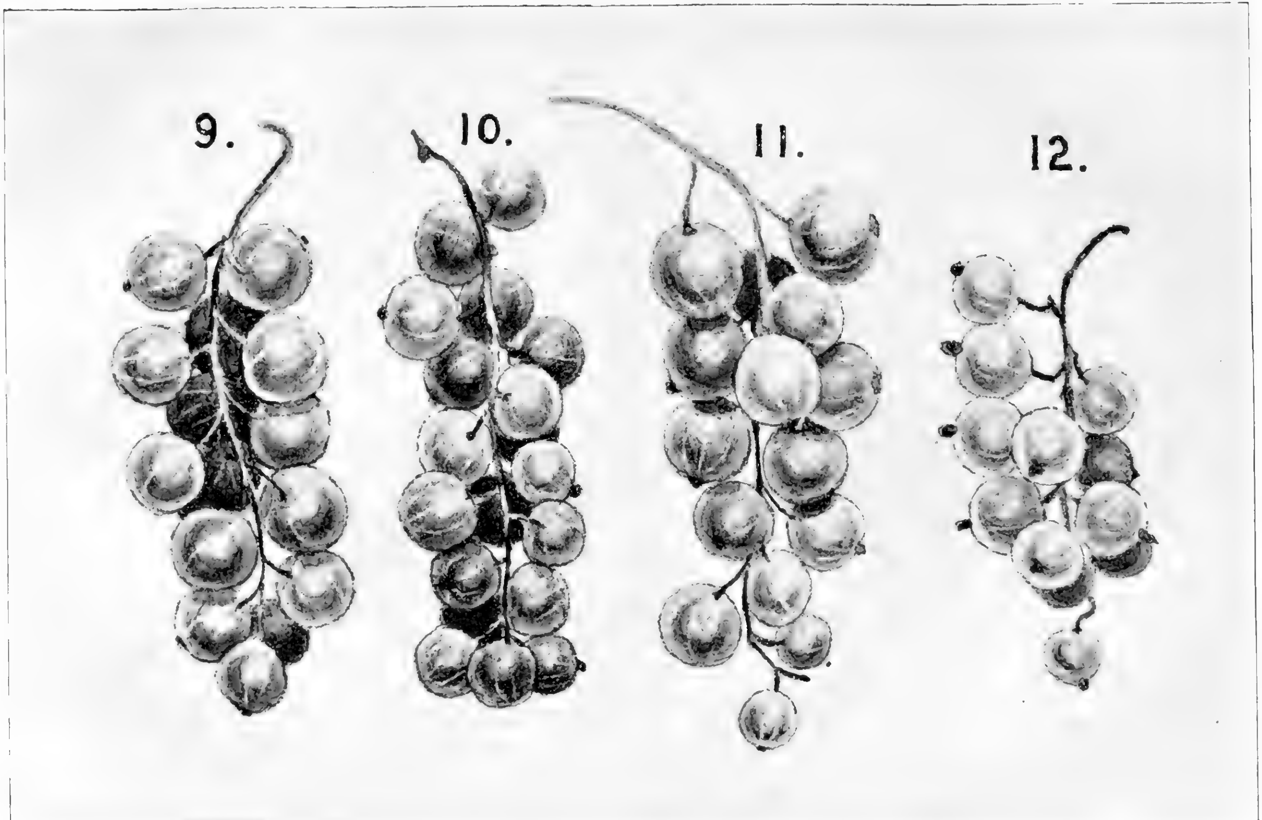


PLATE VII.— 9. *Mills No. 22.* 10. Raby Castle. 11. Wilder. 12. Prince Albert.

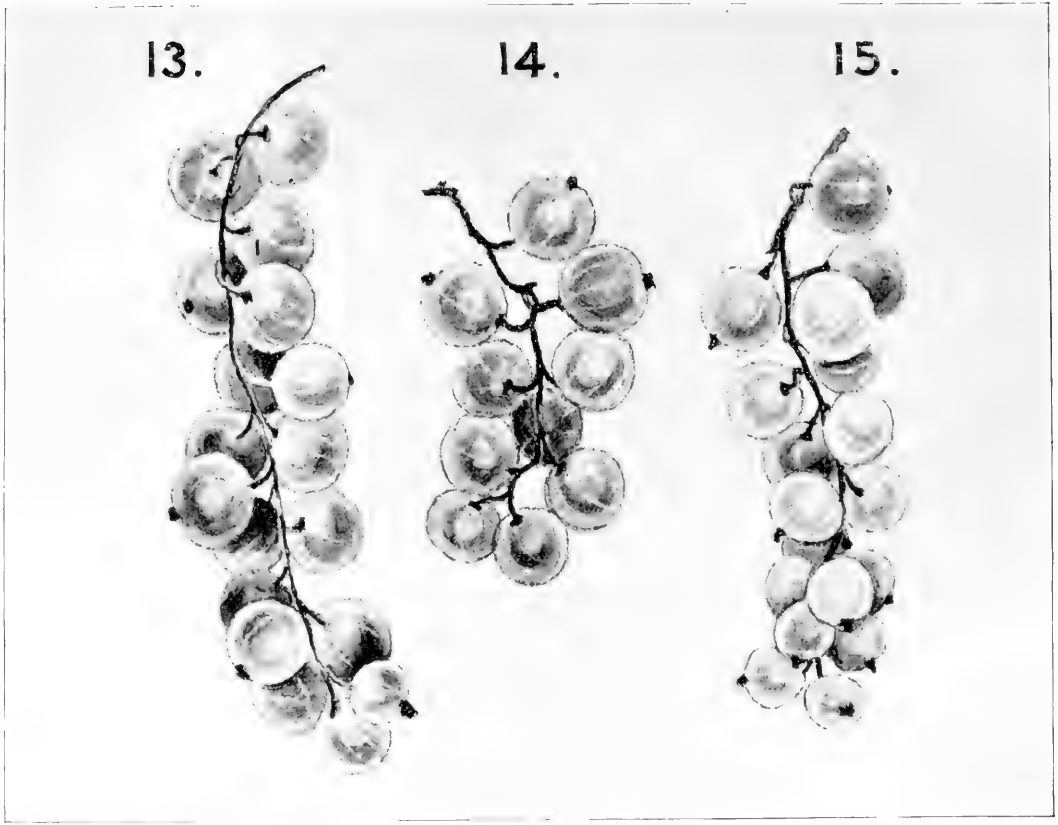


PLATE VIII.—13. White Grape. 14. *Caywood's Seedling.* 15. White Dutch

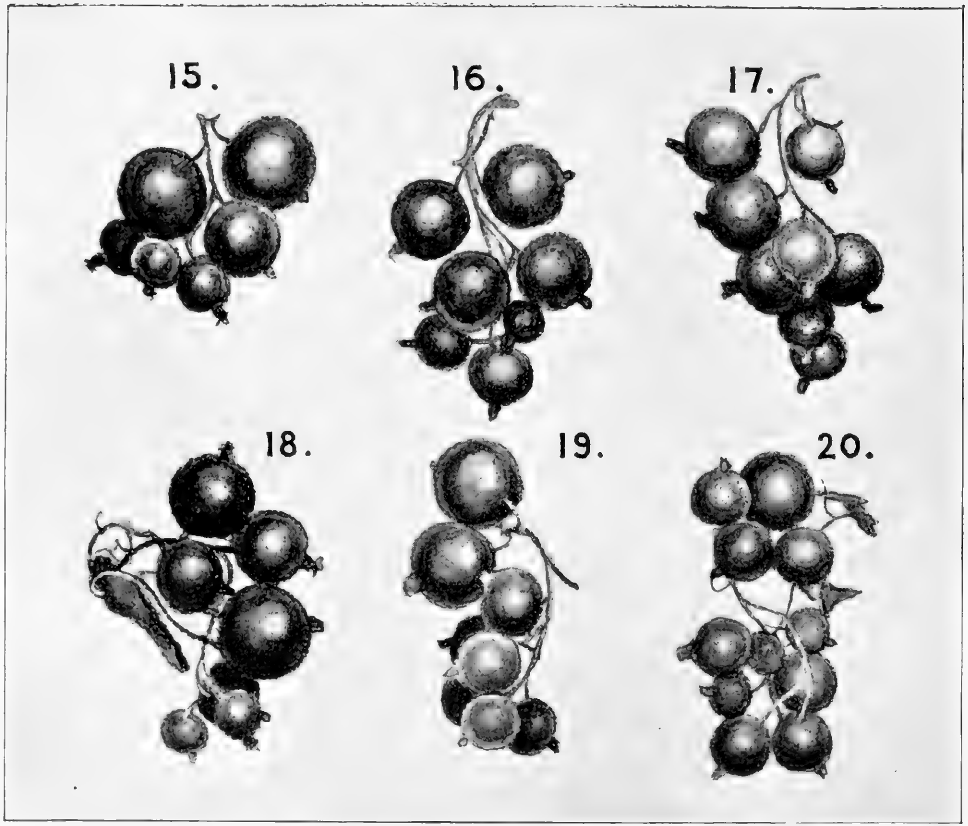
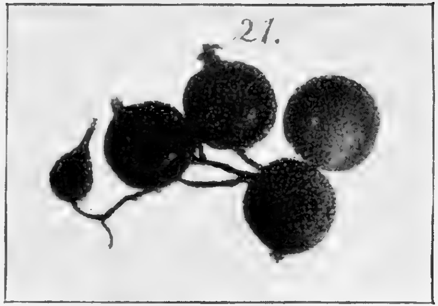
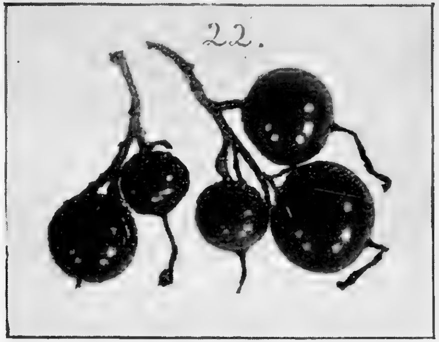
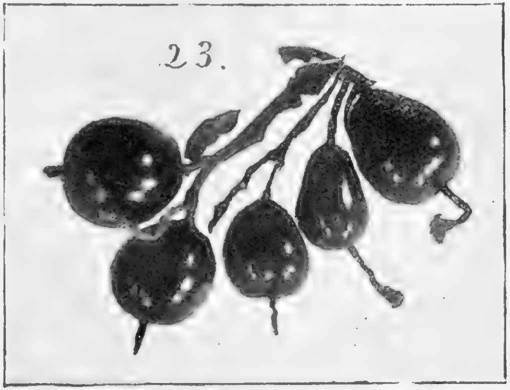


Plate IX.—15. Baldwin. 16. Naples. 17. Lee. 18. Black Grape. 19. Champion. 20. Common Black.







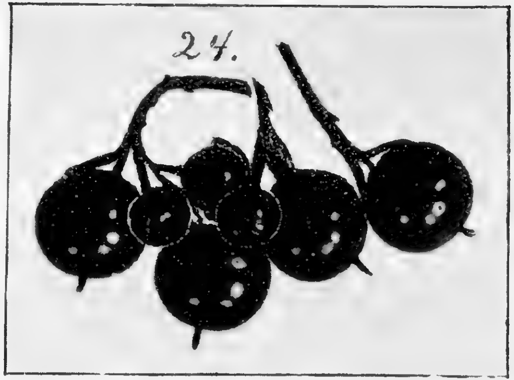


PLATE B.—21. Prince of Wales. 22. Crandall (from Ford). 23. Crandall (from Pierson). 24. Jelly

medium size, translucent, slightly darker in color than White Grape. Pulp comparatively mild acid. Quality excellent. It begins to ripen a few days earlier than most of the red varieties.

White Grape. — Bush moderately vigorous, rather slender branches, somewhat spreading, productive. Bunches three to four inches long. (See Plate VIII, figure 13.) Berries quite uniformly large, but vary from medium to very large. Translucent, whitish, attractive in color, mild flavored, good quality. It has larger and better colored fruit than White Dutch, but is inferior to that variety in quality.

White Versaillaise.— Received in November, 1893, from John Charlton, Rochester, N. Y., with the statement that it was received from France a few years ago. He characterized it as a stout, vigorous grower, more so than White Grape and other white kinds; bunches long, resembling Versaillaise in shape, character of bunch, etc.

So far as tested here it is, as Mr. Charlton says, vigorous in growth and upright. The base of the cluster-stem has no fruit so that it is easily picked. Bunches three and a half to four inches long. The berries average large, a shade darker than White Grape in color. Pulp not quite so juicy, but about the same in acidity as White Grape. It has not been fruited here long enough to justify a report as to its productiveness.

EUROPEAN BLACK CURRANT.

Ribes nigrum, L.

The black currant commonly cultivated in gardens for its fruit is indigenous to northern Europe and northern Asia. De Candolle * thinks its cultivation began before the Middle Ages. In botanical characters it is somewhat similar to the wild black currant of our woods, *Ribes floridum*, L'Her., but readily distinguished from it by the strong odor of its branches, leaves and fruit, and by the greener flowers, smaller flower clusters and very small bracts. So far as I know the wild black currant just referred to is not cultivated for its fruit. It is quite distinct from the wild black currant of the prairies, the so-called Missouri or Buffalo currant, which will be referred to later.

DESCRIPTION OF VARIETIES.

A description of the varieties of the garden black currant that are growing at this Station is herewith given.

* Origin of Cultivated Plants, 278.

Baldwin.— Bush moderately vigorous and productive. Fruit varies from small to large, averaging medium size. (See Plate IX, figure 15.) Flavor milder than that of Common Black. It is several days later than Common Black in ripening.

Black Grape.— *Ogden's Black Grape.* A vigorous grower, but one of the most unproductive kinds we have tested. Fruit varies from small to very large in size, with strong flavored acid pulp. (See Plate IX, figure 18.)

Champion.— Bush vigorous, productive. Fruit varies from small to large, and averages above medium. (See Plate IX, figure 19.) Pulp nearly sweet and milder flavored than that of Common Black. A desirable variety.

Common Black.—*Black English.* Bush very vigorous and productive. Fruit varies from small to large, but averages medium. (See Plate IX, figure 20.) Pulp rather acid and strong flavored.

English, see **Common Black.**

Lee.—*Lee's Prolific.* Bush dwarfish, moderately vigorous, productive. Fruit rather brighter in color than most kinds of black currants, varying from small to largest in size. (See Plate IX, figure 17.) Pulp acid and strong flavored.

Naples.— Bush very vigorous, moderately productive. Fruit varies from small to large, and averages above medium size. (See Plate IX, figure 16.) Pulp rather acid with strong flavor.

Prince of Wales.— Bush vigorous and very productive. This variety has given the highest average yield per bush for the last three years of all the black currants in full bearing at this Station. The fruit varies from small to large, is milder flavored than Common Black, and nearly sweet when fully ripe. Figure 21 shows a good cluster of Prince of Wales, life size.

Saunders.—This was received here from Smith & Kernan, St. Catharines, Ontario, 1888, under the name of Saunders No. 1. Mr. Smith writes that it was named as a compliment to Prof. William Saunders, its originator, now director of the Central Experiment Farm at Ottawa, and has been sent out by the Ontario Fruit Grower's Association under the name of Saunders. He also says that it is pretty well disseminated in Canada and he thinks that it ranks as high as any of the black currants for a market variety.

As grown here the bush is vigorous and productive. The fruit varies from small to large, averaging medium or above. Pulp rather mild acid. In 1893 when the bushes had been set five years, it ranked fifth in yield as compared with varieties that were set at the same time; in 1894, it ranked third and in 1895, second.

Saunders No. 2.—From Smith & Kernan, St. Catharines, Ontario, 1888. This, like the Saunders, was originated by Prof. William Saunders. Since 1893 it has ranked seventh in yield each year and it does not appear to have sufficient merit to make it worth cultivating. Bush vigorous. Fruit varies from small to large, averaging medium. It is milder in flavor than Common Black and nearly sweet.

From the following table a comparison may be made of the fruitfulness of these varieties as grown here. It contains a statement of their average yield in pounds per bush during the last three years.

Name.	Average yield per plant in pounds.
Baldwin	3.87
Black Grape	*
Champion	*
Common Black	4.58
Lee	4.30
Naples	3.37
Prince of Wales	5.45
Saunders	4.13
Saunders No. 2	3.04

It will be noticed that as a rule the average yield of black currants per bush is less than the average yield per bush of standard varieties of red or white currants. The highest average yield per bush for the last three years is 8.86 pounds for the reds, 6.19 pounds for the whites, and but 5.45 pounds for the blacks. The general average for the reds and whites combined, omitting Gloire des Sablons, which is cultivated only because of the color of its fruit, is 5.97 pounds per bush; see tables page 286 and page 288. For the black varieties grown in the same field and given similar treatment the general average for the same period is but 4.11 pounds per bush, or 1.86 pounds per bush less than the general average of reds and whites. This may be taken as a fair indication of the general difference in productiveness of the two classes of fruit, but it should be remembered that varieties in the two classes vary greatly as to productiveness, as has already been shown. With plants set four

* The record of the yield in 1894 is incomplete for Black Grape and Champion. The average yield per plant for 1893 and 1895 combined is 2.15 pounds for Black Grape and for Champion is 4.23 pounds.

by six feet apart there are 1815 plants to the acre, and a difference of 1.86 pounds per bush amounts to 3,395.9 pounds per acre. It appears from the above calculation that one would need to secure from one and a half to two cents more per pound for black than for the best varieties of red currants in order to secure equally good returns per acre. There is a limited demand for black currants in some markets and they are grown to some extent on a commercial scale.

NATIVE BLACK CURRANTS.

Ribes aureum, Pursh.

The wild black currant of our woods has already been referred to in comparing it with the European black currant. So far as I know this species is not cultivated for its fruit. It bears dull black fruit, which is rather insipid. It begins to ripen usually the last week in July, being somewhat later in season than the ordinary garden currants.

There is a black currant native to the western prairies that has been introduced to garden culture to some extent. It is known as the Missouri currant, Buffalo currant, Golden currant, etc. It is sometimes planted in dooryards as a flowering shrub. It bears an abundance of yellow flowers, of spicy fragrance, and yellow or black fruits either singly or in leafy-bracted racemes. It is known to botanists as *Ribes aureum*, Pursh.

One of the most widely advertised varieties of this species is the Crandall currant which originated in Kansas and was introduced seven or eight years ago. Other varieties of this species which we have received for testing are Utah, Golden, Jelly and Yellow Utah.

DESCRIPTION OF VARIETIES.

Crandall.—*From F. Ford & Son, Ravenna, Ohio*, 1889. Bush very vigorous, tall and upright. It is very unproductive as compared with cultivated currants of ordinary varieties. Its average yield per bush for the last three years has been less than a pound. The fruit has a thick tough skin that makes it objectionable for most culinary uses. The fruit varies from small to very large in size borne either singly or in small clusters with leafy bracts. Figure 22 is from a life size photograph of good clusters of this variety.

We have also received the Crandall from M. F. Pierson, Seneca Castle, N. Y., which differs somewhat from the Crandall sent here by the introducers of this fruit, Messrs. Ford & Son. The fruit of the plants received from Mr. Pierson is frequently one-half to three-fourths of an inch long, broad towards the apex and tapering towards the stem, making it somewhat pear shaped, while the plants from Messrs. Ford & Son have fruit more nearly round. Both varieties have a strong tendency to sucker. Figure 23 is from a life sized photograph of good clusters from plants received from Mr. Pierson.

Jelly.—*From R. H. Blair & Co., Kansas City, Mo.*, 1893. Replying to an inqury as to the origin of this currant Messrs. Blair & Co. wrote March 25, 1893, as follows:

"The Jelly currants were selected in western Kansas from acres of them growing on the prairies; but this variety being so much superior was selected. We have fruited them and they are yielding such heavy crops and fine quality for jelly, we think they will be an acquisition to the currant list, specially in the west."

As grown here the bush is tall, upright, with a tendency to form more fruit spurs and fewer suckers than the Crandall. Fruit usually borne in small clusters with leafy bracts. Berries medium to very large, some being three-fourths of an inch or more in diameter. Skin thick, tough, with a bluish black metallic lustre like that of Crandall. Pulp dark greenish yellow, seedy and with a peculiar flavor less agreeable than the flavor of white or red currants but more agreeable than that of the ordinary European black currants.

Figure 24 is from a life-size photograph of good clusters of this variety. The fruit is more uniformly large than that of Crandall and the plants appear to be as productive as Crandall though not so productive as ordinary red or black currants. So far as we can judge from a limited experience with it, it is preferable to Crandall.

While the varieties of the Missouri currant such as Crandall and Jelly, may have value in localities where the commonly cultivated currants do not thrive, as suggested in the letter of Messrs. Blair & Co., yet we do not consider them worthy of cultivation where ordinary currants can be grown.

It is possible that in the course of time the improvement of cultivated varieties of the Missouri currant may result in the production of late ripening fruit that will meet with sale in market because it does not come into competition with the kinds now commonly found in market. Considerable improvement will need to be made over existing varieties before currants of this class are grown extensively for market.

PROPAGATION.

Varieties of currants do not reproduce themselves true from seed and so when it is desired to increase the number of plants of a variety it must be done by division of the plant in some way. Sometimes this is done in a small way by separating rooted canes from an old plant. In the nurseries, however, currants are propagated either by layers or by cuttings, the latter method being more commonly practiced.

PROPAGATION BY CUTTINGS.

Currants grow very readily from cuttings of young canes of a season's growth. The cuttings may be made as soon as the wood is ripe and hard, which in this section is usually after the first of October, and set at once in nursery rows. Currant bushes that are sprayed and well cared for may hold their foliage till November, and so need to be stripped of leaves when the cuttings are made. It is thought that cuttings from ripe, hard currant wood, root more readily and give a larger percentage of plants than do cuttings from immature wood. Sometimes it happens that the currants lose their leaves by leaf blight very early in autumn. In such instances the growth practically ceases and cuttings may be made at any time thereafter when it is convenient.

Many nurserymen make the cuttings early in the fall even when it is necessary to strip the leaves from the canes. They do this not because they think the immature wood is better than well ripened wood for cuttings, but because it is convenient to do the work then, so as to have it out of the way before the rush of work that comes with the fall delivery season. Then, too, when the cuttings are made and planted early in the fall and the weather proves favorable, they begin to root before winter sets in and so are ready to start at once into growth when spring opens. This insures a long season for growth and favors the production of stronger one-year plants than can be grown from cuttings set in the spring.

Spring Setting.—If the cuttings are not to be set out till spring they are tied in bunches, properly labeled and buried in a pit in well drained soil and covered about six inches deep with earth. The bunches are set in the pit with the butts upwards so as to keep the top buds dormant till the cuttings are planted. They may be set as soon as the ground is fit to work in the spring, but it frequently happens that it is convenient to delay setting for some time after spring opens. In this case the pit should be covered with coarse manure or mulch of some kind while the ground is still frozen so that the soil covering the pit may be kept frozen and the cuttings kept dormant till the time when they are to be set.

The cuttings usually are about eight inches long and are made from the new wood; that is to say, from the new growth of the past season. If they are to be buried in pits to keep them for setting in spring the bundles should be tied with wire or willows, for twine is liable to rot and break.

Soil and Cultivation.—The soil for growing the cuttings should be well drained and fertile, plowed from ten to twelve inches deep and thoroughly pulverized. A trench about eight inches deep is made with the spade, against the perpendicular side of which the cuttings are placed one and a half to two inches apart, and with the top buds just above the surface of the ground. A little earth is filled in and tramped very firmly around the base of the cuttings. This is one of the most important points in growing currant cuttings, that the soil be made firm around the base of the cuttings, and it can not be done satisfactorily if the trench is filled before the earth is tramped. After this has been done the trench should be filled and the earth tramped again. If the cuttings are set in the fall they should be completely covered when the ground begins to freeze, using either earth, coarse manure or some other mulch to prevent heaving by the frost. The objection to covering with earth is that the cuttings are more liable to be injured by the tools when they are uncovered in the spring than they are if covered with manure or straw. Should the cuttings be heaved or loosened by frost the ground should be tramped around them again after the frost has left the ground in the spring.

During the growing season the ground should be kept well cultivated and free from weeds. When the branches begin to appear these should be pruned away to a height of three or four inches from the ground. The plants are commonly grown two seasons in the nursery row before being set in the permanent location for fruiting. Strong one-year plants are very desirable for setting and scrub stock three or four years old is not desirable even though it be of larger size than the one-year plants.

PROPAGATION BY LAYERS.

When currants are grown from layers the old plants, called stools, are headed back so that they may send out numerous branches close to the ground. When the wood of the new growth has become somewhat hardened, in this section in June, the soil is thrown over the base of the new shoots a few inches deep so as to induce the formation of roots. In the fall the earth is drawn away from the stools, and the rooted shoots are cut off, leaving good eyes or buds on the stools from which to grow another crop of shoots the following season. The rooted shoots may either be planted in nursery row at once or kept till spring before planting. The cultivation and pruning is the same as that already described for cuttings.

PROPAGATION FROM SEED.

Currants may be propagated from seed but each plant thus secured is a new variety and the chances are that it will be inferior to the standard sorts already in cultivation. Some persons, however, take an interest in raising currants from seed with the hope of securing something worth introducing as a new variety. In some cases where this work has been done in an intelligent and systematic way, encouraging results are being secured as is shown by the promising seedlings that have been sent to this Station for testing in recent years. Brief accounts of some of these new kinds, together with illustrations of the fruit have been given on preceding pages.

The following method of growing currants from seed has been employed at this Station: As soon as the fruit is ripe the seed is separated from the pulp and planted in shallow, well drained boxes. The boxes are set in open frames and allowed to remain unprotected till the following spring. The seeds begin to germinate rather early in the spring. The boxes are then weeded and watered if necessary to keep the seedlings in good growing condition. When the seedlings are three or four inches high they are transplanted to an open frame or bed where they can be easily cared for during the rest of the season. The following season they are set in permanent position in field or garden. If they are being grown in large numbers it would be better to transplant them from the boxes to beds and the following year grow them in nursery rows thus having the plants two years old before setting them in permanent position for fruiting.

At the end of the first season the plants usually are from two to eight inches high and unbranched. At the end of the second season vigorous ones are frequently found eighteen inches or more in height and with strong branches. During the third season's growth fruit spurs may begin to develop.

In preparing the boxes for the seed a layer of coarse gravel or potsherds is placed in the bottom of the box. The box is then filled with soil consisting of one part rotted manure and two parts of good loam. If the loam is heavy it may be lightened by mixing with an equal measure of sand. In preparing the soil for growing the seedlings the second year it is given a liberal dressing of well-rotted manure and then spaded and worked till it is mellow.

Field and Garden Culture.

When grown for home use currants are too frequently neglected as to cultivation. Often they are allowed to stand in sod along fence rows, or under large trees where the ground is so crowded with the roots of other plants that the currants are necessarily too much occupied in a struggle for existence to give either abundant yields or large fine flavored fruit. When currants are grown for home use they should be given thorough cultivation the same as when grown for market. To this end it is always best to select a location where a horse cultivator can be used.

In the fruit growing sections of New York currants are grown to some extent in field plantations by themselves but more frequently they are grown as a secondary crop in well cultivated orchards, especially in orchards of young trees or trees that do not completely shade the ground. Currants are also grown to some extent in vineyards, being set between the trellises. Where the Kniffen system of training grapes is followed currants are sometimes set between the vines under the trellis, the currants alternating with the vines, that is to say, a currant bush between two vines. In this position, however, the fruit is more liable to be spotted by the spraying mixture when the vineyard is sprayed than is the fruit on bushes set midway between the rows.

Distance apart.—When set between vineyard rows the currants should stand five feet apart, although some advocate placing them as close as three and a half feet. Strong growing varieties need more room than the stocky moderately vigorous kinds. In orchards the currants should not be set nearer the trees than six feet. In the open field our practice has been to set them about four feet apart in the row with rows six feet apart. If they are to be cultivated both ways they should stand at least 5′x5′. There seems to be a difference of opinion as to the advisability of cultivating both ways, many good cultivators holding to the opinion that it disturbs the roots too much. Others believe that it lessons the cost of cultivation more than enough to counterbalance any injurious effects on the plants. So far as I know no exact comparison of the two methods has been made. No doubt the mistake is frequently made of allowing the cultivator to run too deep close to the plant. In such cases when the cultivator is run both ways the roots would probably be disturbed enough to work more harm than good especially with shallow rooted kinds.

Planting.—Before setting the plants the broken or bruised roots should be removed with a clean cut, since the clean cut surface will heal more readily than will the bruised or broken tissues. The roots have been much shortened in digging and preparing for planting and the tops also should be shortened by removing enough branches to correspond with the amount of roots that have been removed. New branches will push out later in the season as fast as the new roots are able to support them.

The plants should be set about as deep as they stood in the nursery or a little deeper, since the earth that is filled around them will settle somewhat after they are planted. After the hole is prepared for the plant the roots should be spread out, and covered a little with earth which should be tramped firmly around them. The hole is then filled and the earth again tramped firmly. A thin layer of fresh, loose earth is added to retain the moisture and prevent the rapid evaporation that takes place when the surface of the earth is hard and compact.

Fertilization.— For currants the soil must be kept fertile in order to secure good growth of plants and consequent good crops of fruit. It is our practice to put a forkful or two of stable manure around each bush in the fall. On our clay loam this not only furnishes plant food but has a beneficial mechanical effect in loosening the soil. With this treatment abundant crops of fine fruit are secured every year.

Mr. James R. Clarke, Milton-on-Hudson, N. Y., a successful grower of currants, in replying to an inquiry as to his method of fertilizing currants writes as follows:

"I do not use stable manure on my fruit, as I consider fertilizer much better. The first three years after setting I use nothing but fine ground bone with a small amount of muriate of potash; on older bushes I add nitrogen in some available form. I think that one thousand pounds of fertilizer to an acre can be used to advantage on full bearing bushes, namely:

600 pounds of bone.
250 pounds muriate of potash.
150 pounds nitrate of soda or that amount of ammonia in some other form."

An application of a thousand pounds per acre of this mixture would give from 120 to 150 pounds of phosphoric acid, from 40 to 50 pounds of nitrogen and from 120 to 130 pounds of potash per acre. It is not to be supposed that the exact formula for commercial fertilizers that Mr. Clarke has found best adapted for his soil will also be the best formula for other kinds of soil in which currants are successfully grown, but it contains helpful suggestions for those who wish to use commercial fertilizers for currants. For a general discussion of the use of commercial fertilizers the reader is referred to Bulletin 94 of this Station.

Cultivation.—As soon as the ground is fit to plow in spring it is our practice to work the manure, which was placed around the bushes the fall previous, into the soil by shallow cultivation near the bushes and somewhat deeper, perhaps three or four inches deep, midway between the rows. We believe that it is not well to disturb the roots by deep cultivation, especially near the bushes.

After this first cultivation the ground is given frequent shallow cultivation till about the middle of August when cultivation ceases so that the growth may be checked and the wood well ripened before freezing weather comes.

Pruning.— In large plantations it has been found most satisfactory to permit currants to grow in bush form rather than in the tree form, as the old canes may then be removed when they become unproductive as they do after a few years, and their places may be taken by new canes that have been permitted to grow for this purpose. Then, too, if the trunk of a currant in tree form is broken off or injured in any way a new plant must be set in its place, but when several canes are permitted to grow as is the case when the plants are grown in bush form, the accidental breaking of a trunk does not cause the death of the whole plant, but its place is readily filled by permitting other canes to grow from the root.

The tree form is well adapted to well-cultivated gardens as the plants may be pruned into more symmetrical, attractive shape as trees than as bushes. To grow currants in tree form it is simply necessary to remove all buds from the part of the cutting or layer that is put in the ground. This prevents the growth of shoots from below the surface of the soil and consequently no suckers are formed. The tree currants may be kept in symmetrical shape by annually cutting back the shoots of new wood leaving but two or three buds to the shoot. This may be done at any convenient time while the leaves are off.

No definite rule can be given for pruning currants grown in bush form, for the kind and amount of pruning necessary is in each case determined by the condition and individual habits of growth of the bush to be pruned. In general it may be said that during the first two or three years the bushes require but little pruning except to head back the new shoots so that the fruit spurs will develope all along the cane. Otherwise the fruit bearing branches and fruit spurs will be found mostly near the top of a long cane. When this is permitted, especially with some varieties, such as Fay for example, the weight of the fruit is quite apt to bend the canes nearly or quite to the ground.

Besides this heading-in to keep the bushes in shape the pruning consists of removing the broken branches or those that droop too closely to the ground, and removing the old wood after it has passed the age of greatest productiveness. Mr. S. Haviland, a practical fruit grower, of Marlboro, N. Y., has, I believe, correct ideas on this subject. He writes as follows:

"I am particular about trimming currants the first five years from setting, cutting a few inches from the end of all the new wood. If you do not, the end buds being stronger will push out and all the others will die and the bush will soon be very tall, with few fruit buds. If cut back nearly all the other buds will start, forming a cluster of fruit buds at their base, thereby increasing the crop and keeping the bush low for a much longer time."

Insect and Fungous foes.—Fighting the insect and fungous foes has come to be one of the essentials of successful currant culture. Chief among the insect enemies is the so-called "currant worm" which is the larva of a sawfly. It has four wings and the female is somewhat larger than the common housefly, her body being mostly yellow. On warm days early in spring these flies appear and deposit their eggs in chains along the veins and midrib on the under side of the leaf. In about ten days the eggs hatch into the minute white worms, or rather, larvæ. These begin to feed on the leaves, grow rapidly and spread over the bushes, often stripping them of their foilage in a few days. As they grow they assume a light green color and at one stage they are covered with many black dots. When full grown they are about three-quarters of an inch long. These flies do not appear all at once and later in the season another brood is developed so that continual watchfulness is necessary to hold these insects in check.

Early in the season before the fruit has attained much size, London Purple or Paris Green may be used against these insects, but later it is better to use powdered hellebore, which may be applied even when the fruit is ripening without any fear of rendering the fruit unfit for food. These substances may be dusted on the foliage or applied in the form of a spray. We prefer the latter method, especially if there are very many bushes to be treated. When London Purple or Paris Green is used, mix at the rate of one pound of the poison to from one hundred and fifty to two hundred gallons of water. When hellebore is used mix at the rate of one pound to fifty gallons of water. The applications should be made as soon as the worms, or larvæ, are discovered.

The currant borer is the larva of a small bluish-black moth, having three bright yellow bands across the abdomen. There is but one brood a year of this insect. The moth lays the eggs on or near the buds and the larva bores down through the pith of the cane. Pruning and burning the infested canes in autumn appears to be the best known way of fighting this insect.

The four-lined leaf bug, or yellow lined currant bug, is an insect that infests the leaves of the new growth. Slingerland advocates * the pruning and burning of the tips of infested shoots in autumn, jarring the insects into a dish of kerosene and water, spraying with kerosene emulsion, 1 to 5, as soon as the red young of the insect (nymphs) are seen in the spring.

The leaf spot diseases are probably best controlled by spraying with Bordeaux mixture, 1 to 11 formula. † According to Pammel's

* Bull. 58, Cornell Expt. Station, Oct., 1893.

† See Bull. of this Station, No. 86: 110.

experiments,* spraying should begin soon after the fruit sets and continue at intervals of about two weeks till the fruit begins to color. To avoid spotting the fruit, no further spraying is done till the fruit is picked when one or two further applications are made.

So far as I have observed the leaf spot disease does not usually work much injury in this State before midsummer, so that two thorough applications of Bordeaux mixture, the first made as soon as the fruit is picked and the second about two weeks thereafter, will probably be sufficently to control the disease. This opinion is based on general observation and not on definite experiments.

Leaf disease of black currants.— It should be remembered that the European black currants though not troubled by the currant worms (saw-fly larvæ) which are so destructive to foliage of other currants, may be seriously affected with the leaf blight. Sometimes they are nearly defoliated by it in late summer or autumn. Spraying with Bordeaux mixture has given good results in treating this trouble the same as in treating the leaf disease of red currants.

Dying of canes.— In 1891, Mr. D. G. Fairchild's attention was called to a dying of currant canes which was caused by a parasitic fungus which infested the cane. The disease was then reported from a district along the Hudson. During the past season a similar trouble, probably identical with that which Mr. Fairchild observed, has been reported to the Station by a fruit grower in the Hudson river valley. The diseased canes were submitted to Mr. F. C. Stewart of the Station staff in the second judicial department, who found mycelium very abundant in both pith and cambium. He has not yet determined the life history of the fungous parasite and has as yet no remedies to suggest. Dr. Halsted, Botanist of the New Jersey Experiment Station, in his annual report for 1894, page 327, speaks of fungi parasitic on currant canes, one a species of *Nectria*, and one a species of *Homostegia*. He recommends cutting out the diseased parts.

Preparation and application of remedies.— A more complete discussion of the preparation and application of Bordeaux mixture, Paris Green or London Purple, Hellebore, etc., is given in another portion of this report.

BLACKBERRIES AND DEWBERRIES.

In common with many other plantations of blackberries in various parts of the State, the blackberries at this Station were

* Pammel, L. H., Bull. 17, Iowa Expt. Station, 419-421; Bull. 20, 716-718; Bull. 30. 289-291.

severely injured by the winter of 1894–5. Though the season has not been satisfactory, so far as the crop of fruit is concerned, yet it has been of value in indicating the hardiness of different varieties.

The table below contains a list of the varieties of blackberries and dewberries grown at this Station in 1895, together with a statement of the per cent. of injury done to the canes by the winter:

TABLE III. LIST OF BLACKBERRIES NOW GROWING ON THE STATION GROUNDS TOGETHER WITH THE PER CENT. THAT THE CANES WERE INJURED BY THE WINTER.

NAME.	Per cent of canes winter killed.
Blackberries.	
Agawam	50
Ancient Briton	70
Barnard	55
Carlo	75
Child's Everbearing Tree	10
Dorchester	75
Early Cluster	90
Early Harvest	25
Early Mammoth (Thompson's)	60
Eldorado	20
Evergreen	25
Lincoln	25
Lovett	25
Luther	50
Minnewaski	50
New Rochelle	25
Snyder	10
Stone's Hardy	60
Taylor	30
Wachusett	25
Western Triumph	....
Wilson's Early	40
Wilson Junior	60
Dewberries.	
Bartel	80
Lucretia	75
Mammoth	80

LIST OF BLACKBERRIES AND DEWBERRIES SET IN THE SPRING OF 1895.

Blackberries.

Maxwell. From Thompson's Sons, Rio Vista, Va.
Piasa. From E. A. Riehl, Alton, Ills.

Dewberries.

Austin. From J. W. Austin, Pilot Point, Texas.
Maynard. From C. C. Maynard, Kincaid, Kansas.

BLACK RASPBERRIES.

Most of the black raspberries now growing on the Station grounds are young plants, and until they become better established their season and productiveness can not be determined. Notes on the newer varieties, or those that have fruited here for the first time are given below.

NOTES ON VARIETIES.

Babcock No. 3. *From D. W. Babcock, Dansville, N. Y.*, 1894 Fruit very large, good black color, medium grains, fair flavor and quality. Promises to be a valuable sort on account of its size and productiveness. Canes killed back by the winter 15 per cent.

Babcock No. 5. *From D. W. Babcock, Dansville, N. Y.*, 1894. Fruit medium to large, compact grains, moderately firm, juicy, sweet, very good quality, productive. Worthy of further testing. Was hurt but little by the winter.

Babcock No. 9. *From D. W. Babcock, Dansville, N. Y.*, 1894. Fruit small with small grains, good color and good quality. Too small to deserve further testing. The canes were killed back but 3 per cent. by the winter.

Eureka.—*From W. N. Scarff, New Carlisle, O.*, 1893, *and A. M. Purdy, Palmyra, N. Y.*, 1894. Fruit large to very large, good color, grains medium, firm, sweet, mild, fair flavor and quality. Canes were winter killed 15 per cent. Worthy of further testing. See remarks under Mohler.

Hopkins.—*From A. M. Purdy, Palmyra, N. Y.*, 1894. Canes were winter killed but little. Fruit large to very large, compact with medium grains, good color, sweet, good quality.

Kansas.—*From A. H. Griesa, Lawrence, Kansas*, 1893. Fruit medium to very large but does not average large, many berries imperfect this season; good color, medium size grains, seedy, firm, mild, sweet, good quality. Canes winter killed 25 per cent. Not as good as other varieties for this locality.

Manwaring No. 1. From C. H. Manwaring, Lawrence, Kansas, 1893. Fruit small to medium, good black color, firm, mild sub-acid, good quality. Canes were killed back but very little by the winter.

Mohler.—*From D. M. Mohler & Co., New Paris, O.,* 1893. This variety received favorable notice in the reports of this Station for 1894; this season's test confirms our former good opinion. Canes large and vigorous, killed back by the winter 25 per cent. Berries large, firm, good black color; very productive. Season early, ripened the majority of its crop between the dates of July 1 and 12; first fruit was picked June 29; last picking July 23. Seems to be worthy of extended trial on account of its size, appearance and productiveness. This variety is decidedly similar to Eureka but our Eureka has fruited only one season and we need to compare these two varieties more carefully before expressing an opinion as to whether or not they are identical.

Palmer.—*From C. Mills, Fairmount, N. Y.,* 1894, *and W. D. Barns & Son, Middle Hope, N. Y.,* 1895. Fruit medium to large, compact, firm; grains small, nearly sweet, good quality. A standard variety in some localities. Winter killed but 5 per cent.

Poscharsky, No. 3. From. F. W. Poscharsky, Princeton, Ills., 1894. Fruit medium size with small compact grains, soft, sub-acid, good black color, good quality. Canes were injured by the winter, Not a promising variety.

Poscharsky No. 9. From F. W. Poscharsky, Princeton, Ills., 1894. Fruit medium to large with small compact grains, moderately firm, mild sub-acid, good. Gives promise of being productive. Canes were injured but little by the winter. Deserves further testing.

Poscharsky No. 15. From F. W. Poscharsky, Princeton, Ills., 1894. Fruit medium size, grains small, firm, good color and quality. Canes were uninjured by the winter.

Townsend's No. 2. From G. Townsend, Gordon, O., 1894. Fruit medium to large, firm, medium grains, somewhat seedy, sweet, very good quality. Canes were winter killed but 3 per cent.

INJURY BY WINTER.

Many varieties of raspberries were injured by the winter of 1894-5, although they did not suffer so severely from this cause as did the blackberries. The following table gives a list of the black raspberries grown here in 1895 and the estimated per cent. of injury to the canes by the winter:

TABLE IV. — LIST OF BLACK RASPBERRIES GROWING ON THE STATION GROUNDS AND THE PER CENT. OF INJURY THE CANES RECEIVED DURING THE WINTER.

NAME.	Per cent. of canes winter killed.
American Everbearing	0
Arctic	0
Babcock No. 3	15
Babcock No. 5	0
Babcock No. 9	3
Carman	5
Cromwell	....
Eureka	15
Haynes Seedling	5
Hilborn	50
Hopkins	50
Kansas	15
Lotta	80
Lovett's	5
Manwaring No. 1	2
Mills	5
Mohler	25
Ohio	10
Older	0
Onondaga	10
Palmer	5
Poscharsky No. 3	0
Poscharsky No. 9	2
Poscharsky No. 15	0
Smith's No. 2	0
Smith's Prolfic	60
Spry's Early	25
Townsend's No. 2	3

RED RASPBERRIES.

NOTES ON VARIETIES.

Cline.—*From G. W. Cline, Winona, Ont.* A chance seedling of *Idæus* type. Fruit medium size with medium to large grains, red color, firm, sweet, good flavor and quality. Inferior to Turner. Evidently will prove to be very early. Plants not yet established.

Harris.—*From Z. H. Harris, Rochester, N. Y.* This berry has received notice in previous bulletins and reports of this Station as a productive variety of very good quality. The canes are of the *strigosus* type, vigorous but not tall and need not be pruned. This season the fruit is of good size and quite firm, but not so good in quality as usual. The canes of plants that were set in 1889 were killed back 75 per cent by the winter but younger plants set in 1893 were injured but very little. It has been quite hardy heretofore.

I. X. L.—*From C. Schlessler, Naperville, Ills.* A chance seedling of unknown parentage. Canes vigorous, *strigosus* type. Berries medium size, grains medium to large, color dull light red, disposed to crumble, nearly sweet, good.

Kenyon.— *From O. A. Kenyon, McGregor, Iowa. Strigosus* type, moderately vigorous. Berries medium to large with large grains, dark red color, moderately firm, sub-acid, quality only fair.

King.—*From Cleveland Nursery Co., Rio Vista, Va.* Canes vigorous, show evidence of *Idæus* parentage. Fruit medium to large, fine bright red color; grains large, moderately firm, juicy, mild sub-acid, fair to good in quality.

Loudon.—*From F. W. Loudon, Janesville, Wis.* Canes vigorous, *strigosus* type. Berry as large or larger than Cuthbert, inclined to conic, grains large with a suture, moderately firm, good red color, not as good quality as Cuthbert.

Talbot.—(*Talbot Prolific*) *From M. J. Ellis, Norwood, Mass.* Berries medium to large, with large grains, soft, juicy, mild acid, very good. Canes show evidence of *Idæus* parentage, strong and vigorous.

TABLE V.—SHOWING RELATIVE PRODUCTIVENESS, AND EARLY AND LATE YIELD OF RED RASPBERRIES IN 1895.

Rank as to yield.	NAME.	When set.	Yield of matted row, 25 feet long. Ounces.	Per cent. of crop picked before July 9.	Per cent. of crop picked after July 26
1	Superb	1892	427	15	20
2	Cuthbert	1892	421	0	15
3	Pomona	1892	345	30	2
3	Pride of Kent	1892	345	4	4
4	Olathe	1892	332	0	24
5	Royal Church	1892	327	4	19
6	Turner	1892	254	35	2
7	Miller's Woodland	1892	188	6	13
8	Thompson	1892	165	15	5
*	Talbot (*Talbot Prolific.*)	1894	110	4	22
9	Crimson Beauty	1893	109	12	6
10	Brandywine	1892	108	0	27
*	Loudon	1894	90	0	29
*	King	1894	78	8	15
11	Reliance	1893	72	12	11
12	Clarke	1892	64	14	3
*	Kenyon	1894	55	7	11
13	Reder	1893	46	11	30
14	Pride (*Thompson's Early Pride.*)	1893	44	27	9
15	Harris	1893	39	13	26
16	Naomi	1893	25	12	20
17	Cline	1893	24	71	0
*	I. X. L.	1894	11	18	0

* Yielded first crop in 1889.

Again consulting Table V, we find a list of eight varieties that yielded a fifth or more of their crop after July 26. These are classed together as late varieties.

TABLE VI.—LATE RED RASPBERRIES RANKED ACCORDING TO YIELD AFTER JULY 26.

NAME.	Date of last picking.	Yield after July 26. Ounces.	Total Yield. Ounces.	Rank as to total yield.
Superb	August 5	84	427	1
Olathe	August 8	81	332	4
Brandywine	August 8	29	108	*
Loudon	August 3	26	90	*
Talbot	August 1	24	110	*
Reder	August 5	14	46	13
Harris	August 3	10	39	15
Naomi	August 1	5	25	16

*First crop.

Superb takes first rank both as to total yield and to the amount of late fruit produced. Last season it stood third in rank as to total yield and seventh as to the amount of late fruit produced. Olathe has received favorable notice in previous reports of this Station as a productive late variety. It gave good satisfaction this season. The fruit is of good size, firm and attractive.

The greater part of the crop of red raspberries ripened this season between the dates of July 9 and July 26. Table V shows that four varieties yielded a fourth or more of their crop before July 9. These may be called early for this season.

TABLE VII.—EARLY RED RASPBERRIES RANKED ACCORDING TO THEIR YIELD BEFORE JULY 9.

NAME.	Date of last picking.	Yield before July 9. Ounces.	Total yield. Ounces.	Rank as to total yield.
Pomona	June 29	102	345	3
Turner	June 29	90	254	6
Cline	June 29	17	24	17
Pride (*Thompson's Early Pride*)	July 1	12	44	14

Pomona has always done well on our grounds. Turner is one of the standard berries. Cline was first fruited here in 1893, so that the plants have not become well established. It has not yet shown any points of superiority. Pride has done fairly well heretofore. Its fruit is of medium size, firm, good color and good quality.

PURPLE RASPBERRIES.

Among the purple raspberries the Columbian was the most productive. The plants produced their first crop this season, yet it ranks second in productiveness among the raspberries fruited, giving a yield of 540 ounces from a row 25 feet long. A similar area of Caroline yielded 633 ounces. Its manner of growth and fruiting is much like the Shaffer, but it is more vigorous and was injured less by the winter. As compared with Shaffer the fruit is larger, firmer, and a shade lighter in color. It yields a larger per cent. of its crop late in the season than does the Shaffer.

This is a promising variety and is worthy of extended trial.

Cardinal ranked second in productiveness among the purple berries. Its canes were injured but little by the winter.

YELLOW RASPBERRIES.

The yellow raspberries are valuable for the home garden. Of the varieties fruited on the Station grounds the Caroline and Golden Queen are the most satisfactory as to yield. Caroline has always been productive here, and this year it gives the largest yield of any of the raspberries.

LIST OF RASPBERRIES SET IN THE SPRING OF 1895.

All Summer. From Lovett & Co., Little Silver, N. J.

Cromwell. From W. D. Barns & Son, Middlehope, N. Y.

Gault. From W. C. Gault, Ruggles, Ohio, and Storrs, Harrison & Co., Painesville, Ohio.

Marlboro. From C. G. Velie, Marlboro, N. Y.

Miller. From Slaymaker & Son, Dover, Del.

Telataugh. From I. F. Street, Middletown, Ind.

Thomson. From Ellwanger & Barry, Rochester, N. Y.

Townsend's No. 1. From Geo. Townsend, Gordon, Ohio.

Unknown Red. From W. D. Barns & Son, Middlehope, N. Y.

Wade. From Albertson & Hobbs, Bridgeport, Ind.

Whyte, No. 6. From R. B. Whyte, Ottawa, Canada.

Whyte, No. 7. From R. B. Whyte, Ottawa, Canada.
Whyte, No. 13. From R. B. Whyte, Ottawa, Canada.
Whyte, No. 17. From R. B. Whyte, Ottawa, Canada.

Miscellaneous.

Japan Golden Mayberry. From A. Blanc & Co., Phila., Pa.
Logan Berry. From A. Blanc & Co., Philadelphia, Pa.
Rubus Capensis. From A. Blanc & Co., Philadelphia, Pa.
Stanley Berry. From A. Blanc & Co., Philadelphia, Pa.
Strawberry Raspberry. From A. Blanc & Co., Philadelphia, Pa.

STRAWBERRIES.

The strawberries tested at this Station are grown in matted rows. Young plants set in the spring or fall are given thorough cultivation through the first season. The following winter as soon as the ground freezes the beds are covered with a few inches of straw. They are given one cultivation in the spring as soon as the ground is fit to work. As soon as growth starts the straw is removed from the beds and placed between the rows. One or two inches of the straw is left on the beds to serve as a mulch to keep the berries from the ground. The soil is a stiff clay loam, well underdrained, and fertilized with stable manure.

The difference between staminate and pistillate varieties of strawberries is now quite generally understood, as is also the necessity of planting a staminate variety with the pistillate berries so that the blossoms of the latter may be fertilized. In the following notes on varieties, the staminate berries are designated by an "S," while the pistillate ones are marked "P."

Notes on Varieties.

Aldridge No. 25. S. *From Slaymaker & Son, Dover, Del.* Plants very vigorous, foliage good; fruit stems long; runners abundant. Fruit scarlet, medium to large, moderately firm, fair quality. Productiveness cannot be definitely stated but it does not rank high.

**Allen's No.* 5. P. *From W. F. Allen, Jr., Salisbury, Md.* Blossoms with Beder Wood. Dark crimson color. Among the

*Varieties marked with a * were fruited in beds two years old. More complete descriptions of them may be found in Bulletin 76 of this Station or the Annual Report for 1894.

varieties fruited here for the first time in 1894 it took first rank. When fruited this year in two-year-old beds it proved unsatisfactory.

**Allen's No.* 6. P. *From W. F. Allen, Jr., Salisbury, Md.* Blossoms with Beder Wood. Dark scarlet color. Among the varieties fruited here for the first time in 1894 it ranked tenth in productiveness. This year it was unsatisfactory in two-year old beds.

**Allen's No.* 13. P. *From W. F. Allen, Jr., Salisbury, Md.* Blossoms with Beder Wood. Dark scarlet color. Unproductive in two-years old beds, although it took fifth rank as to productiveness in 1894 among varieties fruited for the first time.

**Allen's No.* 14. P. *From W. F. Allen, Jr., Salisbury, Md.* Blossoms with Beder Wood. Good light scarlet color. Moderately productive.

Annie Laurie.— S. *From M. Crawford, Cuyahoga Falls, O.* Fruit medium to large, oblate with Crescent tip, bright scarlet color, moderately firm, good quality. Foliage very vigorous; fruit stems good; runners abundant. Moderately productive; late.

* **Beauty.**— P. *From J. H. Haynes, Delphi, Ind.* Blossoms with Sharpless. Bright scarlet color. Retains its good reputation of last season. Among the varieties fruited in two-year old beds it takes second rank as to productiveness.

Blonde.— S. *From G. Cowing, Muncie, Ind.* Fruit medium to large, pale scarlet color, firm, poor quality. Foliage vigorous, stems good, runners abundant. Moderately productive.

Bostonian.— P. *From B. F. Lincoln, West Hingham, Mass.* Blossoms with Sharpless. Foliage vigorous; fruit stems good; runners abundant. Fruit medium size, inclined to a neck; scarlet color, soft, fair quality. Among the varieties fruited here for the first time in 1895 it ranked fourth in productiveness.

* **Brandywine.**— S. *From E. T. Ingram, Westchester, Pa.* Moderately productive. Fruit dark scarlet color.

Brunette.— S. *From G. Cowing, Muncie, Ind.* Fruit medium size, round to conic, color dark scarlet to crimson, quality good. Foliage vigorous; fruit stems good, runners abundant. Only moderately productive.

---

*Varieties marked with a * were fruited in beds two years old. More complete descriptions of them may be found in Bulletin 76 of this Station or the Annual Report for 1894.

* **Bryant,** *Perkins No. 2.* S. *From Jackson & Perkins, Newark, N. Y.* Unproductive in two-year-old bed. Plants weak and run out.

Charlie.—P. *From Cleveland Nursery Co., Rio Vista, Va.* Fruit medium size; fine scarlet color; firm; fair quality. Foliage vigorous, stems long, runners abundant. Ranks tenth in productiveness among the varieties fruited for the first time this season.

* **Columbia.**—S. *From West Jersey Nursery Co., Bridgeton, N. J.* Fruit pale crimson color. Poor quality. Unproductive.

* **Cyclone.** S. *From E. W. Cruse, Leavenworth, Kansas.* Fruit medium size; scarlet color; moderately productive.

Dewdrop.—S. *From B. F. Smith, Lawrence, Kansas.* Foliage and fruit stems good; runners abundant. Fruit medium size, good scarlet color, firm, good quality. Moderately productive. A late variety.

Eicholtz Seedling. From the U. S. Division of Pomology, Washington, D. C. Fruit medium to large, light scarlet color, firm, good quality. Foliage vigorous; fruit stems long; runners abundant. This variety was only moderately productive this year but it is considered worthy of further testing.

Equinox.—S. *From Cleveland Nursery Co., Rio Vista, Va.* Foliage moderately vigorous; runners abundant; fruit stems good. Fruit medium to large, unattractive, dull scarlet color, firm, poor quality. Among the varieties fruited for the first time this season this variety ranks second in productiveness. On this account it is considered worthy of further testing.

Giant.—*S. From W. Y. Velie, Marlboro, N. Y.* Foliage vigorous, fruit stems good, runners abundant. Fruit medium to large; light scarlet color; moderately firm; poor quality. Among the varieties fruited for the first time this season Giant ranked fifth in productiveness.

Hadsell's Seedling. P. *From J. H. Hadsell, Bath, N. Y.* Has not fruited yet.

**Haynes'* 31. P. *From J. H. Haynes, Delphi, Ind.* Blossoms with Beder Wood. Fruit medium size, deep scarlet color. Among the varieties fruited for the first time in 1894 it took second rank in productiveness. This season it stands fourth in productiveness among varieties fruited in two-year-old beds.

---

* Varieties marked with a * were fruited in beds two years old. More complete descriptions of them may be found in Bulletin 76 of this Station or the Annual Report for 1894.

Iowa Beauty.—S. *From E. J. Hull, Olyphant, Pa.* Fruit medium to large; dark scarlet color; moderately firm; good quality. Moderately vigorous, fruit stems good, runners abundant. Only moderately productive this season, but it is considered worthy of further testing on account of the size and quality of the fruit.

Jay Gould.—P. *From C. A. Green, Rochester, N. Y.* Blossoms with Sharpless. Foliage very vigorous; runners abundant; fruit stems long. Fruit medium or below, good scarlet color, firm, good quality, unproductive this season.

* **Leader.**—S. *From Wm. Parry, Parry, N. J.* Fruit medium size or below. Plants weak and unproductive this season.

* **Luther.**—S. *From A. Luther, Leeds, Jackson Co., Mo.,* Fruit medium size, scarlet color. Foliage weak and but few run ders, but it takes fifth rank in productiveness among the varieties fruited in two-year-old beds.

**Manchester No.* 1. P. *From Jackson & Perkins, Newark, N. Y.* Blossoms with Beder Wood. Fruit medium or above, scarlet color. Moderately productive. Plants are not very vigorous in two-year-old beds.

Marshall.—S. *From L. J. Farmer, Pulaski, N. Y.* Fruit medium to very large; irregular in shape; good dark scarlet color; firm; good quality. Plants vigorous, with large leaves, runners abundant, fruit stems good. Only moderately productive but considered worthy of further testing on account of the vigor of the plants and the size and quality of the fruit.

Marston.—P. *From C. S. Pratt, Reading, Mass.* Blossoms with Beder Wood. Foliage vigorous: fruit stems good; runners abundant. Fruit medium or below, scarlet, moderately firm, fair quality. Among the varieties fruited for the first time this season it stands first in productiveness.

Mexican Everbearing.— S. *From B. M. Watson, Plymouth, Mass.* Alpine type.

Nan.— S. *From T. J. Dwyer, Cornwall, N. Y.* Foliage good, runners moderately abundant; fruit stems good. Fruit medium to large, good scarlet color, good quality. Only moderately productive, but worthy of further testing.

Ona.— P. *From E. J. Hull, Olyphant, Pa.* Fruit medium or above in size; good scarlet color; moderately firm; fair quality.

* Varieties marked with a * were fruited in beds two years old. More complete descriptions of them may be found in Bulletin 76 of this Station or the Annual Report for 1894.

Foliage moderately vigorous, runners not abundant, fruit stems good. Blossoms with Beder Wood. In productiveness it stands sixth in rank among the varieties fruited here for the first time this season.

Orange County.— P. *From E. J. Hull, Olyphant, Pa.* Blossoms with Beder Wood. Foliage vigorous, runners abundant, fruit stems good. Fruit medium to large; roundish oblate; light scarlet color; soft; good quality. Moderately productive.

* **Random.**— S. *From G. W. Cline, Winona, Ontario.* Fruit medium size; light scarlet color. Unproductive in two-year old bed.

**Riehl's No. 5.* P. *From E. A. Reihl, Alton, Ills.* Begins to blossom a few days before Sharpless. Fruit medium size, dark scarlet color. Unproductive in two-year old bed.

**Riehl's No. 6.* S. *From E. A. Reihl, Alton, Ills.* Plants weak and unproductive in two-year old bed. Fruit medium or above; scarlet color.

* **Rush.**— P. *From Jackson & Perkins, Newark, N. Y.* Begins to blossom two or three days later than Beder Wood. Fruit medium size; dark scarlet color. Unproductive.

* **Saunders' Success.**— S. *From A. Saunders, Sac City, Ia.* Fruit scarlet, medium size. Unproductive last year, but this season it ranks eighth in productiveness among the varieties fruited in two-year old beds.

* *See No.* 1. S. *From H. S. & A. J. See, Geneva, Pa.* Fruit medium or below; good scarlet color. Worthless this season in two-year old beds.

**See No.* 2. P. *From H. S. & A. J. See, Geneva, Pa.* Blossoms with Beder Wood. Fruit medium size; dark scarlet color. It retains its reputation for productiveness this year, standing sixth in rank among the varieties fruited in two-year old beds.

* **Sherman.**— S. *From J. H. Haynes, Delphi, Ind.* Fruit medium size, bright scarlet color. A handsome berry but only moderately productive.

* **Shuckless.**— P. *From Hoover & Gaines, Dayton, Ohio.* Fruit scarlet, medium size. Unsatisfactory in two-year-old beds.

* **Splendid.**— S. *From C. H. Sumner, Sterling, Ill.* Fruit scarlet color. Moderately productive this year the same as last.

---

* Varieties marked with a * were fruited in beds two years old. More complete description of them may be found in Bulletin 76 of this Station or the Annual Report for 1894.

Sunny Side.— P. *From C. S. Pratt, Reading, Mass.* Blossoms about with Sharpless. Plants very vigorous, runners abundant, fruit stems good. Fruit medium to large; round to wedge shape; light scarlet color; attractive; moderately firm; fair quality; mid-season. Among the varieties fruited in one-year old beds it takes fourth rank as to productiveness. In 1893 it took first rank in productiveness and was mentioned as being worthy of further testing as a late market variety.

Tennesee.— S. *From W. T. Wood & Co., Richmond, Va.* Fruit medium to large; attractive; bright scarlet color; moderately firm, fair quality. Foliage vigorous, runners abundant, fruit stems long, prostrate. It ranks third in productiveness among the varieties that fruited here for the first time this year.

* **Timbrell.**— P. *From E. W. Reid, Bridgeport, Ohio.* Unproductive on our soil.

White Novelty.— S. *From B. M. Watson, Plymouth, Mass.* A variety of *Fragaria vesca*; bears small white fruit.

Wilder No. 5. P. *From H. A. Wilder, Akron, N. Y.* Has not fruited yet.

Wilder No. 7. S. *From H. A. Wilder, Akron, N. Y.* Has not fruited yet.

* **Wilson, Jr.**— S. *From F. L. Ray, East Claridon, Ohio.* Fruit medium size; unattractive dark scarlet or crimson color. Only moderately productive.

Young's Seedling. S. *From R. D. McGeehon, Atlantic, Iowa.* Plants vigorous, runners abundant, fruit stems good. Fruit medium or above; good light scarlet color; moderately firm; poor quality. Moderately productive.

---

* Varieties marked with a * were fruited in beds two years old. More complete descriptions of them may be found in Bulletin 76 of this Station or the Annual Report for 1894.

TABLE VIII.— LIST OF STRAWBERRIES FRUITED IN ONE-YEAR OLD BEDS, WITH A COMPARATIVE STATEMENT OF THE PER CENT. OF EARLY AND LATE YIELD OF EACH VARIETY.

Rank as to yield, 1895.	NAME OF VARIETY.	Yield of 33 square feet in ounces.	Per cent. of crop picked before June 17.	Per cent. of crop picked after June 29.
1	Barton's Eclipse..........P	320	14	6
2	Edgar Queen..........P	270	0	16
3	Edward's Favorite..........S	240	5	24
4	Sunny Side..........P	224	0	12
5	Princeton Chief..........P	217	5	12
6	Beder Wood..........S	210	15	3
7	Marston..........P	209	29	2
8	Equinox..........S	206	0	16
9	Tennessee..........S	205	14	2
10	Bubach..........P	199	10	2
11	Sadie..........P	190	14	7
12	*Feicht No.* 3..........P	167	0	18
13	Bostonian..........P	161	0	0
14	Middlefield..........P	157	0	20
15	Lovett..........S	156	22	4
16	Walton..........P	145	10	14
16	*Staymans No.* 1..........P	145	0	15
17	*Feicht No.* 2..........S	127	15	5
18	Sharpless..........S	123	0	19
19	Crosby..........S	118	0	12
20	Gandy..........S	117	0	26
21	*Young's Seedling*..........S	107	14	4
22	*Thompson No.* 40..........P	106	0	6
22	*Crosby No.* 10..........S	106	0	5
23	*Phillips' Seedling*..........S	105	5	10
24	Waldron..........P	101	0	4
25	Nan..........S	100	33	0
26	Charlie..........P	92	16	0
27	Annie Laurie..........S	86	0	4
28	*Crosby No.* 91..........S	85	0	22
29	Dewdrop..........S	77	32	0
30	Jay Gould..........P	64	23	0
31	Marshall..........S	62	0	0
32	*Townsend's No.* 2..........S	43	0	0
	Aldridge No. 25..........S	....	..	...
	Great Pacific..........P	....	..	...

EARLY VARIETIES.

Those varieties which yielded a considerable portion of their crop before June 16 may be called early. They are given below in the order of their productiveness.

TABLE IX.—EARLY VARIETIES RANKED ACCORDING TO YIELD BEFORE JUNE 16, 1895.

NAME.	Date of first picking.	Yield before June 16. Ounces.	Total yield 1895.	Rank as to yield, 1895.
Marston	June 13	47	209	7
Lovett	June 13	35	156	15
Nan	June 12	25	100	25

Marston gave the largest early yield and was the most productive variety fruited here for the first time this season. It is worthy of further testing. Lovett has been fruited here for several years and is only moderately productive of medium-size fruit. Nan fruited here for the first time this season.

LATE VARIETIES.

By consulting table VIII only four varieties are found that yielded a fifth or more of their crop after June 29. These may be classed as late. They are given below in the order of their productiveness :

TABLE X.—LATE VARIETIES RANKED ACCORDING TO THEIR YIELD AFTER JUNE 29.

NAME.	Date of last picking.	Yield after June 29. Ounces.	Total yield 1895. Ounces.	Rank as to yield, 1895.
Edward's Favorite	July 8	57	240	3
Middlefield	July 8	32	157	14
Gandy	July 8	31	117	20
Crosby No. 91	July 5	19	85	28

Edward's Favorite has received favorable notice in previous reports of this Station as a moderately productive variety. This season it takes first rank as a late variety and stands third in productiveness among the varieties fruited in one-year-old beds. Middlefield has also received favorable notice in former reports. It was only moderately productive this season. Gandy is a popular late variety. It has been only moderately productive on our grounds.

TABLE XI.—YIELD OF VARIETIES FRUITED IN TWO-YEAR OLD BEDS IN 1895, TOGETHER WITH THE YIELD OF SAME BEDS IN 1894, WHEN THEY WERE BUT ONE YEAR OLD.

NAME.	Rank as to yield, 1895.	Yield of 33 sq. ft. in ounces 1895.	Rank as to yield, 1894.	Yield of 33 sq. ft. in ounces 1894.	Season.
Beauty ....P	1	207	7	142	Late.
Hunn ....P	2	202	6	144	Late.
Haynes' No. 31........P	3	159	2	283	Mid season.
Luther................S	4	156	23	84	Early.
See No. 2.............P	5	148	3	196	Mid season.
Cruse No. 9...........S	6	141	13	129	Mid season.
Splendid ....S	7	115	11	133	Mid season.
Saunders' Success .....S	8	114	27	33	Mid season.
Manchester No. 1......P	9	109	17	108	Late.
Shuckless ....S	10	87	22	92	Late.
Cyclone...............S	11	79	20	94	Early.
Sherman ....S	12	78	16	117	Mid season.
Brandywine ....S	12	78	18	107	Mid season.
Wilson, Jr.............S	13	75	9	139	Mid season.
Allen's No. 14.........P	14	69	14	127	Mid season.
Timbrell ....P	15	66	26	74	Late.
Riehl's No. 6..........S	16	61	15	119	Mid season.
Allen's No. 13.........P	17	58	5	147	Mid season.
Riehl's No. 5..........P	18	51	4	187	Late.
Random ....S	19	49	24	83	Mid season.
Allen's No. 5..........P	20	37	1	312	Mid season.
Allen's No. 6..........P	21	34	10	138	Mid season.
Columbia ....S	22	33	?	?	Mid season.
Leader................S	23	27	19	96	Late.
See No. 1 ....S	24	21	8	139	Early.
Bryant, *Perkins' No.* 2 .S	25	6	?	?	

Several varieties that were fruited in one year beds gave a larger yield than any of the varieties in two-year old beds, a result in line with the common experience that the first crop from a bed of strawberries is usually the best. The table shows that only five of the twenty-six varieties named in the list (19 per cent.) gave a better yield in the second season than they did the first, while many varieties deteriorated so much as to be unprofitable in two-year beds.

The evidence of this table confirms the opinion formed after studying the tests of hundreds of new strawberries that have been tried at this Station, namely, that a large proportion of them ought never to have been introduced into cultivation because they are inferior to well-known cultivated sorts.

The following varieties of strawberries now growing at this Station have not yet fruited here:

Allen,
America,
Australian Everbearing,
Beecher, H. W.,
Bissel,
Burnett,
Canada Wilson,
Columbian,
Earliest,
Eleanor,
Edith,
Enormous,
Hadsell's Seedling,
Hersey,
Hull No. 3,
Hull No. 4,
Maple Bank,
Margaret,
Mary,
Murray,
Omega,
Oregon No. 1,
Oregon No. 2,
Robinson,
See's No. 3,
See's No. 4,
See's No. 5,
Slaymaker No. 1,
Slaymaker No. 5,
Slaymaker No. 8,
Slaymaker No. 9,
Slaymaker No. 12,
Slaymaker No. 25,
Staples,
Thompson (*Lady Thompson*),
Thompson No. 100,
Thompson No. 101,
Tubbs,
Viscomtesse Hericart de Thury,
Weston,
William Belt,
Williams.

PRODUCTIVENESS OF GRAPES AS AFFECTED BY SELF-FERTILIZATION OF THEIR BLOSSOMS.

Many kinds of grapes are unable to set fruit when standing alone, others are apt to produce abortive berries and imperfect clusters, while still others produce satisfactory clusters. Some of the kinds which can not set any fruit or which do not form satisfactory clusters when standing alone, are able to set fruit when their blossoms are fertilized by pollen from other varieties of grapes. So it happens that some kinds of grapes do very well when they are mingled with other varieties, but when planted in blocks by themselves they either do not bear at all or the yield is unsatsfactory.

It is a matter of practical importance to grape growers to know which kinds of grapes can set fruit satisfactorily when standing alone and which can not. Investigations on this subject were begun at this Station in 1892 and have been continued each succeeding season so far as time and opportunity permitted. Some account of this work is given in this Station's reports 1892: 597-606. 1894: 636-648.

The experiments thus far have been conducted solely in the Station's vineyards. The method of investigation has been to cover the clusters of unopened flower buds with paper bags so as to exclude all outside pollen. In 1895, 610 clusters distributed among 80 varieties were thus bagged. The result of the investigations for 1895 are combined with the results obtained in previous years and given in the following lists:

NOTE.—The character of the stamens is indicated by "l" if they are long, "s" if they are short, and "int." if they are intermediate between long and short. In stating the parentage the male parent is named last and the female parent, that is, the vine which bore the seed from which the variety was grown, is named first.

CLASS I.

Self-fertile. May be planted alone.

Varieties named in this class can form practically perfect clusters of themselves.

Character of stamens.	NAME.	Names of parents.	Species represented in parentage.
l	Ambrosia	Salem	Lab., vin.
l	Bertha	Unknown	
l	Croton	Delaware X Chasselas, de Fontainbleu	Vin., Bourq., Lab.
l	Delaware	Unknown	Bourq., Lab.
l	Diamond	Concord X Iona	Lab.
l	Early Golden (*Campbell*)*	Triumph	Lab., vin.
l	Etta	Elvira	Lab., vul.
l	Herald		Lab., (and ?).
l	Janesville		Lab., vul.
l	Lady Washington	Concord X Allen's Hybrid	Lab. vin.
l	Leavenworth	Concord	Lab.
l	Lutie	Unknown	Lab.
l	Mabel*	Walter	Lab., Bourq.
l	Marvin's Seedling, White	Unknown	
l	Mary's Favorite	Delaware X ?	Bourq., Lab., (and vin. ?)
l	Matilde	Delaware	Bourq., Lab.
l	Metternich	Clinton X Poughkeepsie Red	vul., Lab., Bourq.
l	Monroe	Delaware X Concord	Lab., Bourq.
l	Moore's Early †	Concord	Lab.
l	Niagara	Concord X Cassady	Lab., (and vin ?).
l	Opal	Lindley	Lab., vin.
l	Poughkeepsie Red	Iona X Delaware or Walter	Lab., Bourq.
l	Prentiss	Isabella	Lab.
l	Profitable	Elvira X Perkins	Lab., vul.
l	Rochester	Unknown	Lab., (and ?).
l	*Rogers No.* 13	Mammoth Globe X White Chasselas	Lab., vin.
l	*Rogers No.* 24	Mammoth Globe X Black Hamburg	Lab., vin.
l	*Rogers No.* 32	Mammoth Globe X Black Hamburg	Lab., vin.
l	Senasqua	Concord X Black Prince	Lab., vin.
l	Telegraph		Lab.
l	Winchell (*Green Mountain*)	Unknown	Lab.

* Further testing may show that this variety belongs in Class II.
† Further testing may show that this variety belongs in another class.

CLASS II.

Partly Self-fertile. May be planted alone.

The clusters of varieties named in this list are liable to be rather loose or unsymmetrical when self-fertilized, yet are perfect enough to market well.

*Character of stamens.	NAME.	Names of parents.	Species represented in parentage.
1	Agawam (*Rogers* 15).	Mammoth Globe X Black Hamburg	Lab., vin.
1	Alice	Unknown	Lab.
1	Big B. Con	Post Oak X Concord	Lin., Lab.
1	Brilliant	Lindley X Delaware	Lab., vin., Bourq.
1	*Burrows No*. 42c	Concord X Jefferson	Lab.
1	Carman	Post Oak X Triumph	Lin., Lab., vin.
1	Catawba	Unknown	Lab.
1	*Caywood No*. 50	Unknown	
1	Centennial	Eumelan	Lab., vin.
1	Champion (*Cortland*)	Concord X Hartford	Lab.
1	Chandler	Unknown	Lab.
1	Clinton	Unknown	vul.
1	Colerain	Concord	Lab.
1	Concord	Unknown	Lab.
1	Cottage	Concord	Lab.
1	Diana*	Catawba	Lab.
1	Early Ohio	Unknown	Lab.
1	*Edmeston No*. 1	Concord	Lab.
1	Elsinburg		æst.
1	(*Elvicand?*)		
1	Elvira	Taylor	vul., Lab.
1	Empire State	Hartford X Clinton	Lab., vul.
1	Esther	Concord	Lab.
1	Glenfeld	Unknown	Lab.
1	Golden Grain	Lindley X Delaware	Lab., vin., Bourq.
1	Hartford		Lab.
1	Highland	Concord X Jura Muscat.	Lab., vin.
1	Hopican	Unknown	Lab., vin.
1	Illinois City	Unknown	
1	Isabella		Lab.
1	*Isabella Seedling*	Isabella	Lab.
1	Iona	Catawba	Lab.
1	Jefferson	Concord X Iona	Lab.
1	Jessica		
1	Lady	Concord	Lab.
1	Leader	Unknown	
1	Lindmar	Lindley X Martha	Lab., vin.
1	Little Blue	Unknown	Lab. (and ?)
1	Mills	Muscat Hamburg X Creveling	vin., æst.
1	Missouri Riessling	Taylor	vul., Lab.
1	Olita	Delaware	Bourq., Lab.
1	Paradox	Hartford X Iona	Lab.
1	Paragon	Unknown	Lab.
1	Perkins		Lab.

*This variety may possibly belong in Class I.

CLASS II — (*Concluded*).

Character of stamens.	NAME.	Names of parents.	Species represented in parentage.
1	Pocklington*	Concord	Lab.
1	Rockwood	Concord	Lab.
1	Rommel	Elvira X Triumph	Lab., vin., vul.
1	Rutland		Lab. (vin ?)
1	Standard	Delaware	Bourq., Lab.
1	Triumph	Concord X Chasselas Musqué	Lab., vin.
1	Ulster	Catawba X æstivalis	Lab., æst.
1	Vergennes	Unknown	Lab.
1	Victoria	Concord	Lab.
1	Wheaton	Delaware	Bourq., Lab.
1	Worden	Concord	Lab.

*This variety may possibly belong in Class I.

CLASS III.

Partly Self-fertile. Should not be planted alone.

The varieties named in this class are capable of setting some fruit when standing alone, but their clusters are apt to be imperfect and unsatisfactory. Some of these varieties, like Eumelan, for example, rarely set any fruit when self-fertilized while others do nearly as well as some kinds in Class II. Whenever the kinds named below are planted they should be mingled with other kinds that blossom at the same time these do.

Character of stamens.	NAME.	Names of parents.	Species represented in parentage.
1	Adirondack		Lab.
s	Alexander Winter	Unknown	
s	Amber Queen	Marion X Black Hamburg	Vul., vin.
s	Beagle	Elvira X Ives	Lab., vul.
1	Canada	Clinton X Black St. Peters	Vul., vin.
1	Canonicus		Lab., vul.
1	Daisy	Gœthe	Lab., vin.
1	Dr. Collier	Post Oak X Concord	Lin., Lab.
1	Dracut Amber		Lab., (— ?)
1	Duchess	White Concord X Delaware or Walter	Lab., Bourq.
1	Early Market	Elvira	Lab., vul.
s	Eumelan	Unknown	(Lab., vin ?)

CLASS III — (*Concluded*).

Character of stamens.	NAME.	Names of parents.	Species represented in parentage.
1	Geneva	(Lab. X Muscat Alex.) X Iona	Lab., vin.
1	Gold Dust	Lindley X Delaware	Lab., vin., Bourq.
1	Nectar	Concord X Delaware	Lab., Bourq.
1	Noah	Taylor	Vul., Lab.
1	Northern Muscadine.		Lab.
1	Woodruff	Unknown	Lab.

CLASS IV.

Self-sterile — Unable to Set Fruit Alone — If Planted Should be Mingled with Other Varieties.

The varieties named in this class, so far as tested at this Station, are not able to set fruit of themselves, although some of them may form abortive berries when self-fertilized. They may fruit quite well when mingled with varieties that blossom at the same time with them.

Character of stamens.	NAME.	Names of parents.	Species represented in parentage.
1	Aledo		
	Amber	Taylor	vul.
s	America		Lin., rup.
s	Aminia (*Rogers* 39)	Mammoth Globe X Black Hamburg	Lab., vin.
s	Barry (*Rogers* 43)	Mammoth Globe X Black Hamburg	Lab., vin.
s	Black Eagle		Lab., vin.
s	Blanco	Elvira X Triumph	Lab., vin., vul.
s	Brighton	Concord X Diana Hamburg	Lab., vin.
s	Burnet.	Hartford X Black Hamburg	Lab., vin.
s	Clevener	Unknown	
s	Creveling	Unknown	(vin., æst. ?).
1	Denison	Moore's Early	Lab.
s	Dr Hexamer	Post Oak X Triumph	Lin., Lab., vin.
1	Eaton*	Concord.	Lab.
s	Eldorado	Concord X Allen's Hybrid	Lab., vin.
s	Elvibach	Elvira X Bacchus.	vul., Lab.
s	Essex (*Rogers* 41)	Mammoth Globe X Black Hamburg	Lab., vin.

* Further testing may show that this belongs in another class.

CLASS IV — (*Concluded*).

Character of stamens.	NAME.	Names of parents.	Species represented in parentage.
l	Faith	Taylor	vul., Lab.
s	Gærtner (*Rogers* 14)	Mammoth Globe X White Chasselas	Lab., vin.
s	Grein Golden	Taylor	vul., Lab.
l	Hayes	Concord	Lab.
int	Herbert (*Rogers* 44)	Mammoth Globe X Black Hamburg	Lab., vin.
s	Hercules	Unknown	Lab., vin.
s	Jewel	Delaware	Bourq., Lab.
l	Juno	Delaware	Bourq., Lab.
s	Lindley (*Rogers* 9)	Mammoth Globe X White Chasselas	Lab., vin.
s	Marion	....	vul., Lab.
s	Massasoit (*Rogers* 3)	Mammoth Globe X Black Hamburg	Lab., vin.
l	Maxatawney	Unknown	Lab.
s	Merrimack (*Rogers* 19)	Mammoth Globe X Black Hamburg	Lab., vin.
l	Montefiore	Taylor	Vul., Lab.
s	Norwood	Labrusca X Black Hamburg	Lab., vin.
s	Red Bird	Lindley X Champion	Lab., vin.
s	Red Eagle	Black Eagle X ?	Lab., vin.
s	Requa (*Rogers* 28	Mammoth Globe X Black Hamburg	Lab., vin.
s	*Rogers No.* 5	Mammoth Globe X White Chasselas	Lab., vin.
s	Roscoe	Delaware X Martha	Lab. Bourq.
s	Rustler	Lindley X Martha	Lab., vin.
s	Salem (*Rogers* 53)	Mammoth Globe X Black Hamburg	Lab., vin.
l	White Jewel	Elvira X ?	vul., Lab.
s	Wilder (*Rogers* 4)	Mammoth Globe X Black Hamburg	Lab., vin.

None of the varieties in these lists that have short stamens can set fruit satisfactorily of themselves. Judging from these investigations short stamens in cultivated varieties of grapes are an indication of partial or complete self-sterility and varieties having short stamens may be expected to prove unreliable unless planted near other kinds of grapes that blossom with them.

It should also be noted that not all kinds of grapes that have long stamens can set fruit of themselves. Most of the grapes mentioned in these lists that are unable to set fruit satisfactorily of themselves are hybrids.

FORCING LETTUCE IN POTS.

The following description of a method of forcing lettuce in pots that has been followed at this Station may be of interest to those who grow lettuce under glass, either in an amateur way or as a commercial product.

The seed is sown in flats as usual, that is to say in boxes about twelve by ten inches and three inches deep, or on the bench. When the plants are about two inches high they are transplanted to two inch pots. The benches are filled with soil, in which the pots containing the lettuce are plunged so that the tops of the pots are covered with about half an inch of soil.

PREPARATION OF SOIL.

Soil for lettuce should not be too heavy, and as the soil which we use for potting is a rather heavy clay loam, sand is mixed with it in preparing it for the lettuce house. The potting soil is composed of three parts by measure of loam, one of manure and one of sand.

The benches are six inches deep; the lower three inches being filled with well rotted manure and the upper three inches with potted soil prepared as described above.

The soil in the pots is the same as that used on the bench except that it is sifted while that on the bench is not. A little drainage material is put in the bottom of each pot. The plants are usually set on the benches about ten inches apart each way. The roots soon fill the pot and grow out into the soil of the bench through the drainage hole in the bottom of the pot. Being thus buried in the soil the little pots do not dry out as rapidly as they would do were they exposed to the air.

MARKETING.

The plants may be marketed without disturbing their roots and for this reason they keep fresh for a longer time than do the plants whose roots are disturbed in preparing them for market. See Plate X. When the plant is ready for market it may be knocked out of the pot and the ball of earth containing the roots undisturbed may be wrapped snugly in oiled paper. The earth will thus keep moist for a long time and furnish moisture to the plant through the roots which are inbedded in it. Local customers may be supplied with lettuce in the pots and the pots returned after the plants are taken from them.

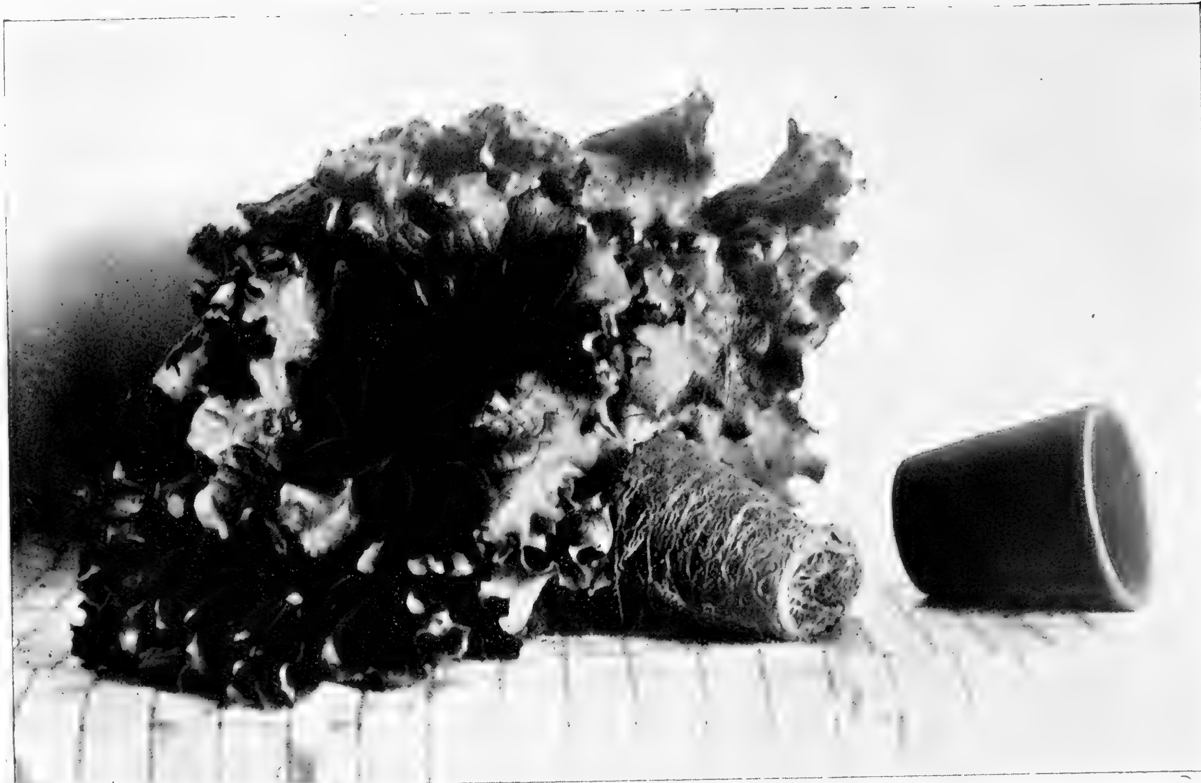


PLATE X.— Lettuce grown in a two inch pot.

Grocers and other retail dealers readily appreciate the advantages of having lettuce grown in this way. It permits them to keep the lettuce on hand for a considerable length of time and still present it to their customers crisp, fresh and attractive instead of wilted and unattractive.

The moment a pot is removed from the bench another may immediately be set in its place without waiting to clear the bench, or any portion of it, of the rest of the lettuce. The method thus proves economical both of time and space.

This method will undoubtedly commend itself to growers who are forcing lettuce to a limited extent. Whether it can be employed to advantage by those who have extensive houses devoted to lettuce can be decided only by trial.

VARIETIES.

The varieties of lettuce selected for forcing must, in general, be determined by the market demand, and it should be the aim of the grower to furnish what his market calls for, rather than what he may think it ought to have. The following varieties have been forced satisfactorily in the Station houses.

Big Boston is a large head lettuce. It requires more room than most other kinds which we have forced. The plants are set a little more than ten inches apart each way. It is a rather slow grower; pale green in color. One of the best large cabbage lettuces for forcing that we know.

Salamander is a light green, curled, cabbage lettuce not quite so large as Big Boston but more rapid in its growth and very satisfactory when forced. Set plants ten inches apart each way.

Drumhead is an upright, light green, slightly curled, early maturing, cabbage lettuce which forces well. It is not quite so large as Big Boston. Set plants ten inches apart each way.

Henderson's New York was tested for forcing this winter with good success. It is an upright, curled, cabbage lettuce of good size but not so large as Big Boston. Its color is rather dark silvery green when grown outdoors but it has a lighter color when forced.

Grand Rapids is one of the best of its class for forcing. It does not mature quite so rapidly as some other varieties do. It is not a cabbage variety but forms a loose head. The leaves are much curled and of a pale green color. The plants are set ten inches apart.

Hanson.—A curled variety of an attractive light color, that forces well. It is not a cabbage lettuce but forms a rather loose head. Plants are set ten inches apart.

New Iceberg.—A handsome curled lettuce with paler foilage than Henderson's New York and not so compact a head. It forces well. Set plants ten inches apart.

Golden Ball is a dwarf cabbage lettuce, pale green in color, slightly tinged with yellow, making a very beautiful and attractive lettuce when fresh and well grown. It forces satisfactorily but does not head quite so early as the Golden Queen. Set ten inches apart.

Golden Queen has less of the yellow tinge in its foliage than has the Golden Ball but it heads more rapidly than that variety. It is also a dwarf cabbage lettuce that forces well. Set ten inches apart.

Prize Head forces well but it belongs to the class having reddish brown leaves and on this account not commonly used for forcing. This variety is tinged with brown when young, but becomes lighter and has but a slight red tinge when mature. It is a curled, garnishing lettuce, quite attractive in appearance when fresh and well grown. It is not a cabbage lettuce, but forms a rather loose head.

Other varieties that we have tried are on the whole no better or not so good as the varieties described above. Some do not come well from seed, or can not be relied upon for uniform results after they are transplanted. Some are less attractive in form or color than are those named above. Some have their leaves too close to the soil so that they are liable to become soiled or blighted, thus injuring their appearance and making it necessary to trim them before sending them to market. Some are peculiarly subject to blight along the edges of the leaves. Those which are described above have all done well here, and include representatives of most of the different types of lettuce except the cos or romaine varieties.

While the subject of forcing is thus under consideration a few hints on the care of a crop may not be amiss.

1. The temperature should be kept down to from fifty to sixty degrees during the day and forty-five to fifty during the night. A higher temperature favors a more rapid growth, but the

plants produced in a higher temperature have a tendency to a spindling growth, and to lack the crispness and compactness of lettuce grown in a cooler temperature. Plant lice become more troublesome in a higher temperature than in a moderately cool temperature. Extremes of heat or cold should be avoided, as also should rapid fluctuations from one extreme to the other.

2. As much ventilation should be given as possible and still keep the temperature within the range just given. The crop succeeds best when it is given plenty of fresh air.

3. So far as possible water only on bright, sunny days, preferably early in the day, when the houses may be ventilated freely so that the leaves, and especially the tender hearts, will soon dry. Water standing on the leaves a long time offers favorable conditions for the development of blight. Of course this caution does not apply where sub-irrigation is practiced.

4. The aphis (green fly) should not be allowed to get established on the plants. Just before the pot is plunged into the soil it is turned upside down and the under side of the leaves, as well as the upper surface, is dusted thoroughly with tobacco dust. The plants are not watered over head for three or four days afterward to avoid washing off the tobacco. About a week later they are dusted with tobacco again, taking especial care to cover thoroughly the tender foliage in the center of the plant. By free ventilation and keeping the temperature cool, and by watchful care of the plants, not waiting for the aphis to get established before fighting them, a lettuce house has been run at this Station all winter without fumigating once. Fumigation should be used only as a last resort. Neglecting the ventilation, neglecting the heating and neglecting the cleanliness of the house and plants in general may be expected to lead rapidly to conditions where the only remedy is fumigation.

SUMMARY.

The growing of lettuce in pots is believed to have several advantages over growing it in benches, namely:

1. Plants may be marketed without disturbing their roots, and so may be kept perfectly fresh for a long time, an advantage that is much appreciated by retail dealers.

2. As soon as a plant is removed from the bench its place may be immediately filled with another potted plant, so that the entire bench room may be kept constantly occupied.

The method may be briefly outlined as follows:

The bench, six inches deep, is half filled with well-rotted manure, over which is spread three inches of soil.

The soil is made of one part by measure of manure to three parts of rotted sod. Should the sod be from a heavy loam it is made lighter by adding one part by measure of sand to three parts of sod.

The plants are transplanted but once and that is from the seed flats to two inch pots.

The pots are plunged into the soil on the benches so that the tops are covered with nearly half an inch of soil.

The distance between the plants on the bench varies with the variety, but is usually ten inches each way.

Before the pot is plunged in the soil it is turned up side down and the under side of the leaves thoroughly dusted with tobacco to prevent attacks of aphis. The upper side of the leaves is then dusted with tobacco and about a week later the plants are dusted again, being especially careful to apply the tobacco thoroughly in the tender centres of the growing plants.

As to the care of lettuce under glass it may be said that:

The house should be kept at a cool even temperature, running a few degrees above fifty in the day and remaining at fifty or a little below at night.

Sudden fluctuations from high to low temperature or vice versa should be avoided.

The plants should have plenty of fresh air especially on sunny days when the temperature is high outside.

When the plants are watered over head it is best to select a time when the foliage will dry quickly. Avoid watering so late in the day that the plants will not dry before night.

The following varieties have forced well at this Station:

Cabbage lettuce:

Big Boston, large.
Salamander.
Drumhead.
Henderson's New York, curled.
Golden Ball, dwarf.
Golden Queen, dwarf.

Varieties forming loose heads :

Grand Rapids, curled.
Hanson, curled.
New Iceberg, curled.
Prize Head, curled, tinged with reddish brown.

MUSHROOMS AS A GREENHOUSE CROP.

Within the last two years many inquires concerning the growing of mushrooms have come to this Station, showing that in various parts of the State there is an increasing demand for information on this subject. At present many gardeners are not giving mushrooms the attention they deserve as a secondary crop for utilizing space under greenhouse benches. It is a crop particularly adapted for growing under benches, if the heat is not too great, or in cellars, or other dark apartments, for mushrooms develop readily in the dark as well as in the light.

This article has been prepared for the purpose of giving an account of some methods which have been successfully followed in growing mushrooms in the Station greenhouses, together with a few suggestions for the benefit of gardeners not familiar with the ordinary methods of growing this crop, who are looking for some profitable way of using the space under their greenhouse benches. The account does not pretend to be an exhaustive treatise on mushroom culture, neither does it present anything new to horticultural science. Those who wish to secure more detailed instructions than can be attempted here should consult some of the standard books on mushroom culture.

The extent to which gardeners may engage in mushroom growing with prospects of fair remuneration must depend largely on local conditions, chief among which is accessibility to a good market. Those who are inexperienced, either in growing or in marketing this crop, should not attempt its cultivation on a very extensive scale till they have learned something about the business. Although good directions for growing mushrooms may be secured from an experienced neighbor, or from some reliable publication, it should be remembered that skill is born of training and experience, and can be imparted neither by printed page nor by word of mouth. In growing mushrooms, as in all other work connected with gardening, a certain degree of skill is essential to permanent success and this cannot be gained without experience. Sometimes even experienced growers do not secure good results from their beds on account of poor spawn or failure of some sort in securing the conditions most favorable to the development of the crop. Faithful attention to what may appear to inexperienced growers to be trifling details, is essential to success. The novice may consider these details unimportant, but experience teaches the contrary and impresses the lessons so thoroughly that they are not forgotten in a day as may be the case with some point in printed instructions which he is following.

Gardeners who are forcing vegetables in the vicinity of villages and small cities where mushrooms are seldom seen in winter market, will probably find that an effort to bring this luxury to the attention of their customers will result in a considerable demand for mushrooms at paying prices. During the winter of 1893-4 all of the mushrooms that were sold from the Station greenhouses brought one dollar per pound in the local market and at this price the demand exceeded the supply. The beds yielded on an average about three-fourths of a pound per square foot of surface. Some idea of the market prices in New York city during the same period may be gained from the following quotations taken from *Garden and Forest.*

December 27, 1893. One dollar per pound.

April 11, 1894. Fifty cents per pound. Mushrooms are just now a little higher but all winter long the wholesale price has been steady at about fifty cents per pound.

May 2, 1894. Mushrooms are now plentiful at fifty cents per quart.

December 5, 1894. Mushrooms are in rather short supply and command $1.25 per pound.

Mushrooms were grown in two of the greenhouses at this Station during the winter of 1893-4. In one, the main crop was tomatoes. It was heated with hot water, having two flow and two return pipes under the side benches, and no pipes under the center bench. The space under the center bench was used for the mushroom beds. The temperature was varied somewhat during the day to suit the different stages of development of the main crop, usually being kept between 60 and 70 degrees, Fahr. At night the temperature was kept as nearly as possible at 55 degrees, Fahr., but occasionally, on account of insufficient heating capacity, it dropped below 50 degrees.

In growing mushrooms we prefer not to have the temperature drop below 50 degrees.

The other house was piped under the side benches in the manner just described for the tomato house, and in addition there was a single pipe around three sides of the center bench. This pipe was set on brick pillars, which raised it about two inches above the surface of the bed. See Plate XI. The temperature of this house was kept about the same as in the tomato house during the day and about five degrees higher than that house during the night.

While a temperature of less than fifty degrees is not fatal to a mushroom bed, still it is commonly held that the crop does better if the temperature is kept above fifty degrees Fahr. When the bed is first spawned its temperature may run as high as ninety degrees. Spawning beds at even higher temperature has been successfully practiced, but we do not recommend the practice. Mushrooms have been successfully grown where the temperature of the houses runs up to seventy degrees or more in the sun, but, notwithstanding all this, it is generally conceded that the crop thrives best in a temperature of from fifty to sixty degrees, and that it delights in a cool, even temperature and in a moist, but not wet, soil. At less than fifty degrees the crop does not thrive, although the spawn in the soil may endure a temperature below freezing without being killed, for mushrooms grow wild in the fields in this climate.

PREPARATION OF THE SOIL.

In preparing the soil for the beds fresh horse manure was mixed with loam in the following manner: The fresh loam was piled in a shed, where it was sheltered at all times from rain, great care being taken to keep it from getting wet. The manure was secured each morning from the stables and taken to the shed. Here it was carefully mixed with the loam, using three shovelfuls of manure to one of loam, piled alternately in thin layers. It was kept in a separate pile for two days and then thrown into the general pile. This process was continued until the desired amount of soil was thus accumulated. Both the general and the separate piles were turned each day so as to thoroughly mix the soil and manure and also to prevent too rapid fermentation or too great heating. This process of mixing was continued each day till it was thought that there was no longer danger that it would heat too much, or fire fang, after being packed firmly in the bed. It will be noticed that when the prepared manure has reached the proper stage just referred to, and is ready for the bed, that it has lost most of its former rank odor, and although it is moist, it is not wet, and when wrung or twisted, leaves no stain on the hands. If the weather is quite cold it will not be necessary to turn the manure as often as once a day, but it may be left two or three days or perhaps longer. If the object of turning the manure be borne in mind there should be no difficulty in preparing it properly. The manure is turned to facilitate the escape of steam or excessive moisture and to check too rapid heating.

PREPARATION OF THE BED.

The beds, located under the center benches of the greenhouses as before stated, were inclosed with rough boards eight inches wide and one inch thick. The boards were set on edge and raised slightly above the floor so that with a bed ten inches thick the top of the bed would not extend much above the upper edge of the boards.

Fresh manure was secured daily from the Station horse stables and mixed with soil as explained on a previous page. As fast as a sufficient amount of properly prepared manure accumulated it was at once taken to the greenhouse and a section of the bed about ten feet long was filled with it. The beds were seven feet wide. A layer of the prepared manure was spread evenly over the bottom of the bed to the depth of about three inches and this was then firmed by pounding with a brick. Simply pressing the manure does not make the bed as firm as desirable, neither does the bed need hard pounding, but it should be pounded enough to make it firm and still leave it somewhat elastic. In places where beds are located so that it can be done, the firming is done by treading with the feet, but for beds under greenhouse benches the method just described is a good one.

After the first layer was firmed it was covered with a second layer of about the same thickness, which was also made firm by pounding. A third layer was then added in the same manner, making the bed about eight inches thick. A thermometer was then buried in the bed and nothing more was done till the temperature ceased to rise above ninety degrees Fahr.

SPAWNING THE BED.

After it was found that the temperature remained below ninety degree Fahr, the bed was spawned, using either the "French" spawn or the "English" spawn as desired. The French spawn is prepared in loose flakes, the English spawn is prepared in bricks. The spawn is imported by seedsmen from whom it may be obtained.

The bricks from different sources are not always of the same size, but the ordinary weight for a brick is one pound and the dimensions are a little more than eight by five inches and one and a quarter inches thick. Sixteen of these bricks make a bushel. A brick of this kind is broken into a dozen pieces, nearly uniform in size, which are inserted in the bed about nine inches apart so that the top of each piece is at least an inch below the surface. The manure is then packed firmly over the pieces leaving the surface of the bed smooth as before. The flake spawn is used in a similar manner.

COATING WITH SOIL.

About two weeks after the beds were spawned they were coated two inches deep with fine mellow loam. Many gardeners prefer for this purpose loam taken from sod ground but commercial growers do not hesitate to use garden soil, or soil from plowed fields when it is more convenient. The loam should neither be dry nor wet, but simply moist. The coating of loam is not applied till the spawn begins to spread in the manure. When the spawn begins to spread it can be seen like a filmy, white, or bluish white, mold growing from the pieces of brick or flakes that were planted, and extending into the surrounding manure.

The beds were then covered with excelsior two or three inches deep to keep the surface of the soil from drying. A roof of heavy paper was made over the bed to protect it from the drip from the benches overhead. The strips were passed over a wire running under the centre of the bench and the ends were fastened to nails in the side of the bed by loops of twine. It is believed that this paper roof was of some advantage also in protecting the bed from draughts and helping to keep an even condition of moisture and temperature.

WATERING.

Whenever the surface of the soil commenced to look dry it was syringed with water, at 100 degrees, sufficiently to wet the soil.

Care was always taken that the surface of the bed should not get dry. When the bed was watered care was taken not to put on so much water that it would soak through into the manure below.

The excelsior was rolled back so as to uncover the bed and the water was applied with a syringe, having a fine rose, after which the excelsior was returned to its place. The excelsior was sometimes sprinkled to check evaporation from the surface of the bed and to help in keeping it moist.

NITRATE OF SODA.

After the beds began to bear they were watered twice a week with nitrate of soda dissolved in water, at the rate of an ounce to a gallon of water. It was applied in a fine spray in sufficient quantities to moisten, but not to soak, the surface of the bed in the manner above described.

SECOND CASING.

When the beds were past full bearing and the production of mushrooms was on the decline, they were coated over again with fine mellow loam to the depth of half an inch or more. This second coating is simply pressed or pounded lightly so as to make the soil compact. In watering this coating the customary caution was used so as not to put on enough water to soak through into the manure underneath. After being treated in this way the beds frequently bear a considerable quantity of mushrooms before they become exhausted.

* * * * * * *

The foregoing account has not been given with the idea that it is the only way mushrooms can be successfully grown in green-houses but simply to set forth somewhat in detail one method which has been successfully followed. As indicated below the details may be varied somewhat to suit circumstances.

Mixing loam with manure.— In preparing the manure for the mushroom bed it is not essential that loam be mixed with the manure. In the instance given above, fresh horse manure was secured each day and the loam was mixed with it to absorb the surplus moisture and the ammoniacal substances that might be rendered volatile during the fermentation of the manure. The soil also acts as a check to too rapid fermentation.

Many mushroom growers do not make a practice of mixing loam with the manure in this way. They throw the manure into a heap, using urine-soaked straw as well as the manure, and wetting those portions of the straw or manure which are very dry. This manure is turned in the manner before described, or even less frequently should the fermentation not be so rapid as to demand turning the heap every day. When the manure is in proper condition for the beds it is, as described for the mixture of manure and loam free from rank odors and excessive heat, and is moist without being so wet that wringing with the hands will leave any stain. It is then made into beds in the manner described for the mixture of manure and loam. Horse manure is much prefered for this purpose, though manure from other animals has been used successfully for growing mushrooms. If the manure is not perfectly fresh, it should, at least, be fresh enough to heat up rather briskly when thrown into heaps to prepare it for the beds.

American Spawn.— Sometimes the question is asked whether or not spawn can be prepared in this country. Certainly it can, but it is usually cheaper to buy imported spawn than to prepare it. (See American Made Mushroom Spawn, S. Edward Paschell, Gardening, Vol. II, p. 264 and Vol. III, p. 27).

Keeping Spawn.— Spawn may undoubtedly be kept over from one season to another without perishing, but we greatly prefer to use fresh spawn. However well preparations may be made for growing mushrooms, good results can not be hoped for if the spawn is poor. While under favorable conditions spawn may be kept alive for an indefinite length of time, yet it is thought that freezing the spawn in the brick or flake will injure it, as will also keeping it in too moist an atmosphere. For these reasons it is best to get spawn from reliable dealers with their assurance that it is fresh.

Coating the Beds.— Opinions differ as to the best time for putting the coating of loam over the beds after they are spawned. We prefer in greenhouse work to wait about two weeks or until the spawn begins to spread through the manure, before coating the beds with loam.

Covering the Beds.—In the case described above, excelsior was used for this purpose because there was sufficient supply of it on hand and because it is clean; but ordinarily clean straw is used. When there is no danger of water dripping on the beds the roof over the beds may be dispensed with.

Putting Beds near Hot Pipes.—Where heating pipes run under the benches the question may arise whether or not the temperature under these benches would be so great as to interfere with the successful growing of mushrooms. The space under the center bench of one house at this Station was used for growing mushrooms as stated on page 333 and yet a single pipe about two inches above the top of the bed passed under three sides of this bench. It was a hot water pipe three inches in diameter. Sphagnum was packed in the bed immediately underneath this pipe and the bed was watered as often as was necessary to keep the surface moist. Under these conditions mushrooms were grown successfully very near to the pipes as shown in Figure 13, Plate XI, which is reproduced from a photograph of a portion of this bed. In this case the results were quite satisfactory, showing that mushrooms may be grown under benches near heating pipes. At the present writing, during the winter of 1894-5, mushrooms are being grown at this Station under side benches, although the bed is built next to two flow and two return pipes for hot water, the pipes being three inches in diameter. An inch board back of the bed separates the bed from the pipes. The bed is about a foot wide and ten inches deep, enclosed with inch boards.

While it is true that mushrooms may be grown next to heating pipes, yet space under benches where there are no heating pipes is preferable to a location where the heating pipes are in contact with, or in close proximity to the bed.

Picking.—Mushrooms should be gathered as soon as the cap expands and while the gills are of a dull pink color. If left too long the gills become black and the mushrooms are not then so attractive and fresh looking as they are if picked soon after the cap expands and while the gills are still pink.

As grown in beds mushrooms sometimes come up singly, but they very frequently grow up in groups or clusters so close together that great care must be taken in gathering the mature mushrooms not to disturb the immature buttons which are growing up with them. It has been found that it is better to break or twist off the mushrooms at the surface of the soil rather than cut the stalks. With a little practice this can be done without disturbing the rest of the cluster. When the stalks are cut the stump that is left is liable to rot and spread the rot to the surrounding spawn, or buttons.

Mushrooms are apt to come up in clusters, and it frequently happens that full grown specimens and buttons are so closely attached together that one can not be removed without taking the other with it. Examples of this kind are illustrated in figures 6, 8 and 10, Plate XI. On this account the gathered mushrooms, although consisting mostly of freshly opened specimens, may also show all stages from buttons to fully expanded mushrooms.

After the mushrooms are picked they are then sorted for market, so that each package will contain specimens nearly uniform in size, so that if a customer wants only large mushrooms he can get them without either taking small ones or sorting different packages, and if he wants buttons he can get them without taking fully developed mushrooms. If the mushrooms are well sorted and put in packages of a size adapted to the demands of the customers they need not be disturbed after they are packed till they reach the customer.

Different stages in the development of mushrooms are shown in Plate XI. Figures 10, 11 and 12 illustrate specimens of mature mushrooms. The upper expanded portion is called the "cap," from the under side of which are suspended the "gills," like thin, delicate leaves, as shown on the under side of the cap in figures 9 and 10. When the mushrooms are fresh the gills are of a dull pink color. The part which extends from the ground to the cap supporting the cap is called the "stalk." On the stalk a short distance below the cap is a rather ragged ring, showing where the veil was attached to the stalk (see figure 10). The name "veil" is given to the thin covering which, in the button stage, extends from the circumference of the cap to the stalk, completely hiding the gills, as shown in figures 7 and 8. In figure 9 it will be noticed that the cap has expanded sufficiently to partly rupture the veil. From the time the mushrooms first appear above ground till the cap expands so as to break the veil they are called "buttons." Buttons are shown in figures 1 to 8, and the stage intermediate between buttons and fully developed mushrooms is illustrated by figure 9. Figure 12 shows the upper side of a cap.

The spores of the mushrooms correspond to the seeds of higher plants. In the case of the mushroom commonly cultivated these are borne on the gills. The spores may be collected in great numbers by simply cutting the cap from its stalk and setting it gills downward on a piece of paper, where it is left for a few hours. On lifting it from the paper it will then be seen that an outline of the gills, made of fine dark colored powder, appears on the paper where the cap rested. This powder consists of the spores of the mushroom. It thus appears that the mushroom is the fruit of the

EXPLANATION OF PLATE XI.

Figures 1 to 8, Mushroom buttons.

Figure 9, Mushroom showing the breaking of the veil by the expansion of the cap.

Figures 10 to 12, Mature mushrooms.

Figure 13 Mushrooms under greenhouse bench, growing near hot water pipe.

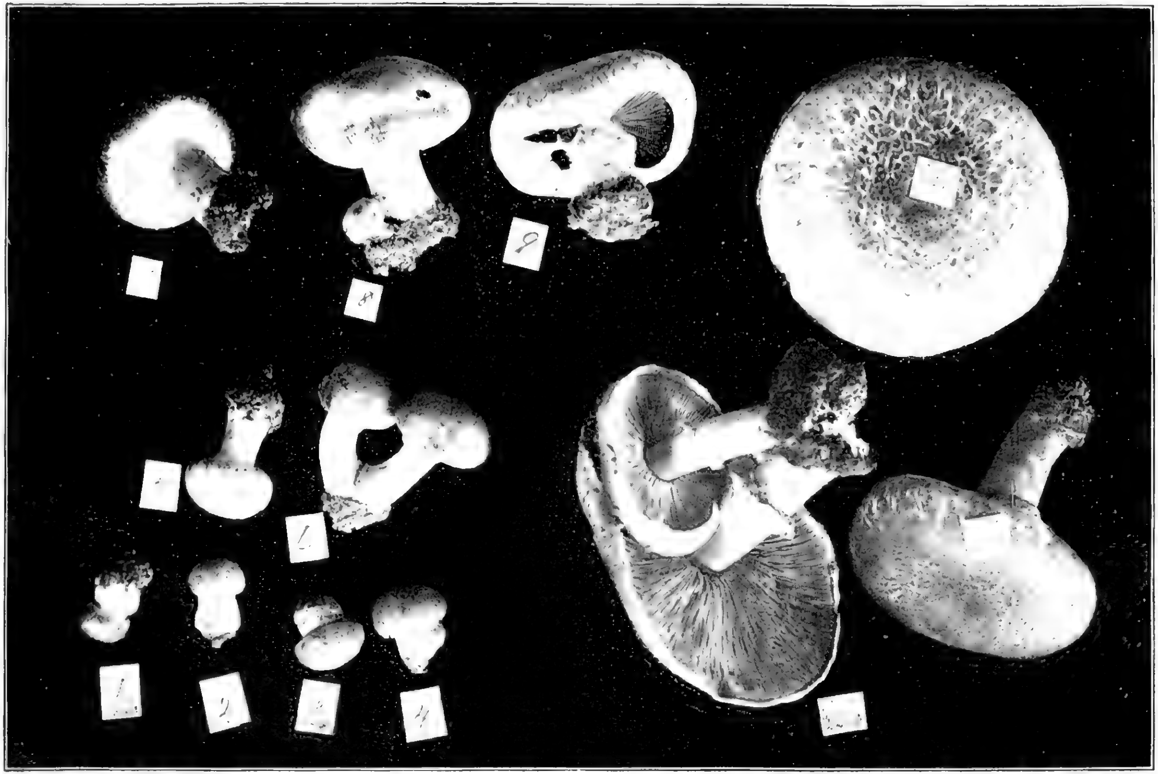


PLATE XI. Figures 1 to 12 illustrate different stages of growth of the common mushroom, *Agaricus campestris*.

Plate XI.—Figure 13. Mushrooms growing near a hot-water pipe.

plant and bears the seed, while the real mushroom plant is the spawn that runs through the manure and soil, taking its nourishment from the organic matter it finds there.

MUSHROOMS AS FOOD.

The scientific name of the commonly cultivated mushroom is *Agaricus Campestris.* As is commonly the case with fresh vegetables, this mushroom contains a large per cent. of water, so that a pound fresh and uncooked shows on analysis much less food material than a pound of beefsteak. An analysis of the dry material shows that they contain a very high per cent. of nitrogenous compounds. In making up a bill of fare it should be remembered that they fall into the same general class of foods that lean meats or beans do. This is shown by the following analysis of mature mushrooms and buttons of *Agaricus Campestris* made at this Station:

	Mature.	Buttons.
Moisture...........	91.80 per cent.	90.33 per cent.
Dry Matter.........	8.20 per cent.	9.67 per cent.
The dry matter contains:		
Ash	12.37 per cent.	11.96 per cent.
Nitrogen Total......	9.43 per cent.	9.30 per cent.
Nitrogen Albuminoid	5.01 per cent.	5.34 per cent.
Albuminoids........	31.31 per cent.	33.38 per cent.
Fat................	3.72 per cent.	3.19 per cent.

With this analysis may be compared the following statements of the amount of albuminoids and fat in sirloin steak and beans:

	Sirloin Steak.*	Beans.†
Moisture...........	60.00 per cent.	12.6 per cent.
Dry Matter.........	40.00 per cent.	87.4 per cent.
The dry matter contains:		
Ash...............	1.55 per cent.	3.54 per cent.
Albuminoids	29.01 per cent.	26.43 per cent.
Fat................	31.72 per cent.	2.28 per cent.

PREPARING MUSHROOMS FOR THE TABLE.

Mushrooms are used to a comparatively limited extent in this country, and consequently many American cooks have had little or

* U. S. Dept. of Agr., Farmers' Bulletin No. 23, p. 26.
† U. S. Dept. of Agr., Farmers' Bulletin No. 23, p. 27.

no experience in preparing them for the table. The following receipts are suggested:

Baked Mushrooms.—Remove the skin and upper portion of stem; invert them and place bits of butter, with salt and pepper, upon them. Add water enough to prevent burning; place in a dripping pan and cover closely in order to preserve the flavor. A quick oven will steam them sufficiently in one-half hour, if the mushrooms are of medium size. When done place them upon hot buttered toast and serve on a hot water plate.

Steamed Mushrooms.—Remove the skin from mushrooms and place them in a stew pan, with a cup of hot water poured over them. Season well with salt and pepper, and butter sufficient to brown them after the water has evaporated; then cover the stew pan and allow the mushrooms to cook till tender, adding more water if necessary. The cover is then removed and the water is allowed to evaporate. They brown very rapidly and require very close watching.

The following method of preparing mushrooms for the table has the merit of preserving the aroma and flavor. It is taken from Cook's Edible and Poisonous Mushrooms:

Baked Mushrooms.—Lay the mushrooms, when wiped, sliced or otherwise prepared, in a shallow dish, sprinkle with salt and pepper, place a small piece of butter on each, cover closely with a plate and place in an oven so that they are cooked gradually and all of the aroma and flavor is retained. Serve them hot in the same dish and without uncovering.

RASPBERRY ANTHRACNOSE.

A preliminary account is given of an experiment for the prevention of the anthracnose of raspberries in Bulletin No. 81 of this Station, and in the Annual Report, 1894: 574 and 684. It is there stated that a plantation of three acres of Gregg raspberries on the farm of Mr. S. A. Hosmer, Clifton, N. Y., was treated for the prevention of this disease. At one time the plantation consisted of twenty-five acres, and raspberries was one of the principal products of the farm. Of late years the crop has become unprofitable through the ravages of anthracnose, and the canes have been killed out until now but three acres remain. When these plants were first seen in the spring of 1894 they were very badly affected; on nearly every cane were large diseased spots and scabs.

The plan of the experiment may be briefly outlined as follows: The first treatment was made before the leaf buds opened, so that stronger solutions could be used, without doing injury, than would be possible after the leaves had expanded. Solutions of different materials were used, so that a comparison might be made as to their effectiveness. Accordingly, the first three rows were sprayed with a solution of copper sulphate, three pounds to eleven gallons of water; the next three with a saturated solution of iron sulphate, while the next three rows were left untreated for comparison. This plan was continued throughout the plantation, with the exception of the last two rows, making in all eighteen rows treated with the copper solution, fifteen rows treated with the solution of iron sulphate, and fifteen untreated or check rows.

Early in the spring before the leaves started one of the last two rows was sprayed with a ten per cent. solution of sulphuric acid, and the other with a solution made up of ten parts of a saturated solution of iron sulphate to one part of sulphuric acid. After this time all treated rows were sprayed alike with Bordeaux mixture, using one pound of copper sulphate to make eleven gallons of the mixture.

In 1894 the plantation was sprayed six times on the following dates: April 18th, May 1st, May 16th, May 30th, June 21st and August 9th.

Notes taken at various times throughout the season show that the treatment was effective. The place was visited on November 22d, when it was found that the canes in the treated rows were nearly free from disease, while those that were not sprayed were still very badly affected.

The plantation was given the same treatment throughout the season of 1895. The first spraying was given on April 26th, just as the leaf buds began to swell. The second treatment was begun on the 11th of May, but on account of rain it was not completed until the 13th; at this time the new canes had just begun to grow. On May 24th a third spraying was given; the largest of the new canes were now twelve to fourteen inches high. At this time it was noticed that the two rows which had been treated with sulphuric acid had been seriously injured by the application. A fourth treatment was given on June 10th. A few of the characteristic spots of anthracnose were now noticed for the first time on the new canes in the untreated rows, showing that the disease was spreading very slowly.

June 24th the fifth treatment was made. It was again noted that the disease was spreading but little on the unsprayed plants, and scarcely any could be found on the treated canes. As soon as the fruiting saason was over the old canes were removed from all the rows and the sixth spraying was given August 15th.

Observations made on November 19th show that the canes in the sprayed rows were nearly free from disease, and since the removal of the old canes in August but comparatively little disease is to be found in the untreated rows. The extremely dry weather of the past season was unfavorable to the spread of most plant diseases. It has been Mr. Hosmer's previous experience that the third year the crop would be much lessened, and the fourth year it would be almost an entire failure. Unfortunately for experimental purposes the past two seasons have been exceptions in this respect, and the gains resulting from the treatment are not as marked as could be desired. Although the fruiting canes in the sprayed rows had the advantage during the season of 1895 in being almost free from disease, yet the gain from the increased yield of the treated over the untreated rows was slight.

The results obtained in 1894, clearly indicate that the anthracnose of black raspberries can be successfully combated with Bordeaux mixture. The least number of treatments necessary to do this have not been determined. In 1895, the rows that were sprayed with iron sulphate before the leaves expanded bore a larger amount of fruit than any of the other rows. Further experimenting however will be necessary to determine the value of the early treatment with strong solutions. It is certain that the sulphuric acid treatment is too heroic to be used on raspberries.

As was stated above, the exact number of sprayings necessary to prevent the spread of anthracnose has not been determined, nor can it well be since no two seasons are alike, but from observations made during the past two seasons we feel warranted in making the following recommendations: Give the new canes three sprayings with Bordeaux mixture beginning when the largest of them are about six inches tall. Let the other applications follow at intervals of about two weeks. The spray should be directed at the young canes alone, since they are the only parts of the plants that need protection. The work must be thoroughly done and care must be taken that the Bordeaux mixture is properly made. When the disease is severe the old canes should be cut out and removed from the field as soon as the fruiting season is over. In any case it is to be presumed that the best of attention will be given to cultivation.

Mr. Hosmer's plantation will be treated during the season of 1896 in the same manner as before, and the results obtained will be published at the close of the season.

IV. TREATMENT OF COMMON DISEASES AND INSECTS INJURIOUS TO FRUITS AND VEGETABLES.

This subject is here discussed for the purpose of giving plain directions for treating some of the common diseases and insects injurious to fruits and vegetables in New York State, either by spraying or otherwise. It is composed of four articles, namely:

1. Common Diseases and Insects Injurious to Fruits.
2. Common Diseases and Insects Injurious to Vegetables.
3. Common Diseases and Insects Injurious to Nursery Stock.
4. Fungicides and Insecticides.

By consulting the index the reader will readily find any subject that is here treated. The principal subjects in each article are presented in alphabetical order and under each fruit or vegetable the diseases are first considered and then the insects.

An account is first given of the common appearance or characters of the disease or insect and of the injuries caused by it whenever it is thought necessary to do so in order that the reader may know just what insect or disease is meant. Then a remedy or line of treatment is "recommended" or "suggested." Nothing is "recommended" that has not proved good under trial. Remedies or lines of treatment are simply "suggested" whenever they have not been tested sufficiently to permit of their being confidently recommended. Recommendations quoted from other authors are given simply on their authority. In describing the appearance of insects or giving their life histories Saunder's Insects Injurious to Fruits has been freely consulted. Other authors are given credit in foot notes.

1. COMMON DISEASES AND INSECTS INJURIOUS TO FRUITS.

Apple.

APPLE SCAB.—Apple scab is the name commonly given to the dark rough spots that are frequently found on the surface of the fruit varying in size from small dots to large blotches that make the fruit one-sided, frequently causing it to crack open and rendering it especially liable to decay. Some varieties, like the Fameuse and Fall Pippin are particularly subject to this trouble; others, such as Maiden Blush, for example, are comparatively free from it.

The scab is caused by a fungus which grows on the leaves as well as on the fruit. Attacking, as it does, both leaves and fruit, in many instances it undoubtedly causes a serious dropping of fruit that otherwise might develop into perfect specimens. There is a dropping of fruit soon after blossoming which is the result of the process of discarding the superflous fruits in the clusters. This is a natural occurrence with perfectly healthy trees, and should not be confounded with the later dropping which may be caused by insect or fungous attacks.

The scab fungus may attack either the upper or under side of a leaf. When in an active condition it appears in spots like a very dark green velvety mould or spreads in irregular threads near the veins or over the surface of the leaf causing it to become crumpled. In connection with severe attacks the leaves turn yellow and fall in great numbers, a result for which the scab fungus is no doubt largely, though not always wholly, accountable. The fungus feeds on the leaf or fruit, causing the portion that is attacked to die. When the infested leaves do not fall the dead parts may become dried, break and fall away leaving the leaves ragged. If the fruit is not attacked too severely it will heal under the dead skin leaving a russet brown scar after the dead skin falls away.

This somewhat lengthy description has been given that the reader may know just what disease is called "apple scab" and something of the nature of the injury it inflicts on apple foliage and fruit.

Remedy.—As explained quite fully in Bulletin 84 of this Station, it has been determined that three treatments with Bordeaux mixture, 1 to 11 formula, will control this disease even in a very unfavorable season. The manner of preparing the Bordeaux mixture is given in article 4 on Fungicides and Insecticides. The treatments should be made as follows:

1. After the buds break but before the blossoms open.
2. As soon as the blossoms have fallen.
3. From ten to fourteen days after the second treatment.

Paris green or London purple may be used with the Bordeaux mixture in fighting injurious insects, as stated hereafter. The trees should not be sprayed while in blossom, for the spray may injure the delicate parts of the flower, and the poison may kill the bees and other insects that play an important part in fertilizing the blossoms.

Borers.—The insects known as borers are the larvæ, or grubs, of beetles. The female beetle lays its eggs on the trunks of the trees, where they hatch in a few days. The larva at once gnaws its way into the sapwood, where it feeds on the tender wood next to the bark. One species lives in the tree three years. They may do great damage, especially to young trees, which are sometimes girdled and killed by them. The trees should be examined at least once a year, that the borers may be dug out and killed. This is done with a knife, or they may be killed by inserting a piece of copper wire into the hole. They should be looked for at the base of the tree or just below the surface of the ground. Their presence may be detected by the darker colored bark and by their castings.

Bud Moth.—The adult insect is a small gray moth that lays its eggs in the summer. The eggs soon hatch, and the larvæ at once form a web on the under side of the leaves where they feed. According to Slingerland, they pass the winter as half grown larvæ in silken cases attached to the twigs. They come forth in the spring as small brown caterpillars, and begin their attacks as soon as the buds begin to unfold.

The caterpillar works its way to the centre of the bud, where it feeds on the young leaves or flowers. Spray should be applied to the trees when the buds begin to open,[1] for when the caterpillar is once inside the bud it immediately begins to form a covering by tying the leaves together with a web. When thus covered it is very difficult to reach it with the spray.

Remedy.—Where an orchard is badly infested it will pay to spray with Paris green as the buds begin to open, using one pound for from one hundred and fifty to two hundred gallons of water. A second treatment with Paris green should be made within a few days especially if rain falls so as to wash off the first application. If it is desired to treat the trees for apple scab, Bordeaux mixture may be combined with the Paris green for either of the above treatments, but only one treatment with Bordeaux mixture for apple scab need be made before the blossoms open.

---

1 Bulletin 50, Cornell Experiment Station: 27.

CANKER WORM.—After the codling moth, the canker worm is perhaps the next worst insect enemy of the apple grower. There are two forms of this insect, known as the Spring Cankerworm and the Fall Cankerworm. They resemble each other in general appearance, and in the injury that they do. When an orchard is badly infested nearly every leaf may be stripped from the trees. When left undisturbed the insects increase rapidly from year to year and do serious damage. The eggs of both species hatch when the buds are unfolding and the little worms at once begin feeding on the tender leaves. They are commonly known as loop worms, or measuring worms. When first hatched the worms are very small and of a light green color, so that they are not readily seen. They grow rapidly, and when mature are about an inch long, varying in color from light green to brown. They now drop from the trees by a thread and go into the ground, where they enter what is termed a resting stage. Most of the Spring Cankerworms remain in the ground in this form over winter and in the spring the mature insect emerges as a moth. The female is wingless and is slow and awkward in her movements, so that it is difficult to believe that she is related to the graceful flying male. The moths come out of the ground in greatest numbers after the ground begins to get warm in the spring, but some of them appear before the snow has gone. After emerging from the ground, the females at once crawl up the trees to lay their eggs.

In the case of the Fall Cankerworm the moths issue from the ground in the fall, when the female lays its eggs on the twigs. As mentioned above, the eggs hatch at the same time that those of the other species do, and the worms mature at the same time.

Remedies.— The most practical way to combat this insect is to poison the worms. The infested trees should be sprayed with Paris green when the first leaves are expanding, as the little worms begin feeding at this time. It often happens that rainy weather in the spring of the year greatly interferes with spraying, by preventing the applications from being made when necessary, or if applied, a good share of the poison may be washed off the trees. In such cases the previous use of traps will be a valuable aid. If rain interferes seriously with the Paris green treatment it is suggested that kerosene emulsion be tried, being careful to hit as many as possible with the spray. The number of treatments that will be necessary to control this insect must be determined by the circumstances. When the trees are to be treated for scab, the Paris green may be combined with the Bordeaux mixture.

As previously stated the female moth is wingless and must crawl up the tree if she deposits her eggs on the branches. Advantage is taken of this condition and traps arê used to prevent the female moths from ascending the tree. Cloth or paper bands five or six inches wide, made sticky with tar, printers' ink or some other sticky substance, are fastened around the trunks of the trees. Care should be taken to leave no crevice under the band through which either the moths or the young worms might crawl. The bands must be in position to catch those moths which emerge on warm days in spring, sometimes before the snow is all gone and they must be examined every two or three days if necessary, smearing them afresh and keeping them in working condition. Bands of raw cotton or of wool have also been advocated for this purpose.

In opposing this insect it should be remembered that prevention is better than cure and the trees should be sprayed regularly with arsenites each season as advocated for the codling moth and bud moth. Where an orchard has been allowed to become badly infested, probably more than one season's work will be necessary to free it from this pest and all practical remedies should be used vigorously and thoroughly.

CASE BEARER.—The larvæ of this curious insect may be found in the spring attached to the twigs in what Saunders[2] describes as a pistol-shaped case. As the buds begin to swell, the insect commences to feed on them, often leaving nothing but the empty shell. Later on they move to the leaves and continue their depredations. Here they may be seen with their heads attached to the leaves on which they are feeding and the cases containing their bodies projecting out from the surface of the leaves.

Remedy.— In some sections of the State these insects have appeared in sufficient numbers to damage the foliage to a considerable extent. In orchards where they are so numerous as this Paris green should be applied when the buds begin to open as recommended for the bud moth. If in addition to this treatment Paris green be used with Bordeaux mixture in the apple scab treatment this insect will probably be held in check.

Codling Moth.— The adult insect is a small brown moth that

---

2 Insects Injurious to Fruits, p. 115.

flies mostly at night, so it is not commonly known. But we are all familiar with the work of its lavra, which causes the wormy apples.

The moth first appears about the time the trees commence to bloom and soon begins to deposit her eggs. About fifty eggs in all may be deposited by one insect. Later attacks may come from late appearing moths or from a second brood. The eggs begin to hatch in about a week after they are laid, so here we have a hint as to when the first spraying should be made.

Remedy.— Paris green is sprayed on the young fruit to poison the insect before it eats into the apple. This insect is such a universal pest, that where spraying is practiced to prevent the ravages of apple scab, Paris green is usually combined with the Bordeaux mixture, so that remedies for both pests are applied at the same time. At the second spraying for apple scab, applied when the last petals are falling from the flowers, Paris green is combined with the Bordeaux mixture. At the third spraying for apple scab, Paris green is again combined with the mixture. One pound of Paris green is used for from one hundred and fifty to two hundred gallons.

If it is not thought necessary to spray for apple scab the Paris green, mixed with lime and water, can be applied alone at the time specified above. But these two pests, the scab and the codling moth, are so universal, and the cost of making the mixture is so small, that it is by far the better practice to apply both remedies at once.

Now to summarize: Where orchards are badly infested with cankerworm, bud moth or the case bearer, the trees should be sprayed with Paris green as soon as the leaf buds begin to unfold in the spring. For apple scap, spray the trees with Bordeaux mixture after the buds break but before the blossoms open as recommended on page 346. If the trees are infested with the cankerworm, bud moth, case bearer, codling moth, or any insect that chews its food, Paris green should be combined with each Bordeaux mixture treatment.

Apricots.

FRUIT ROT.—This disease is more fully discussed under the subject of Cherry Fruit Rot on a subsequent page.

LEAF BLIGHT.—The disease is caused by a fungus which also causes the leaf blight on cherry and plum. The diseased portion usually drops out leaving a hole in the leaf. The apricot appears to drop the diseased parts of the leaf in this way more readily than cherries or plums, and so the foliage of trees that have been attacked quite severely appears as if riddled with holes. Where the disease is prevalent it is suggested that the treatment set forth under "Cherry Leaf Blight" be given.

CURCULIO.—This insect causes great damage in apricot orchards by attacking the fruit, causing wormy fruit. Frequently a large part of the crop becomes infested and drops unless measures are taken to kill the beetles before they deposit their eggs in the young fruit. This is best done by jarring as recommended in the discussion of this insect under the heading of "Plum Curculio."

The other insects mentioned as attacking the peach are also liable to trouble the apricot.

Blackberries.

ANTHRACNOSE.—Same as Raspberry Anthracnose described on a subsequent page.

BLIGHT.—Same as Blight of Raspberries described on a subsequent page.

RUST.—Same as Rust of Raspberries described on a subsequent page.

Cherry.

BLACK KNOT.—The black knot of cherry is said by good authority to be caused by the same fungus that causes plum black knot, the treatment of which is discussed on a subsequent page under "Plum Black Knot."

FRUIT ROT.—The rotting of the ripening fruit of cherries, plums, peaches and other fruits, frequently causes serious loss to the fruit grower. A fungus of the genus *Monilia* attacks the fruit and causes it to rot. The rotted fruit afterwards becomes covered with a gray powdery mould and frequently hangs to the tree till the next summer in a dried or mummy form. The gray powder consists of the germs of the disease which may be washed by rains, blown by winds or carried by insects to other parts of the tree, thus spreading the disease. The mummy fruits carry the disease over from one season to the next, and therefore the collecting and burning of these fruits appears to be a good sanitary measure. The fungus begins its attacks early in the spring, often destroying many of the blossoms. These decaying blossoms are blown about by the wind, thus spreading the infection. It also attacks the leaves and young twigs, but it is on the fruit that it commonly does the most damage. It attacks the fruit at any stage of its development. but spreads most rapidly when the cherries are nearly ready to pick. With warm, moist weather at this time, the disease spreads very rapidly, often nearly destroying a crop in a few days. Many of the cherries rot and fall to the ground while others dry, and hang to the branches over winter as stated above. The appearance of this disease on the plum is shown in Plate XII, Fig. 1.

Remedy.—As in the case of the leaf blight described below we are only prepared to offer suggestions as to the orchard treatment against the fruit rot, as follows:

1. Just before the blossoms open apply Bordeaux mixture 1 to 11 formula.

2. Just after the blossoms fall apply Bordeaux mixture as before with the addition of one ounce of Paris green for eighteen gallons of the mixture. The Paris green is used against the curculio which causes wormy cherries.

3. Make a third application from ten to fourteen days after the second, using Bordeaux mixture and Paris green as before.

If later applications are found necessary, use the ammoniacal solution of copper carbonate, which contains less copper per gallon than the Bordeaux mixture and leaves less stain. Directions for making this solution and also the Bordeaux mixture are given in article 4 on Fungicides and Insecticides.

LEAF BLIGHT.—See Plate XII, Fig. 2. This is a fungous disease which attacks the leaves of other stone fruits besides the cherry. On the cherry it frequently does considerable damage, in that it seriously injures the foliage or even causes it to drop from the tree. Some varieties, English Morello for example, appear to be more subject to this trouble than others. Treatment of this disease on nursery stock has been quite thoroughly investigated at this Station, but the treatment of orchards has not yet been as thoroughly investigated as is desirable.

Remedy.—While it is known that the disease may be controlled by spraying with Bordeaux mixture, 1 to 11 formula, the best time for treatment and number of treatments can as yet be only suggested. Let the first treatment be made as soon as the blossoms fall; the second about two weeks later, and the third just after the fruit is picked. Should it be found necessary to spray when the fruit is nearly full grown, or ripening, use the ammoniacal solution of copper carbonate. Directions for preparing this and the Bordeaux mixture are given in article 4 on Fungicides and Insecticides.

CURCULIO.—This insect stings the cherries, causing the fruit to become wormy. It is the same insect as the plum curculio, and is discussed more at length under the subject of "Plum Curculio," on a subsequent page.

Remedy.—The curculio is commonly opposed in cherry orchards by one or two applications of Paris green or London purple at the rate of one pound to three hundred gallons of water. Two or three pounds, at least, of unslaked lime should be added for every pound of the poison. Slake the lime and add to the mixture the same as in making Bordeaux mixture. The poison may be mixed with the Bordeaux mixture if desired, as stated on page 366. Make the application immediately after the blossoms have fallen and a second application about ten days later.

SLUG.—This insect also infests pear trees, and it is discussed more fully under the heading of "Pear Slug" on a subsequent page. The remedies to be used are there given.

Currant.

LEAF SPOT.—Two of the fungous diseases which cause spotting of currant leaves have been successfully treated with Bordeaux mixture by Prof. Pammel.[3] The spot diseases are usually seen to some extent each year and in some cases their attacks are so severe as to nearly defoliate the bushes. Judging from the experiments thus far tried, the spraying should begin soon after the fruit sets and continue at intervals of about two weeks till the fruit begins to color. One or two applications may be made after the fruit is harvested if thought necessary.

WORMS.—The imported currant worm, which is the larvæ of a sawfly, is the most injurious insect that feeds on the currant bush. The fly, as described by Saunders, resembles the common house-fly somewhat, the female being larger and the abdomen is mostly yellow. These flies appear early in the spring on warm days, and deposit their eggs on the under side of the leaf, in chains along the veins and midrib. The eggs hatch in about ten days, when the larvæ appear as minute white worms. They at once begin to feed

3 Bulletin 17, Iowa Expt. Station, pp. 419–421 ; Bulletin 20, pp. 716–718.

on the leaves, grow rapidly and spread over the bushes, often stripping them of their foliage in a few days. As the worms grow they assume a light green color and at one stage are covered with many black dots. They are about three quarters of an inch long when full grown.

Remedy.— As soon as the little worms appear, the bushes should be sprayed with hellebore, one ounce to three gallons of water. The spraying should be repeated as often as the worms appear in sufficient numbers to do damage. The insect has two broods and careful watch for the little worms should be kept throughout the summer to prevent the bushes from being defoliated.

Gooseberry.

MILDEW.— The mildew usually makes is first appearance on the young shoots and leaves. Here it will first attract the observer's attention as a collection of some bright, frosty substance. On close examination it will be found to be composed of a mass of glistening white threads that spread rapidly under favorable conditions. The more mature portions of the fungus take on a dirty brown color. Later it attacks the fruit in a similiar manner. The threads often spread over the berries until they are entirely covered with a mass of brown felt-like mould, which renders them unsalable.

European varieties, when grown in this country, are particularly susceptible to the attacks of mildew. Many of these varieties produce very large, fine fruit and are so desirable both for home and market that they would be grown to a much greater extent than they now are, were it not for the attacks of this disease.

It has been found at this Station that with proper attention to location, cultivation and pruning, the mildew may be successfully held under control by spraying with potassium sulphide. When setting out a plantation, a site should be chosen where the land is well underdrained and where there is an abundant circulation of air. Branches that droop close to the ground should be pruned back and the ground underneath kept free from grass or weeds, preferably by frequent shallow cultivation, otherwise by mulching.

Remedy.— Spraying should begin early in the spring after the buds break and before the first leaves unfold, using one ounce of potassium sulphide for two gallons of water. This treatment is repeated at intervals of from seven to ten days depending on the amount of rain that comes to wash off the applications. After the fruit is marketed spraying is no longer resorted to although the mildew may continue through the season on the ends of growing shoots. Bordeaux mixture has not been compared with potassium sulphide as a fungicide for mildew to a sufficient extent to warrant an exact statement of their comparative merits, but so far as it has been used at this Station the results indicate that it is not as efficient as the potassium sulphide for this purpose. The potassium sulphide also has the advantage that it is easily prepared and leaves no stain.

WORMS.—The imported Currant Worm, which has already been described as injurious to currants, also attacks gooseberry foliage. It may be controlled in the way advocated for treating currants infested with it. See page 353.

Grape.

ANTHRACNOSE.—This disease attacks any tender portions of the growing vine. When the leaves are affected dark spots are first formed on their surface. As the disease advances these spots enlarge, and irregular cracks are often formed through the dead tissue. Frequently many of these small cracks run together, forming a long irregular slit through the leaf. Similar marks are formed on the tender shoots, though they are not so noticeable. When the fruit is attacked the disease is sometimes called bird's eye rot. Circular spots are formed on the surface of the berry. The spots may be of different colors and usually have a dark border; as the spots enlarge and eat in, a seed is often exposed in the centre. The berries do not rot, but the tissue becomes hard and wrinkled. Sometimes the disease girdles the stem of the fruit cluster cutting off the supply of sap from the grapes beyond the diseased line and causing them to shrivel and die.

Remedies.—Anthracnose does not spread as rapidly as some other vineyard diseases neither does it yield as readily to treatment. When a vineyard is badly infested with anthracnose, it requires prompt attention and careful treatment to control the disease. In Austria and other portions of Europe, vines infested with anthracnose are treated early in the season, when the buds are swelling, but before the tips of the leaves unfold, with a warm saturated solution of copperas (iron sulphate) to which ten per cent. of sulphuric acid has been added. Similar treatment was recommended for a vineyard near Cayuga lake that was very badly infested with anthrancnose in 1893. It was sprayed in the spring of 1894, with a saturated solution of copperas, without adding sulphuric acid, and afterwards was given the customary Bordeaux mixture treatment for other vineyard diseases. The owner writes that the vines are now quite healthy. Inasmuch as no untreated vines were left for comparison this can not be looked on as a satisfactory experiment, but this, and other similar cases, furnish sufficient evidence of the value of the copperas treatment to warrant the suggestion that vineyards infested with anthracnose be given the treatment as above described. It is hoped that careful tests of the value of this treatment in American vineyards may soon be made.

BLACK ROT.— This disease of the grape is quite prevalent in the Keuka lake region and along the Hudson river, but so far as known to the writer the Chautauqua region seems to be quite free from it. It may usually be seen first on the leaves where it forms circular, bright reddish brown, or pale brown, spots on which there appear later little black dots or pimples. Within the black pimples are developed the germs of the fungus which causes the disease. These germs are given forth and washed by rain, or blown by wind, to other leaves or fruit where they grow and form new diseased spots. In the fruit it also forms circular spots and develops black pimples like those formed on the leaves. The diseased fruit withers, turns black, and becomes hard and shriveled, clinging to the stems sometimes till the following spring. The disease may also attack the green shoots.

Remedies.— All diseased fruit should be taken from the vineyard since it is capable of spreading the disease the following spring. Trimmings from the fruit containing diseased berries ought not to be returned to the vineyard in the shape of compost as is sometimes practiced, since the diseased berries are liable to spread the black rot through the vineyard.

This disease may be successfully controlled by thorough spraying if done at the right time. Bordeaux mixture, 1 to 11 formula, is used for this purpose. It is prepared as directed in article 4 on Fungicides and Insecticides. The applications are made as fol ows

1. Just as the pink tips of the first leaves appear.
2. From ten days to two weeks after the first spraying.

3. Just after the blossoming.

4. From ten to fourteen days after the third treatment.

5. If a fifth treatment is necessary let it follow the fourth after an interval of from ten to fourteen days.

6. If a later treatment than the fifth is needed ammoniacal solution of copper carbonate should be used as that is less liable to stain the fruit than the Bordeaux mixture. Directions for preparing it are found in article 4 on Fungicides and Insecticides.

The number of the treatments will be governed by the weather conditions and the severity of the disease. If the vineyard is not badly diseased, and if there is not an excessive amount of hot, wet weather, four treatments may be found sufficient for all practical purposes.

The early treatments are extremely important.

Thorough treatment is essential to success.

Downy Mildew.—In some grape growing sections of the State this is a very serious disease. It attacks nearly every portion of the vine. Its first appearance on the leaves, that will be noticed by a casual observer, is in dry, brick red spots on the upper surface. On the under side of the leaf the diseased area will be covered with the interlaced threads of the fungus. The red spots increase in size until in many instances the entire leaf dies and falls to the ground. It frequently causes the berries to turn dull brown and become soft and shrivelled. This appearance of it has been commonly called "brown rot." The spores are found on the threads which issue from the under side of the leaves or from the stems or fruit, the whole giving when fresh a glistening white downy appearance from which the disease takes its most common and preferable name of "downy mildew." Later these parts of the fungus exposed on the surface assume a gray hue and so the disease has also been known as "gray rot." Some varieties, like Delaware, appear to be quite susceptible to the attacks of the disease and none of the cultivated varieties are known to be exempt.

Remedy.—It may be successfully treated in the manner just described for Black Rot. See p. 356.

Powdery Mildew.—Unlike many of our fungous diseases, the powdery mildew flourishes best during the dry weather of mid-summer. It usually begins its attack in June, though it may appear earlier and destroy many of the grape blossoms. Its name is descriptive of its appearance, as it forms dull white powdery patches on the young shoots and on the upper surface of the leaves. When the fungus is abundant it seriously checks the growth of the vines, by absorbing the nourishment that should have gone to their development. The berries may be attacked at any stage of growth and they are injured or destroyed in the same way as are the shoots or leaves.

Treatment.—It may be successfully treated in the manner just described for the Black Rot.

Summary.—The use of strong solutions of copper sulphate or iron sulphate is not recommended except in case of severe attacks of anthracnose as previously stated. Fortunately, Bordeaux mixture has been found to be almost a specific and with the exception just named, the various prominent vineyard diseases are controlled with the one line of treatment advocated for Black Rot. See p. 356.

Peach.

Note.—Before discussing the diseases and insect enemies of the peach, attention should be called to the fact that the foliage of stone fruits and especially of the peach is peculiarly liable to injury from Paris green, London purple or copper in solution. For this reason the former should not be used stronger than one pound to about three hundred gallons of water and at least two or three times as much fresh slaked lime as poison should be used. It is doubtful whether more than two sprayings with Paris green or London purple should be given even if diluted to the strength just stated. If Bordeaux mixture is used especial care should be taken to have an excess of lime in the mixture as directed in article IV on Fungicides and Insecticides.

FRUIT ROT.—This disease is more fully discussed under the subject of "Cherry Fruit Rot" on p. 351. It is caused by the same fungus that causes ripe rot in cherries, plums and some other fruits.

Remedies.—Chester[4] reports encouraging results in spraying with a solution of copper sulphate, one pound to twenty-five gallons of water, applied as a heavy spraying in spring "before the buds began to swell." Previous to this the mummy fruits, relics of last year's diseased peaches and still capable of spreading the disease, were removed. A second spraying using, in one instance,

4 Annual Report Del. Expt. Sta. 1893; 106–109.

eight ounces of copper carbonate mixed with one pound of ammonic carbonate and dissolved in forty-five gallons of water, was given just before the blossoms opened. Immediately after the blossoms fell the trees were sprayed with Paris green, one pound to three hundred gallons of water, to kill the curculio and after twelve days this treatment was repeated. About a month later the trees were sprayed with the mixture used in the second treatment. As a result of these sprayings the trees lost considerable foliage but the yield of good, sound fruit was much increased as compared with the untreated trees. Further experiments are necessary to determine the line of treatment that may be relied on to give the best results. Care should be used in spraying as noted in the first paragraph under the subject of the "Peach."

LEAF CURL.— This is a disease which causes the leaves to curl and drop early in the summer. It is caused by a fungus which lives within the twig as well as in the leaf.

Remedies. — Some orchardists claim that good results have followed the use of Bordeaux mixture sprayed on the young foliage soon after the leaves appear. Careful experiments need to be conducted to determine the extent to which the disease may be prevented by spraying. Since the fungus infests the twigs it appears unwise to get cions or buds from trees that have shown the disease, although so far as known to the writer, it has not yet been demonstrated that the disease may be propagated by using diseased cions in budding or grafting. Note the first paragraph under the subject of the "Peach" concerning spraying.

YELLOWS.— The best known treatment for peach yellows is to cut out and burn the diseased trees. The text of the New York State law on this subject is given on page 363.

BORERS.— The peach is subject to the attacks of more than one kind of borer. The trunks should be examined carefully in spring and fall and the borers removed with wire or knife. Their presence may often be detected by gummy exudations mixed with the castings of the insect.

CURCULIO.— The plum curculio sometimes is a serious pest in the peach orchard. Remedies for this insect are discussed under "Plum Curculio."

Pears.

BLIGHT. FIRE BLIGHT.— This disease shows itself in the dying of entire twigs, large branches or even the tree itself. It is generally known under the name of "pear blight." It is a bacterial disease that has long been known but whose real nature was first discovered by Dr. Burrill. It was afterwards studied very carefully at this Station, by Dr. Arthur,[5] and more recently by Mr. M. B. Waite, under the direction of the United States Department of Agriculture.

Remedy.— Although the cause of the disease is now known, no method of treating it has proved successful. The only thing that can be done is to cut out and burn the diseased parts as soon as the blight appears. This should be done promptly, for the disease spreads rapidly. The affected part should be cut below any discoloration, back to perfectly healthy wood. Buds cut from infested twigs and set in healthy stock may communicate the disease to such stock.

Among other plants that are subject to the attacks of this disease may be mentioned the apple and the quince.

LEAF BLIGHT.— This is caused by a parasitic fungus which makes its appearance early in the spring. It is first found on the new leaves, where it appears as bright, reddish spots on the upper surface. These spots rapidly increase in size, and later the leaves turn brown and finally fall. It attacks the young twigs in the same manner and frequently kills many of them back. When the fruit is attacked the bright colored spots are first formed. These spots soon become dark colored, and spread out in every direction; the surface of the pear becomes rough where attacked by the disease, and at these places the growth is checked. Sometimes the fruit becomes cracked as it does when attacked by the scab. This disease appears to be more severe in States south of New York and in regions near the Atlantic coast than it is in the interior of the State, where it causes little damage except as a nursery disease.

Remedy.— The treatment advocated for pear scab is also recommended for this disease when it appears in the orchard.

PEAR SCAB.— This disease is caused by a fungus very similar, both in appearance and in the injury which it does to leaves and fruit, to the apple scab fungus. It robs the leaves of the nourishment which they are preparing for themselves and for the growth of the tree and fruit; it spots the fruit and in very severe attacks causes it to become one-sided, distorted or cracked. While it does

5 See Annual Reports of this Station, 1884: 357; 1885: 241; 1886: 275.

not kill the trees or branches as the blight may do, still it is believed that no disease, year after year, causes so great loss in pear orchards of New York State as does the scab. Some varieties appear to be comparatively exempt from its attacks, while others suffer quite severely. With varieties which are thus injured by the attacks, it weakens the tree, it lessens the yield, it makes a large part of the fruit unsalable or of an inferior grade, and even the number one fruit sells for less in the market than it would were it free from the blemishes caused by the scab. It is also conceded that fruit free from scab keeps better and is handled easier than the fruit of the same variety blemished with scab spots.

Remedy.— The treatment of this disease is discussed quite fully in Bulletin 84 of this Station. It is the same as that recommended for apple scab. See p. 346.

BUD MOTH.— This eye-spotted bud moth, which attacks pears is the same as that which infests apple trees. It is also known as the bud worm. Treatment for it is given under apples. See p. 347.

CASE BEARER.— This insect also infests apple trees and has been considered under apples. See p. 349.

CODLING MOTH.— This insect, which causes so much loss to apple growers by causing wormy apples, also attacks pears. It may be treated in treating scab as recommended under apples. See p. 350.

PSYLLA.— This is the name given to an insect which injures the tree by sucking its nourishment from the leaves. The insect when mature is nearly a tenth of an inch long, the full grown wingless form being about half as long. Its presence is usually betrayed by the honey dew which is secreted by the young wingless forms of the insect. The honey dew afterwards becomes covered with a b ack mold giving the leaves, fruit, or branches on which it is found a black, unsightly appearance. The following statements and recommendations for treatment are based chiefly on Slingerland's account[6] published in 1892.

The adult is an active, four winged insect, resembling in minia ture a seventeen year locust or cicada. A number of broods of the psylla are produced during the summer, and the adults which live through the winter are distinct in form from the summer adults. They appear early in the spring and deposit their eggs which hatch in a few days and the little larvæ or nymphs at once commence to

[6] Bulletin 44; Cornell Exp't Station, Ithaca, N. Y.

suck the juices from the young leaves and twigs. Where the nymphs are numerous they take so much nourishment from the trees that the new growth is seriously checked. The whole tree assumes a stunted, unhealthy appearance. The fruit crop of course is greatly lessened and, in some instances, trees have been killed. The first brood in the spring does the most damage.

Remedy.— The insect is most easily killed in its young stages, so when the leaves are unfolding in the spring close watch should be kept for the appearance of the nymphs. They should be looked for between the axils of the leaves and the stem, as they have a habit of collecting at such points. At the first appearance of the pest no time should be lost in spraying the trees with kerosene emulsion. For this purpose the emulsion may be used as weak as one part of the stock solution to twenty parts of water. The treatment should be repeated if more of the nymphs appear.

When spraying with kerosene emulsion it is absolutely necessary that the spray hit the insects, as it is not a poison but kills by contact with their bodies. Therefore, the trees should be drenched, instead of simply coating the leaves over with the mist-like particles, as is one of the essentials in applying Bordeaux mixture.

SLUG.—The adult insect is a small, dark colored, four-winged fly. The slugs make their appearance in the latter part of May or early June. At first light in color, they soon become darker, and are covered with an abundance of slime. The slugs feed on the upper surface, skeletonizing the leaves. Leaves that are badly injured wither and fall, and where the insects are very abundant they cause serious injury.

Remedies.— If upon examination it is found that the insects are likely to appear in sufficient numbers to cause much damage, no time should be lost in spraying the trees with Paris green. If the trees are being treated for fungous diseases the Paris green should be combined with the Bordeaux mixture. A second brood of this insect usually appears in August. The only thing to be done is to spray when the indications are that the slugs are numerous enough to be injurious. On low trees they are sometimes treated with air-slaked lime or road dust, by throwing the dust or lime over the trees.

Plum.

BLACK KNOT.—This disease causes swellings underneath the bark, finally rupturing it and developing a spongy texture covered with dark olive green mold. In this stage the summer spores are produced which spread the infection to other trees.

Late in the season the knot becomes hard with a black surface, which finally becomes covered with fine black pimples, inside of which are matured the winter spores. The winter spores escape late in the winter or early in spring, and serve to spread the disease. A more extended discussion of this disease is given in Bulletin No. 40 of this Station and in the Annual Report for 1893 : 686.

Remedy.—The best known remedy for this trouble is to cut out and burn the knots. They can be found most readily after the leaves have dropped in the fall. They should then all be removed before mid-winter so as to be sure of destroying them before the spores mature and escape. Early in the summer the new knots should be watched for and promptly removed and destroyed. The infection frequently comes from the knots on neglected plum or cherry trees along fence rows or in neighboring orchards. The black knot law, a copy of which is herewith inserted, provides for the destruction of infested branches wherever found. In removing the knots the branch should be cut off three or four inches or more below where the knot appears, so as to remove the threads of the fungus that may extend down the branch to a considerable distance from the knot. The same disease also affects various wild plums and wild and cultivated cherries. It is rarely found on sweet cherries but sometimes is very destructive to the Morello class.

New York Black Knot and Peach Yellows Law.

§ 82. **The prevention of disease in fruit trees.**— No person shall knowingly or willfully keep any peach, almond, apricot or nectarine tree affected with a contagious disease known as yellows, or offer for sale or shipment, or sell or ship to others any of the fruit thereof. Nor shall any person knowingly or willfully keep any plum, cherry or other trees infected with the contagious disease of fungus, known as black knot. Every such tree and the fruit of a tree infected with yellows shall be a public nuisance, and no damages shall be awarded for entering upon premises and destroying such trees and fruit if infected with yellows or for cutting away the diseased part of any tree infected with black knot or altogether destroying such tree if necessary to suppress such disease, if done in accordance with the provisions of this article. Every person when he becomes aware of the existence of such disease in any tree or fruit owned by him, shall forthwith destroy or cause such tree or fruit to be destroyed or the infected part to be cut away.

§ 83. **Appointment and duties of the agent of the commissioner of agriculture.**— When the commissioner of agriculture knows and has reason to believe that any such contagious disease exists, or that there is good reason to believe it exists, or danger is justly apprehended of its introduction in any town or city in the state, he shall forthwith appoint a competent free holder of such town or city as his agent, who shall hold office during his pleasure and who shall within ten days after his appointment, file an acceptance of the appointment, with the constitutional oath of office, in the office of the town clerk of the town. Such agent shall on or without complaint, whenever it comes to his notice that either of the diseases known as yellows or black knot exists or is supposed to exist within the limits of the town or city, proceed without delay to examine the trees or fruit supposed to be infected, and if the disease is found to exist, a distinguishing mark shall be placed upon the diseased trees. If the disease is the black knot, such distinguishing mark shall be placed on some affected part of the trees, or if in the judgment of such agent any such trees should be entirely destroyed, then the trunk of such tree shall be thoroughly girdled, and thereupon the owner notified personally, or by a written notice signed by such agent and left at his usual place of residence, or if a non-resident by leaving the notice with the person in charge of the trees or fruit, or in whose possession they may be. Such notice shall contain a statement of all the facts found to exist, with an order to effectually remove and destroy by fire or otherwise the trees or parts of trees so marked and designated, within ten days, Sundays excepted, from the day of the service of the notice. In case of fruit so infected, the notice shall require the person in whose possession or control it is found, to immediately destroy the same or cause it to be done.

§ 84. **Proceedings in case of owner's failure to destroy.**— If any person shall refuse or neglect to comply with the order of such agent to remove and destroy trees or parts of trees so marked by him, such agent shall cause such trees or parts of trees to be removed and destroyed forthwith, employing all necessary assistant for that purpose; and such agent or his employes may enter upon any and all premises within the town or city for the purpose of such removal and destruction. Such agent shall be entitled to compensation for his service under this and the preceding sections at a rate of two dollars for each full day spent by him in the discharge of his duties, and the necessary disbursements paid or incurred by him, which with the expense and removal and destruction of any such trees or fruit shall be a town charge.

FRUIT ROT.—The ripening fruit of plums frequently is destroyed by the fungus which attacks in a similiar way peaches, cherries and other fruits. The treatment of this fungus has already been discussed under cherries, see p. 351. As stated there, this disease may

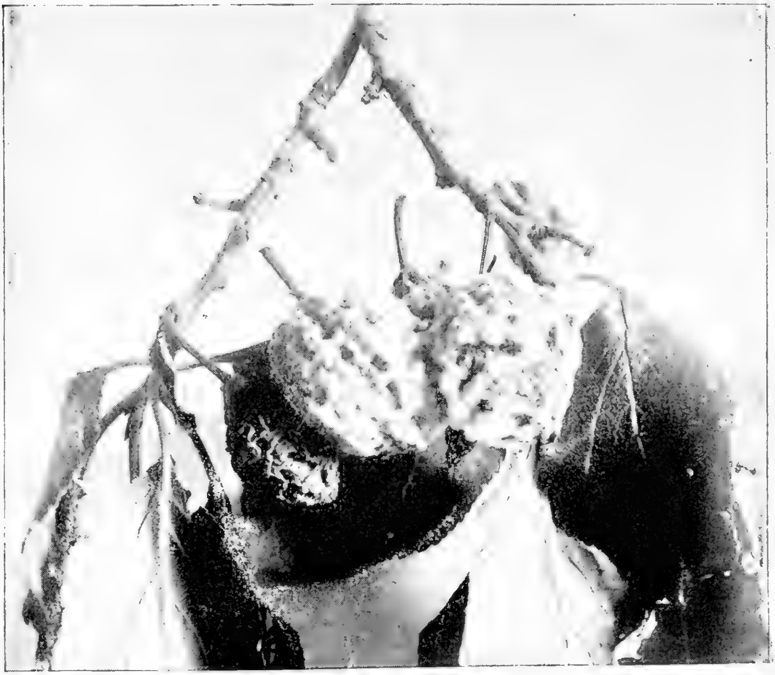


FIG. 1.—Ripe Rot of Plum, *Monilia fructigena.*

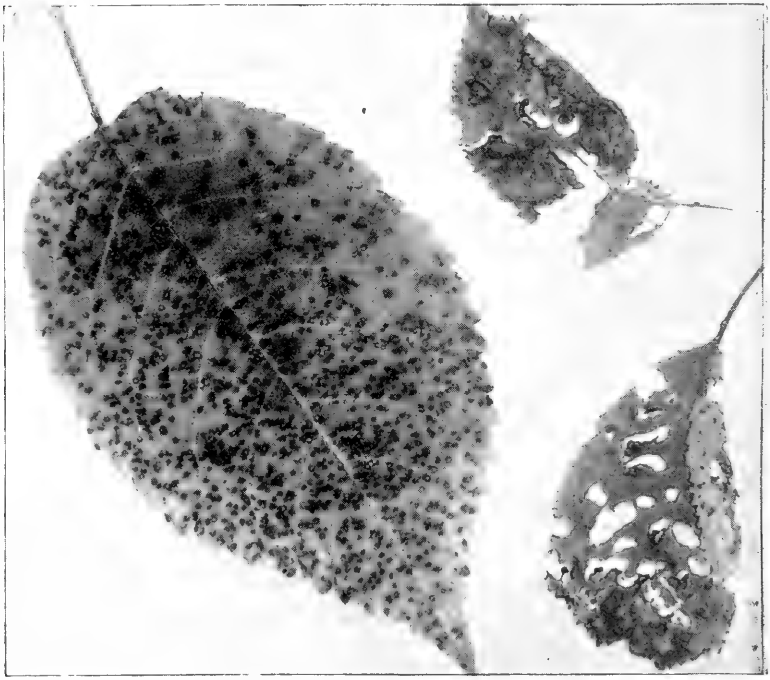


FIG. 2.—Cherry Leaf Blight, *Cylindrosporium Padi.*

attack the blossoms as well as the fruit. Under conditions favorable to the disease at the blossoming season it may thus cause great damage to the crop. The manner in which it destroys the fruit of plums is illustrated in Plate XII, Fig. 1.

LEAF BLIGHT.—This disease also infests cherries and other stone fruits. Its appearance on plums differs somewhat in general from its appearance on cherries, in that while the tissue of some cherry leaves does not readily break away and drop the infested portion out, as illustrated in the largest leaf in Plate I, Fig. 2; in plums the diseased tissue is more liable to drop out, leaving the leaf riddled with holes as a result of the attacks of the fungus, as illustrated by the smaller cherry leaves in Plate XII.

The treatment of this disease is discussed under cherries, see p. 352.

CURCULIO.— The curculio does not confine its attacks to plums, but it usually infests plum orchards, and if left unmolested, often destroys an entire crop.

The mature insect is a small, curiously formed, gray beetle. It passes the winter under the bark of trees, or under rubbish, and comes forth early in the spring to deposit its eggs in the young fruits commencing as soon as they are formed. It does this by puncturing the tissue and inserting the egg. After the egg is deposited, the beetle cuts a crescent-shaped groove around one side of the puncture, evidently to prevent the growing tissue from crushing the egg. The eggs hatch in a few days, when the little worm, or larva, at once commences to feed on the fruit, causing much of the infested fruit to fall while still young, and that which remains on the tree ripens prematurely and soon decays.

Remedies.— It has been found that the beetles' manner of protection is to fall to the ground when disturbed. Here they curl up so as to resemble bits of bark. Advantage is taken of this habit in fighting the insect by a process known as jarring. The trees are jarred by three or four strokes with a padded crutch or mallet, and the insects are caught on sheets spread underneath the tree and destroyed. Where only a few trees are to be treated the sheets are laid on the ground. But when large orchards are to be treated the sheets are stretched over a light frame, so that they are constantly extended, and no time need be consumed in stretching them into position after the tree is reached. One form of these extended sheets for catching the curculio is made by Mr. Henry Lutts, Youngstown, N. Y. The frame over which the sheet is stretched is suspended from the shoulders of the workman who does the jarring, occupying a position at the center of the sheet. The sheet slopes towards several tin cups in which the bugs are collected.

The curculio catcher commonly used in the vicinity of Geneva is one made by Mr. J. B. Johnson, Geneva, N. Y. The frame over which the sheet is stretched is attached to a two-wheeled cart. The sheet slops downwards to the centre where an opening allows the bugs to be swept into a tin box underneath the sheet and between the wheels. A slit at one side allows the cart to be run directly under the tree and two or three jars bring down the bugs which are swept into the box above mentioned, by means of a short handled broom. The cultivated ground is made smooth by rolling to prepare it so that the cart wheels will pass over it readily.

Jarring should be begun as soon as the fruit sets and be continued as long as the curculio are found in sufficient numbers to pay for jarring, which is usually for about three weeks. Early morning is the best time to do this work. Towards the middle of the day, especially on bright days, they are more active and apt to fly. The beetle feeds on the plum leaves and for this reason spraying the trees with Paris green or London purple has been advocated. No doubt the insects may be killed to some extent in this way but the foliage of stone fruit trees is particularly liable to injury from Paris green or London purple so that these poisons must be used sparingly and much diluted. One pound of either may be used with about three hundred gallons of water, or mingled in the same proportion with Bordeaux mixture. In either case at least three times as much fresh slacked lime should be added as the weight of the poison. Should frequent rains come and wash off the poison from the foliage it would necessitate spraying again if spraying alone be depended on to fight the insect, and the cumulative effects of the different sprayings would probably result in injury to the foliage. So while it is doubtless true, that spraying against curculio may be practiced with good results, still in the light of evidence thus far presented on this subject, we would prefer not to spray with an arsenite more than twice; follow the spraying with jarring if it is found necessary.

Quince.

BLIGHT. FIRE BLIGHT.—This is the same bacterial disease as the pear blight which is discussed on page 359.

FRUIT SPOT.—Fruit spot and leaf blight of the quince are caused by the same fungus that causes pear leaf blight. When a fruit is attacked, numerous small black specks appear on the surface. As the spots increase in size they often grow into each other and form a large, dark, diseased area. The disease does not extend so deep into the tissue of the fruit as to make it entirely worthless, but the market value is greatly lessened. When the fruit is attacked before it has reached its full size, it often occurs that the quinces, like the diseased pears, are misshapen and undersized. Greater damage is done to the trees when the leaves are severely attacked. The loss of foliage in midsummer not only leaves the fruit undeveloped but is a severe check to the growth and vigor of the tree.

Remedy.—Favorable results in treating this disease with Bordeaux mixture are reported. It is suggested that the treatment recommended for apple scab be used against quince fruit spot and leaf blight, making the first spraying when the blossom buds have appeared, the second just as the blossoms are falling, and a third about two weeks later.

LEAF BLIGHT.— See Fruit Spot above.

RUST.— Judging from the unusual number of inquiries concerning this disease that were received at this Station in 1894 and from reports from other sources, quince rust was unusually prevalent last season. The rust is due to a fungus which becomes established and develops within the tissues of the quince branches or fruit. It causes knotty branches and peculiarly distorted fruit, on which there appear tiny fringed pits filled with orange colored dust, giving the diseased parts quite a brilliant appearance.

In a different form this rust fungus attacks the red cedar and the common juniper, forming galls on their branches. In these galls are developed spores which, distributed by the winds to quinces, juneberries, hawthorns and apples, become established on these trees and cause the rust. Usually the rust is not abundant enough on quinces to cause serious injury. It is usually recommended that the cedar and juniper trees in the vicinity be destroyed, to prevent the breeding of the fungus on them, and that the rusted fruit or branches also be removed and destroyed. The former recommendation is not always practical, and whether the latter course will do any good has not been definitely determined.

BORERS.— These insects work under the bark, as described under apple borers, and are one of the most serious insect pests the quince grower has to contend with. The trunks of the trees should be examined carefully in spring and fall and the borers dug out.

Various other remedies have been advocated from time to time but none of them take the place of the examination of the trunks and the removal of the insect as above advised. Mr. C. K. Scoon of Geneva, N. Y., finds that strips of tarred paper tied carefully around the trunk of the tree have given encouraging results as a preventive of attacks of borers. The strips of paper are about eight inches high, the lower end being covered with earth. The paper is tied firmly in place encircling the trunk and tied at the top so tightly that insects cannot pass between it and the bark. Should creases or crevices occur in the trunk under the paper, sticks or twigs are driven between the string and the paper so as to force the paper tightly against the bark. The trees are examined for borers the same as before.

CODLING MOTH.—This insect is the same as that which causes wormy apples and pears as previously described, see p. 349. It should be treated by spraying with Paris green or London purple as soon as the fruit sets, followed by one or two later applications at intervals of ten days, or even less if heavy rains fall in the meantime. The poison thus used is also recommended for the curculio mentioned below. It may be combined with Bordeaux mixture when that is used against fruit spot and leaf blight, using one pound for from one hundred and fifty to two hundred gallons.

CURCULIO.—This insect, somewhat larger than the plum curculio, feeds on the quince and also deposits its egg in the fruit. The egg hatches and the larva burrows into the fruit, but according to Saunders does not enter the core.

Remedy.—Spraying with Paris green or London purple as for the Codling Moth mentioned above, is recommended for trees that are headed quite low. This system of training is commonly adopted in large orchards and jarring such trees is a rather slow and expensive operation. No carts adapted for jarring quinces have yet been devised, so that thorough spraying with Paris green or London purple appears to be as effective as any treatment that has yet been tried.

Raspberry.

ANTHRACNOSE.—This disease is very common to both raspberries and blackberries, but is most injurious to black raspberries. It lives over winter in the canes and begins its attack on the new canes when they are six or eight inches high. The first appearance of the disease is shown by minute spots that form on the tender shoots. These are at first grayish white in color, with a dark or purple outline. The spots rapidly enlarge and become darker colored. As the spots become more numerous and each one enlarges rapidly, they often grow into each other and form large blotches or scabs several inches long and extending nearly around the cane, effectually girding it. Thus it often happens that the fruit withers before it is ripe, because the disease has cut off the circulation, so that not enough sap ascends to keep the plant alive. In some localities anthracnose is very destructive, many times killing out a plantation in a few years. It is oftener the case, however, that the disease is not so injurious, but remains in the plantation in an active state without the owner suspecting it, though he complains that his plants do not produce the crop that they once did.

Remedies.— An experiment now being conducted by this Station tends to the conclusion that treatment with Bordeaux mixture will be successful. The exact number of sprayings that will be necessary to prevent the spread of the anthracnose has not yet been determined, but we feel warranted in making the following recommendations : Give the new canes three sprayings with Bordeaux mixture, beginning when the largest of them are about six inches tall. Let the other applications follow at intervals of about two weeks. As anthracnose is a disease more particularly of the canes, and the treatment is entirely preventive, the spray should be directed at the young shoots. An endeavor should be made to keep them coated with the mixture for the first few weeks of their growth. When the disease is severe the old canes should be removed and burned as soon as they have fruited.

Blight.— Pear blight occasionally attacks raspberries and blackberries. The following account is taken from Bulletin No. 6 of the Ohio Experiment Station.

" At the base of the canes, usually quite near the surface of the ground, occur brownish black patches from one-half inch to several inches long and extending completely around the cane. There are also smaller patches at the bases of branches, on the petioles and under the surface of the mid-veins of the leaves, which curl downwards. The parenchymatous portion of the leaf does not seem to be attacked. These blackish patches differ from those caused by anthracnose in that the epidermis does not crack, and though blackish brown in color, they do not look dry. The discoloration extends to the sub-epidermal tissues.

The row of Marlborough raspberry was most affected, the leaves were all curled over and the whole row looked as though blasted. On July 19th I sent a diseased cane of the Marlboro to Professor T. J. Burrill, of Champaign, Ill. * * * *

Again July 28th, Professor Burrill wrote:

"It has now been satisfactorily determined that the disease of raspberry and blackberry canes showing wide dark discolorations of the bark without rupture of any kind is blight—'pear blight.' I have formerly suspected this, now it seems certain. We have the same trouble, and this year more than I had seen before. The same stems frequently are spotted with anthracnose, but the two diseases are very distinct."

No treatment is recommended, but from what we know of attacks of blight on pear trees, it would seem to be the part of wisdom to cut out and burn the diseased canes as soon as they are noticed.

ORANGE RUST.—This fungus occurs in two forms or stages on the host plant, but the first stage is not commonly known. In the second stage the underside of the leaves are covered with a dense mass of orange colored spores, hence the name, orange rust. These spore masses rarely occur on the canes. Clinton states[7] that the fungus enters the very young underground shoots and grows up through the canes to the leaves. Since the disease grows within the canes and infection probably takes place at the root, it appears that any preventive treatment would be useless, other than destroying the infested canes at the first appearance of the disease. They should be dug out and burned promptly as soon as the disease makes its appearance, as it spreads rapidly and is very destructive. The rust is quite common on wild plants, therefore any wild berries that may be growing in the vicinity of a plantation may serve as a source of infection and should be looked after accordingly.

Strawberry.

LEAF BLIGHT.—This disease is also called strawberry "rust" or "leaf spot." It frequently causes much damage by injuring the foliage so that the plants are incapable of perfecting a full crop of fruit even though a full crop has set, or as Thaxter states[8], it also

7 Bulletin 29, Illinois Experiment Station.

8 Annual Rep. Conn. Exp't Sta., 1889; 174.

attacks the fruit stems and hulls "cutting off the supply of nourishment from the berries and disfiguring them by the withering of the calyx."

When the spots first appear on the leaves they are of a deep purple color, but later they enlarge and the center becomes gray or nearly white. Portions of the infested leaves frequently assume bright red tints and when badly diseased finally wither and die.

Treatment.—Bordeaux mixture, 1 to 11 formula, used as advocated by Hunn in the Annual Report of this Station, 1892: 682, gives beneficial results. When setting a new plantation be particular to remove the diseased leaves before taking the plants to the field, or if the plants must be trimmed in the field the diseased leaves should not be left where they can communicate the disease to the new foliage as it grows out. The following treatment is then suggested:

Spray the newly set plants soon after growth begins and follow with three or four treatments during the season as seems necessary. The following spring spray just before blossoming, and again in from ten days to two weeks. As soon as the fruit is gathered it is a good plan to mow off the foliage of badly diseased beds and burn it if the beds are to be fruited a second season.

GRUBS—The larvæ of the May Beetle, a white grub, frequently does much injury to strawberries by eating off the roots. It is said that the insect lays its eggs chiefly in sod ground. These hatch into the larvæ or grubs which feed on roots of various plants till the third year afterwards, when they come from the ground in the form of May beetles. Since the grubs live in the ground till the third season after the eggs are laid, it is a good practice not to use land for strawberries till the third year after it was in the sod.

2. COMMON DISEASES AND INSECTS INJURIOUS TO VEGETABLES.

Bean.

ANTHRACNOSE.—In many parts of the State the bean crop is severely injured by a disease known as anthracnose. It attacks the bean plant in all stages of its growth, and survives the winter in the beans themselves. The badly diseased beans can be readily told by the discolorations, which vary in size from a small spot to large pits and blisters. When such seed is planted the fungus begins to grow with the beans, and appears on the stems and seed-leaves as almost black spots of variable shape and size. These rapidly enlarge and may eat into the stems so as to entirely destroy the young seedlings. When the infested plants are not destroyed in this way they continue to grow and spread the infection to neighboring plants. The disease attacks the under side of the leaves, causing dark spots, and shriveling and discoloring the veins and midribs. The damage which usually attracts most attention is that done to the pods and beans themselves. On the pods, small dark pits are formed with brown or red borders At first small, they rapidly enlarge and become large irregular pits. When thus attacked, the pods are unsalable as snap beans, and the discolored beans are unfit for either market or seed.

Remedy.—The following recommendations for treating this disease are based on experiments conducted on the Station grounds.[9]

It will pay to pick over the beans so that no diseased seed shall be planted.

After the seed has come up, go over the rows and pull up all of the diseased seedlings and destroy them. If they are left lying on the ground the fungus will mature its spores and thus continue the spread of the infection.

About the time the plants have put out the third leaf, begin spraying with Bordeaux mixture, 1 to 11 formula. The method of preparing this mixture is explained in article 4 on Fungicides and Insecticides. Spray again when enough more foliage has grown out to justify another treatment. Probably three or four treatments at least will need to be made. Whether this treatment will make the bean fodder harmful to stock is a point that has not yet been investigated.

Wet weather is favorable to the development and spread of the disease. In infested fields the beans should not be cultivated when wet with rain or dew lest the germs of the disease be distributed rapidly and widely in this way.

WEEVIL.—Dried beans are frequently found to be infested with the weevil, a small dark gray beetle that appears in the spring, many times being carried to the fields in the seed. The eggs are laid in the young pods. If the beans are picked while green, the eggs or larvæ are, of course, destroyed, and no damage is done. When the

---

9 See Bulletin No. 48, Dec., 1892.

beans are allowed to ripen, the grubs mature inside the bean. The grubs are transformed into beetles, within the bean, and these come forth from the stored beans usually in the spring. Several grubs may enter the same seed, so that the beans may be pierced with many small holes. The insect does not feed on the germ of the beans so that infested beans may be used for seed, though they do not produce as vigorous plants as do beans that are free from the weevils.

Remedies.—Care should be taken that none of the insects escape from the stored beans, or that none are taken to the field in the seed. The weevils may be killed by exposing the infested seed to the fumes of carbon bi-sulphide. This is done as recommended in article 4 on Fungicides and Insecticides.

Cabbage.

APHIS.—This insect is treated more fully in Bulletin 83 of this Station from which the following account is taken: Probably there is no better known cabbage pest than the cabbage aphis, also known as cabbage louse and "greenfly." Many heads of cabbage are found to be filthy from the masses of lice on them. It is not an uncommon sight in the fields to see heads with the outside leaves dead and covered with the inflated skins of what have been parasitized aphids; above may be a few half-dead leaves covered with about an equal number of parasitized and live aphids, while within the withy head are masses of perfectly healthy lice. This is especially true of Savoy varieties. Some gardeners have the idea that these varieties are more free from insect injury than other kinds. Observations indicate that this idea is simply due to an appearance contrary to the facts. Plant lice curl the leaves of all cabbage more or less. The Savoys furnish a natural protection for them. Any variety which forms a solid head rapidly will have the advantage over slow heading varieties.

Treatment.—Nearly as many remedies have been recommended for this pest as for the cabbage worms. It should be remembered that plant lice are only killed by insectides which smother or kill by contact. None of the poisons will kill them. The best remedy is kerosene emulsion diluted with ten parts of water. It should be applied to the lower as well as the upper sides of the leaves. The treatment should be begun when the lice make their appearance, and the applications repeated as often as may be necessary to keep them in check.

MAGGOT.—The cabbage maggot is very injurious in some localities. The adult insect is a small fly that makes its appearance in the spring about the time the plants are set in the field. The female deposits her eggs on the stems of the plants at, or just below, the surface of the ground. The eggs hatch in a few days, when the little maggots begin feeding in the roots of the plants. When they occur in large numbers on the same plant the roots are soon reduced to a decaying and foul smelling mass.

Remedy.—Prof. Goff[10] of Wisconsin has devised what appears to be the most practical method of combating this insect. Small cards of tarred paper are fastened tightly around the stems of the plants when they are transplanted so that the cards rest on the surface of the ground after the plants are set. The cards are cut from building paper with a tool made for the purpose. They are six-sided and about three inches in diameter. A slit from one side to a star-shaped puncture in the centre permits the card to be fastened tightly around the plant. When properly applied the cards have proved very effective by preventing the fly from laying her eggs on the plants.

WORMS.—The worms that feed on cabbage are so common that every grower is familiar with them and especially with the damage they do.

Remedies.—Numerous remedies to be used in fighting these pests are recommended each year. Poisoning with arsenic in some of its forms has given the best results. Paris green is commonly used. This may be applied in various ways; mixing the poison with flour or plaster and applying with hand-sifters has given good results. When the poison is applied in a spray it has not been satisfactory, for the reason that the liquid would not stick to the foliage. But it is now thought that this difficulty can be overcome by the addition of lime. In Bulletin No. 83 of this Station it is recommended that a spray mixture for poisoning cabbage worms be made as follows:

Paris green or London purple	1 pound.
Lime, unslacked	16 pounds.
Water (to make)	160 gallons.

Slack the lime and add to the Paris green, with sufficient water to make one hundred and sixty gallons. For a more complete dis-

10 Eighth Annual Report, Wis. Expt. Sta. 169-173; also Bul. 78 Cornell Exp't Sta.

cussion of some of the cabbage insects, the reader is referred to Bulletin No. 83 of this Station.

Celery.

CENTER BLIGHT.— The soft rot of the centers of celery plants, which results from attacks of bacteria, has not yet been successfully treated by spraying. No further work has been done at this Station in treating this trouble since that reported in Bulletin No. 51 and in the Annual Report of this Station for 1892. The suggestions there given are (1) to blanch with boards instead of earth during hot weather; (2) to leave neither the rotted refuse from stripping the plants nor the diseased plants on the fields where celery is to be grown; and (3) to keep the plants in an active growing condition from the time they are planted till marketed, by cultivation, fertilization and spraying for leaf-blight.

LEAF SPOT DISEASES.— These diseases are caused by fungi of different kinds. The investigations above mentioned showed clearly that plants may become infested in the seed bed before they are transplanted. The experiments in treating the diseases were not conclusive, but led to the suggestion that the seedlings be treated with Bordeaux mixture, 1 to 11 formula, before transplanting. The treatment should begin soon after the seeds germinate and should be repeated often enough to protect the new foliage as it develops. Treatment in the field as soon as the plants are transplanted, and afterwards at intervals of ten to fourteen days, is also suggested. Directions for making the Bordeaux mixture are given in article 4 on Fungicides and Insecticides.

The investigations showed that celery sprayed this way was not at all injured for market purposes, as much copper being found in the unsprayed plants as in the sprayed plants after they were stripped ready for market. The very slight amount of copper found in both sprayed and unsprayed was sufficiently accounted for by the slight amount of copper present in the soil. In any case it would be necessary to eat a good many thousand heads of celery at one meal in order to introduce a serious dose of copper into the system.

In the investigations referred to above it was found that one of the fungous diseases of celery not only spots the leaves but also attacks the seeds. It is therefore recommended that seed showing black specks over its surface be not sown without first submitting samples of it to someone competent to say whether or not it is diseased. If it is diseased it should not be used.

Pea.

WEEVIL.— The weevil that infests peas is quite similar to the one that attacks beans, but is somewhat larger. Its life history is the same, and the same treatment applies to this that has been given for the bean weevil.

Tomato.

BLACK ROT.— This disease is caused by the same black mold that attacks the potato causing what some have termed the early blight. It may attack the tomato vines, where it appears as dark spots. Nearly every grower is familiar with the black mold that attacks the fruit in all stages of its growth. It usually appears at the flower end which at first turns dark. If the tomato be cut in two more or less of the tissue will be found to be discolored. As the disease advances a dark velvety mould forms over the diseased area. The tomato clings to its stem until nothing is left of it but the skin.

Rolfs reports[11] good results from treating the plants with Bordeaux mixture, and recommends that the first treatment be applied when the flower buds begin to form. The treatment should be repeated at intervals of about two weeks. The number of treatments that will be necessary will depend on the prevalence of the disease. Howell reports in Bulletin 11, Section of Veg. Path., U. S. Dept. Agr., 1890, that one treatment when the first fruits were about three-fourths of an inch in diameter, and two later treatments at interval of about two weeks were successful in controlling the disease. He used Bordeaux mixture, 1 to $3\frac{2}{3}$ formula.

Potato.

BLIGHT.—The disease which for many years has had the distinction of being known as *the* blight of potatoes is caused by a fungus that may be said to resemble in a general way the fungus that causes the downy mildew of the grape, although the two are not even classed in the same genus. It passes the winter in infested tubers where it may cause a discoloration beneath the surface which is best seen in the ring of darkened tissue near the circumference when a slice is cut through the middle of such a tuber. When the

11 Bulletin No. 21, Florida Experiment Station, 1893.

diseased potatoes are planted the fungus spreads to the stems and leaves and there manifests itself in the dark brown withered parts of leaves or stems. It sends out mildew threads, commonly on the under surface of the leaf, and there produces spores which may be called the seeds of the disease, and which are distributed by wind and rain, thus spreading the infection. In warm, moist weather it spreads most rapidly, in fact so rapidly that fields where the disease is present are frequently said to be "struck with the blight," so sudden, apparently, has been its attack. The disease also spreads to the tubers, and thus attacking both vines and tubers it may occasion very serious loss. If conditions are favorable it may spread rapidly early in the season but more commonly in this State it appears to do most damage after midsummer.

Remedies.—Spraying for blight should be begun when the plants are six or eight inches high. Three and four sprayings with Bordeaux mixture, 1 to 7 formula, making the first treatment as just stated and others at intervals of about two weeks, have been sufficient here to control this disease, and also the one next described.

Macrosporium.— This disease, caused by a species of black mold, has been called by some "Early Blight," because it is commonly found on early potatoes. It makes its appearance usually in June, and attacks the foliage. It may be known by the peculiar spots that it produces on the leaves. These have been described as target-shaped marks from the fact that a number of circles surround a common centre in such a manner as to represent a target in miniature. The affected portions of the leaves become dry and crisp. The disease spreads slowly, and has not been known to be as injurious in this section as the blight first mentioned. The same treatment is used for this trouble as that given above for the blight.

Potato Scab.— This disease is confined to the tubers, so its attacks are not noticed until the potatoes are dug. It causes the outer portion of the potato to become pitted, rough and corky, or "scabby." In some localities this condition is thought to be caused by the larvæ or grubs of the May beetle; hence the name "grubby potatoes" is applied to them. But the attacks of the grubs are local, and their work can be told from the fact that they eat out rather deep grooves or furrows in the surface of the potatoes.

Remedies.— Since this disease does not appear on any part of the plant above ground, any spray applied to the vines would be useless. The only way then to combat it is to improve the sanitary conditions. The first precaution to be taken is not to plant on ground that is badly infested with the fungus. It has been demonstrated that the fungus may persist in the ground for several years, and in cases where the soil is known to be badly infested, no remedy of practical value is known. On some soils applications of lime or wood ashes appear to produce conditions favorable to the development of the disease."[12]

Excellent results have been obtained in many instances by simply soaking the seed in a solution of corrosive sublimate (bichloride of mercury). The seed may be soaked either before or after being cut. *Corrosive sublimate is a poison* and should accordingly be used with caution. One ounce is used for seven or eight gallons of water. It dissolves more readily in hot water and may then be diluted. It should not be used in metal, but in wood or earthenware vessels. The seed should be soaked for one hour and the same solution may be used again and again. After being soaked the seed should neither be put in contact with scabby potatoes nor in receptacles which have held scabby potatoes or scabby beets. With these precautions the seed may be kept any convenient length of time after soaking before it is planted.

Manure from animals fed on uncooked scabby potatoes or beets is capable of communicating the scab to the potato crop for which it is used. For this reason manure of this kind should not be used for potatoes or beets. Scabby potatoes should not be used for seed since they are capable of communicating the disease to the new crop.

POTATO BEETLE.—Every farmer is so familiar with the potato beetle that a description of it would be out of place here. It has been successfully combated for a number of years with Paris green. Formerly the poison was applied in the dry form, and with good results. But it is now considered much the better practice to apply it in the form of spray. This is especially true since the blight has become so universal, and remedies can be applied for both pests at the same time. The Paris green should be used whenever the beetles appear in sufficient numbers to be injurious. Usually it will be sufficient if the poison is mixed with Bordeaux mixture and applied at the time the potatoes are to be treated for blight.

POTATO FLEA BEETLE.—This is a little shiny black beetle, about a quarter of an inch long, which attacks the potato and tomato vines

12 Bulletin 30, R. I. Exp. Station.

PLATE C.—FIG. 3.
Potato leaf eaten by Flea-beetles. (Jones.)

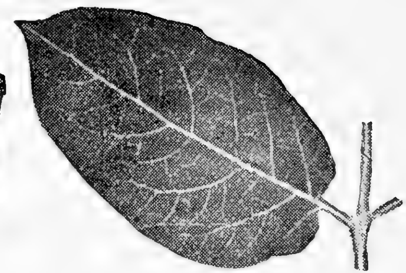


FIG. 4.
Healthy potato leaf sprayed with Bordeaux mixture. (Jones.)

and also tobacco. Jones reports[13] that the Bordeaux mixture as used against the blights prevents to some extent the attacks of this insect. Figure 3 illustrates the work of this insect on the potato leaf which may be compared with the healthy leaf sprayed with Bordeaux mixture illustrated in Fig. 4. For figures 3 and 4 we are indebted to Prof. Jones.

3. Common Diseases and Insects Injurious to Nursery Stock.

Apple.

Powdery Mildew.—Powdery mildew is seldom very injurious to apple stock in this locality. It attacks the leaves and young twigs, where it appears as a light powdery substance. When it is severe the seedlings may receive a serious check by the loss of foliage and the killing back of the young shoots. It usually makes its appearance in the latter part of September. It is suggested that treatment be given, using Bordeaux mixture 1 to 11 formula, beginning in the fore part of September and repeating at intervals of about two weeks until two or three sprayings have been given.

Aphis.—Either the green aphis or the woolly aphis may be treated as directed for cherry aphis below.

Bud Moth.—In the nursery this insect is sometimes fought by pinching the infested leaves and thus killing the insect. Spraying early in the spring, the same as for the same insect in the orchard, is also suggested.

Cherry.

Leaf Blight.—The so-called leaf blight, or shot hole fungus, that has been described as being particularly destructive to plum and cherry trees in the orchard, often causes great damage in the nursery. The injury is due to the loss of foliage; the energy of the tree is exhausted in its effort to produce new leaves, so its growth is impeded or remains nearly or quite at a standstill.

Remedy.—Experiments conducted at this Station[14] show clearly favorable results from treatment with Bordeaux mixture, 1 to 11 formula. The number of treatments necessary to secure the best results have not been fully determined. Bordeaux mixture is preferable to any other remedy that has been tried for this trouble. It is suggested that three or four treatments be given, especially to

13 Bulletin 40 Vt. Expt. Station : 25 ; Bul. 41, : 93--97.

14 See Annual Report, 1892 : 654 ; 1893 : 688.

young stock, beginning about the first of June and repeating the application at intervals of from ten to fourteen days. Directions for making Bordeaux mixture are given in article 4 on Fungicides and Insecticides.

THE CHERRY APHIS.—This little insect is one species of a large family, commonly known as plant lice. They are similar in size and form to common green plant lice, but are nearly black in color. They appear early in the spring and begin sucking the juices from the expanding buds. They multiply very rapidly and as growth takes place move to the new shoots and leaves, where they collect in large numbers, especially on the under side of the leaves, causing them to curl up so as to cover the lice and thus making it difficult to hit them with a spray after they have become well established. Since these insects suck their food they cannot be poisoned but must be killed by contact of the insecticide with their bodies.

Remedy.—In fighting these insects close watch should be kept for their first appearance, so that they may be sprayed at once and not allowed to become established. The treatment should be repeated as circumstances require. Kerosene emulsion diluted from twelve to fifteen times is commonly recommended for plant lice. If the leaves are curled so that the spray cannot reach the insects, dip the infested twigs in whale oil soap and tobacco tea, or in kerosene emulsion prepared as directed in article 4 on Fungicides and Insecticides. The mixture is poured into shallow pans and the twigs are bent over and dipped into it.

Pear.

LEAF BLIGHT.—The leaf blight that has been described as attacking the pear and quince in the orchard, often does great damage to nursery stock. The following account is based on investigations made at this Station.[15] For some as yet unexplained reason the blight is more severe on seedlings than on budded or grafted stock. The disease attacks the leaves and causes many of them to drop off, and in some cases the tender part of the stock is killed back several inches. As soon as the leaves fall, new ones are at once pushed out. This process is very exhausting and where the attack begins early in the season, the seedlings may lose several sets of leaves during the summer. Where this occurs

15 Annual Report of this Station, 1892; 652

many of the seedlings die before winter sets in, and those that survive the winter, are mostly too small to work the next season. On pear stocks in particular, where the blight has been severe, it attacks the green tips of the twigs. Here it forms small dark pits where the disease lives over winter and spreads the infection to the first leaves that appear in the spring.

Remedy.—Encouraging results in treating this trouble on pear stock have been obtained in experiments at this Station. Bordeaux mixture, 1 to 11 formula, thus far has given best results. This treatment has also given good results in some of the Geneva, N. Y., nurseries. It is suggested that treatmnet be given as soon as the first leaves become fully expanded, following with other treatments at intervals of from ten to fourteen days, making five or six treatments in all. Similar treatment is recommended for pear seedlings, beginning as soon as the first leaves unfold.

BUD MOTH.—This insect, described as attacking apples also, is treated as described under apples.

SLUG.—This insect attacks the leaves, sometimes doing considerable injury. It may be fought by dusting with air slaked lime or spraying with Paris green at the rate of one pound to from one hundred and fifty to two hundred gallons of water.

Plum.

LEAF BLIGHT.—This is caused by the same fungus which causes cherry leaf blight above described. The remedies there advocated have given good results in treating plums. In 1893 trees making their second season's growth from the bud were successfully treated with two applications of Bordeaux mixture, 1 to 11 formula, one given about the middle of June the other about the middle of July.[16] Directions for using this mixture are given in article 4 on Fungicides and Insecticides.

APHIS, PLANT LICE.—Give same treatment as for plant lice on cherry as advocated above.

Quince.

LEAF BLIGHT.—This is caused by the fungus that causes pear leaf blight, the treatment of which is given above, on this page.

16 Annual Report of this Station. 1893 ; 688.

4. FUNGICIDES AND INSECTICIDES.

How to Spray.

For a discussion of nozzles, pumps and machines used in spraying the reader is referred to Bulletin 74 of this Station or Annual Report 1894; 687–706. In order that any spraying may be effective it must be thoroughly done. The workman should not hurry through with the job in an effort to see how many trees he can hit with the spray in a day, but should aim to apply the spray thoroughly and evenly over all the foliage.

It is a mistake to think that when a nozzle is throwing a stream to a great distance and using up the liquid fast, that it is doing the best work. The Vermorel nozzle, which is considered the best, does its best work at from three to five feet from the nozzle. While it cannot force a stream to a great distance it throws a very fine spray, and is readily cleaned when it becomes clogged. For these reasons it takes first rank.

Throughout the preceding parts of this discussion spraying with different mixtures has been recommended. The reader must not expect good results to follow the use of any of them unless the spraying be well done. The spraying may be done at the right time and the mixtures prepared correctly, but final success must depend upon thorough work in applying the spray. Thoroughness does not mean that the trees shall be drenched but that the spray shall reach every leaf. The ideal way is to have the spray settle in minute particles over the entire surface of all the foliage and dry there without running together in drops and dripping from the tree. This idea can not be accomplished completely but it should always be worked for.

In applying Bordeaux mixture or Paris green great care must be taken to keep the mixture thoroughly stirred otherwise the heavy parts of the mixture settle rapidly and the spray is not applied in uniform strength. To keep the mixture stirred an agitator should be kept constantly moving. One of the best agitators for this purpose is described in Bulletin 74 of this Station, p. 400, and Annual Report 1894; 701.

In using such insecticides as kerosene emulsion, that kill by contact with the insect, the aim is to hit the insects and the foliage may be drenched if necessary to do this.

Fungicides.

AMMONIACAL SOLUTION OF COPPER CARBONATE.—The formula usually given for making this solution is as follows: Dissolve five ounces of copper carbonate in three pints of ammonia of 26° strength. When ready to apply, dilute with water so as to make fifty gallons. The undiluted solution may be preserved for some time in tightly closed vessels.

Penny finds[17] that the use of the strong ammonia undiluted in dissolving the copper is wasteful and unsafe. He recommends the following method of making the solution: "To one volume of 26° Beaumé ammonia (the strong ammonia of commerce) add from seven to eight volumes of water. Then add copper carbonate, best in successive quantities, until a large portion remains undissolved. The mixture should be vigorously agitated during the solution and finally allowed to subside, and the clear liquid poured off from the undissolved salt. A second portion should then be made by treating the residue of the former lot with more ammonia diluted as before, then with the addition of fresh copper carbonate, in every case with vigorous stirring or agitation. The method of making in successive lots will result in a richer solution of copper, at least unless an unwarranted length of time be taken." He finds that much less ammonia is required to dissolve a given amount of copper carbonate in this way than according to the method formerly followed of adding the strong, undiluted ammonia directly to the copper carbonate.

BORDEAUX MIXTURE.—This is made of various strengths. Successful results have been obtained at this Station and elsewhere with the 1 to 11 formula, that is to say with a mixture using one pound of copper sulphate for eleven gallons, and this is recommended for most purposes. In treating potato blights better results have been obtained from a stronger mixture, using the 1 to 7 formula, that is to say, one pound of copper sulphate for seven gallons of the mixture.

The formulæ referred to in this discussion may be given as follows:

1 to 7 formula: One lb. copper sulphate; ¾ lb. lime, fresh slaked; 7 gallons water.

---

17 Bull. 22, Del. Exp. Sta.

1 to 11 formula: One lb. copper sulphate; ¾ lb. lime, fresh slaked; 11 gallons water.

Preparation of Bordeaux Mixture.—Dissolve the copper sulphate and dilute with from half to two thirds of the required amount of water. Then add the lime in the form of thin whitewash, straining it if necessary to keep out particles that would clog the nozzle. Stir the mixture frequently and thoroughly as the lime is being added. Finally dilute to the required amount.

Dissolving the Copper Sulphate.—For practical operations the copper sulphate may be dissolved in large quantities and kept on hand as a stock solution, as advocated in Bulletin No. 67 of this Station, p. 195. Such a solution should be kept covered to prevent evaporation, which would increase its strength and finally cause the copper sulphate to crystallize on the sides and bottom of the cask in which it is kept. It appears that for all practical purposes a solution containing two pounds of copper sulphate to one gallon of water may safely be used for a stock solution. Thus, one hundred pounds of copper sulphate dissolved in fifty gallons of water contains two pounds for every gallon of the solution, so that one gallon of such a solution contains enough copper sulphate to make twenty-two gallons of Bordeaux mixture of the 1 to 11 formula, or fourteen gallons of Bordeaux mixture of the 1 to 7 formula.

If, instead of using the stock solution, copper sulphate is dissolved each time the mixture is prepared, it is well to get the pulverized copper sulphate instead of the crystals, as that dissolves more quickly. If the solution is wanted immediately, the copper sulphate may be dissolved in hot water. If it is to be dissolved in cold water, use a large amount of water and suspend it near the upper surface of the water, in a basket, coarse sacking, or any other receptacle through which water may pass readily. Copper sulphate should not be dissolved in iron vessels, as it corrodes them very rapidly.

Buying Copper Sulphate.—It is best to buy copper sulphate in sufficient quantity to get wholesale rates, for it may be kept from season to season without injuring its value.

Weighing and Straining the Lime.—When the mixture is used in power spraying machines with stationary nozzles it should be run through a sieve so as to take out all particles that might clog the nozzles. When hand pumps are used straining will not be necessary if care is used in pouring the lime.

The amount of lime necessary to form the Bordeaux mixture was formerly determined by weighing, using two-thirds as much lime as copper sulphate, but by means of the color tests as explained below the necessity of weighing the lime is now obviated.

Excess of Lime.—It is important that enough lime be added, otherwise the mixture may injure the foliage, while an excess of lime will not harm the foliage.

Color tests.—Various color tests may be used for determining whether or not sufficient lime has been added to the copper sulphate solution to form the Bordeaux mixture, as explained in Bulletin 84 of this Station. The one most commonly known is the potassium ferrocyanide test, which is used as follows:

Pour the lime into the copper sulphate solution, stir the mixture thoroughly and then add a drop of the potassium ferrocyanide. If enough lime has been added the drop will not change color when it strikes the mixture, otherwise it will immediately change to a dark reddish brown color. More lime must then be added till the potassium ferrocyanide does not change color when dropped into the mixture. It sometimes happens if the mixture has not been thoroughly stirred, that some of the copper sulphate in the bottom of the barrel has not yet been precipitated, while at the surface the mixture shows no color when the test is applied, so that after the mixture has been standing a few minutes the potassium ferrocyanide will again give the dark color, showing that not enough lime had been used. On this account it is best to add more lime after the test shows no change of color, thus insuring an excess of lime, which does no harm. A mixture with not enough lime in it will hurt the foliage.

The potassium ferrocyanide, also known as the yellow prussiate of potash, is a poisonous substance. It is a yellow salt which readily dissolves in water, and a solution may conveniently be kept on hand in a small bottle. The commercial form of the potassium ferrocyanide may be used. A few cents should purchase enough to last through the season.

COPPER SULPHATE SOLUTION.—As explained before, lime is added to the copper sulphate solution in making Bordeaux mixture, to prevent the solution from injuring the foliage or fruit, but in some cases the copper sulphate solution is used without the lime in making applications in the spring before the leaves put forth. It is made by simply dissolving the copper sulphate in water and diluting to the required strength. In treating raspberry canes for anthracnose before the buds open, we have used one pound of copper sulphate to eleven gallons of water, with good success. Do not prepare it in iron vessels.

IRON SULPHATE, OR COPPERAS, SOLUTION.—This solution will injure foliage and, like the copper sulphate solution, it is used only before the leaves put forth. It is commonly used as a saturated solution, that is to say, a solution made by allowing the water to take up all of the copperas that it is able to dissolve. This has been used against raspberry anthracnose and grape anthracnose before the buds open.

CORROSIVE SUBLIMATE SOLUTION (BICHLORIDE OF MERCURY).—This substance is very poisonous and care should be taken in handling it the same as in handling Paris green or London purple. The solution is used for soaking seed potatoes to kill the fungus which causes potato scab. One ounce of the corrosive sublimate is used for seven and a half or eight gallons of water. The seed is soaked for an hour in this solution. It dissolves more readily in hot water and may then be diluted to the required amount. It should be used in wooden or earthen vessels, not in metal. The solution may be used over and over again.

POTASSIUM SULPHIDE SOLUTION.—This solution has given good results in treating gooseberry mildew and various other mildews. It may be sprayed on the foliage at the strength herewith given, with no fear of injurious results. One ounce of the sulphide is used for two gallons of water. It dissolves more readily in hot water than in cold.

Insecticides.

Insects that chew their food are commonly fought by applying poison to their food. Among the prominent insecticides that are used in this way are Hellebore, London purple and Paris green.

Insects that suck their food pierce through the skin of the foliage with their mouth-parts and suck the juices of the leaf so that they are not injured by poisons that may be applied to the surface of the portion of the plant on which they feed. Aphis and the pear psylla belong to this class of insects. Against such insects kerosene emulsion is commonly used.

The following insecticides have been mentioned on previous pages:

CARBON BISULPHIDE.—The use of this substance is advocated for destroying the bean and pea weevils. It is highly explosive and no kind of fire or light should be allowed near it. It is a heavy, colorless liquid and the offensive fumes which it gives off are heavier than air. Care should be taken not to breathe them. In treating peas or beans with this substance it is placed in a shallow open vessel upon the peas or beans and allowed to evaporate, using it at the rate of about two small teaspoonfuls (two fluid drachms) to one cubic foot of space in the bin or receptacle that holds the beans or peas. It is well to cover the peas or beans with boards or blankets when they are being treated. Carbon bisulphide costs about ten cents per pound in fifty pound cans.

HELLEBORE.—Fresh white hellebore should be obtained. Mix one ounce in three gallons of water and apply for insects that chew. It is commonly used against the worms that infest currant and gooseberry foliage as it may safely be used even when the fruit is developing.

KEROSENE EMULSION.—This is made by dissolving one-half pound of either common soap or whale oil soap, in one gallon of soft water. Heat the mixture and when boiling hot remove it from near the fire and add it to two gallons of kerosene. The whole is now thoroughly mixed by pumping continuously through a small force pump for from five to ten minutes. Mix until the ingredients form a creamy mass that becomes thick when cool and from which the oil does not separate. When using on foliage dilute with from ten to fifteen parts of waters; when used as a winter treatment it may be applied as strong as one part of the mixture to four parts of water. In diluting the stock emulsion first use three or four parts of boiling water and then dilute to the required strength. Soak off with paper any free oil that appears on the surface as it will work injury if applied to the plant. This emulsion is used to kill insects that have sucking mouth parts; it is not a poison but kills by contact.

The emulsion causes rubber valves to swell and clog the tubes in which they work. Where rubber balls are used for valves they should be replaced with glass or marble balls when using the pump for kerosene emulsion.

LONDON PURPLE.— This, like Paris green, is an arsenical poison and is used against insects in the same way that Paris green is, and about the same proportion.

PARIS GREEN.— This is used to poison insects that have biting mouth parts. It may be applied either in the dry form or in a spray. When the spray is used the Paris green may be combined with Bordeaux mixture, or it may be applied mixed with water. In either case the same amount of poison is used. For pomaceous, or kernel fruits, one pound of Paris green to one hundred and fifty or two hundred gallons is commonly used. For stone fruits the mixture should be weaker, using one pound of Paris green to two hundred and fifty or three hundred gallons. When used with water, fresh slaked lime should be added to prevent injury to the foliage. Smith,[18] in 1892, recommended an equal weight, while Sirrine, in Bulletin 83 of this Station, recommends sixteen times as much fresh slaked lime by weight, as Paris green, for the purpose not only of preventing injury to the foliage by the Paris green, but also to make it stick to the foliage more firmly.

TOBACCO.— This is frequently used in greenhouses, and sometimes in gardens in the form of tobacco dust, against soft bodied insects like plant lice. The plants are dusted thoroughly with it on the first appearence of the insects and before they get established on the leaves. As a tea or decoction it is also often used by nurserymen against the lice which infest plum, cherry and other nursery trees. Tobacco stems, or any other cheap form of tobacco, is steeped and to the liquid thus prepared is added whale oil soap at the rate of about one pound for from six to eight gallons. Tobacco differs much in its strength and before using this preparation of whale oil soap and tobacco it should first be tested on the foliage to see how strong it may be used without injuring the foliage. No other method of determining the best strength at which it may be used can be safely followed. The preparation, after being properly diluted, is poured into shallow pans and the infested twigs are bent over and dipped in it. The lice at first are found chiefly on the tender leaves at the growing tip. The leaves soon become curled so that it is impossible to hit all insects with a spray and therefore dipping seems to be the best remedy in such instances. If careful watch is kept for the first appearance of the insects spraying can no doubt be used effectively if done promptly and thoroughly. Kerosene emulsion should then be used. It may also be used for dipping, diluted from twelve to fifteen times. Care should be taken that the emulsion is perfectly made and no free oil left floating on the surface, or the foliage will be injured by the oil.

WHALE OIL SOAP.— This is used in solution chiefly against soft bodied insects such as plant lice. It is commonly combined with a decoction of tobacco as stated above, at the rate of a pound to about eight gallons. When applied alone without the tobacco it is used stronger, taking one pound of soap to four or five gallons of water.

---

[18] Bulletin 86 : 7, and Annual Report of New Jersey Exp't Station, 1892 : 403.

REPORT

OF THE

FIRST ASSISTANT.

WILLIAM P. WHEELER.

REPORT OF THE FIRST ASSISTANT.

By William P. Wheeler.

Similar work to that of the preceeding year, has been in charge of the first assistant during the year 1895. The feeding of the dairy cattle has been superintended, as have also the feeding experiments with poultry and swine. Data concerning the yield and quality of crops from the field plats treated with crude chemicals were again collected. During the first few months of the year much time was spent in attending to part of the routine work connected with the general Station management. Some time has been occupied by a portion of the large amount of Station correspondence. Almost daily attention has necessarily been given to the feeding and care of live stock, but several farmer's meetings were attended, and talks given upon subjects relating to poultry keeping.

Cattle Feeding.

The coarse foods used during the year for feeding milch cows have been, timothy hay, clover hay, mixed hay, mostly timothy and clover, corn silage, alfalfa fodder, oat and pea fodder, corn fodder, carrots and beets. The grain foods used have been, wheat bran, corn meal, wheat middlings, ground oats, linseed meal, O. P., cottonseed meal, gluten meal ("King") and gluten feed.

Three times a day, at 5 o'clock a. m., at about 11.30 a. m. and at 5 o'clock, p. m., some coarse food has been given, either hay, silage or green fodder. Some mixed grain has always been fed separately, twice a day, morning and night, just before the coarse fodder has been weighed out to the cows. Milking has begun at 5 o'clock a. m. and at 5 o'clock p. m.

During January and February mixed hay was fed morning and night, and corn silage at noon. The mixed grain fed consisted of four parts wheat bran, two parts linseed meal, O. P., two parts cottonseed meal, two parts gluten meal and one part wheat middlings.

During March timothy hay was fed morning and night, corn silage at noon, and a mixed grain, consisting of three parts wheat bran, three parts linseed meal, O. P., three parts cottonseed meal, three parts gluten meal, and one part each of ground oats, corn meal and wheat middlings.

From April 1st to 15th clover hay was fed at night, corn silage morning and noon and a mixed grain containing five parts of wheat bran, three parts of linseed meal, O. P., two parts gluten meal, two parts corn meal and one part wheat middlings. For the latter half of the month carrots were fed in place of the corn silage.

From May 1st to 15th clover hay was fed at night, corn silage morning and noon, and a mixed grain composed of four parts wheat bran, two parts cottonseed meal, two parts linseed meal, O. P., one part corn meal and one part wheat middlings. For the rest of the month alfalfa fodder was fed three times daily and a mixed grain composed of four parts wheat bran, three parts corn meal, and one part each of cottonseed meal, linseed meal O. P., and wheat middlings.

From June 1st to 15th clover hay was fed at night, alfalfa fodder morning and noon. For the latter half of the month alfalfa fodder was fed at noon and corn silage morning and night. The grain mixture fed during the month was the same as that fed for the latter half of May.

During July oat-and-pea fodder was fed morning and night and alfalfa fodder at noon. The grain mixture consisted of five parts wheat bran, two parts corn meal, and one part each of wheat middlings, cottonseed meal, linseed meal O. P., ground oats and gluten feed.

For August the ration was the same excepting a very slight change in the grain, wheat bran being substituted for the one part of gluten feed.

For the month of September the ration was corn fodder morning and night, alfalfa fodder at noon and a grain mixture which contained five parts wheat bran, three parts cottonseed meal, two parts linseed meal O. P., and one part each of corn meal, wheat middlings and ground oats.

From the 1st to 15th of October corn fodder was fed three times daily. For the rest of the month clover hay was fed at night and beets morning and noon. The grain mixture fed throughout the month consisted of six parts wheat bran, three parts cottonseed meal, two parts linseed meal O. P., and one part each of wheat middlings and ground oats.

During November corn silage was fed morning and noon, clover hay at night and the same grain mixture that was fed in October.

For December it is intended to feed a ration of corn silage fed morning and noon, mixed clover hay fed at night and a grain mixture of six parts wheat bran, four parts linseed meal, O. P., and one part ground oats.

Cows in approximately the same stage of lactation have been fed as nearly alike as possible, but the proportions of the different foods were varied somewhat according to the condition, appetite, and age of the individual. Two of the cows which are subject to a skin disease in hot weather, were fed for grain during the summer months a mixture of wheat bran and ground oats. For about six weeks or two months before calving, little or no grain has been fed. For about a week, sometimes for several weeks after calving, little grain other than bran and ground oats has been fed.

Corn Silage for Milch Cows.

Silage, especially corn silage, has been fed now for so many years by successful farmers, that there is little doubt of this food being used to advantage. Feeding experiments made at different Stations to determine the value of corn silage as compared with dried corn fodder, corn stover, and other foods, especially roots, have shown the silage to be not inferior in feeding value. A majority of the feeding trials have shown a slight advantage in favor of silage over other forms in which the corn crop is usually fed, and generally greater profit in feeding silage than roots. The many inquiries however, relating to the value of corn silage, especially for milch cows, make it desirable to have as many additional data as possible from which to form opinion.

The results from a number of feeding periods in different years when corn silage has constituted part of the rations, have been averaged and arranged to show any changes in the yield and composition of milk accompanying changes in the food. Most of these records which follow have been prepared with the expectation of soon issuing them in a bulletin. The results which are reported were obtained from cows in the stage of lactation when a fair flow of milk of normal composition would be expected, and any general change in the quantity or quality of the milk, besides the gradual change as the period of lactation advanced, might be reasonably attributed to the influence of the different foods. Individual records for each cow were kept, separate analysis of the milk being made. Only the average results are here given. As varying amounts of milk of differing quality were given by different animals the actual weights of the several constituents yielded by each cow were considered in determining the average composition of all the milk.

For the purpose of securing data, other than those here reported, relative to the production of individual cows, it was necessary to feed a fairly constant proportion of grain at certain months of lactation. On this account no results are here reported that have been obtained when coarse fodder only was fed without grain. The grain was fed in moderate quantities, but always separately from the coarse fodder, so that if any should be left at any time it could be weighed. Feeding and milking were arranged as mentioned on page 391. The hay and coarse fodders were fed in quantities likely to be entirely eaten, but account was kept of any food left. Only the weight of food actually consumed is given in the tables. In estimating the amounts of digestible constituents in the different foods, the average co-efficients of digestibility obtained in digestive experiments in this country and Germany were used. Whenever enough data were available the American co-efficients were used.

In calculating the cost of the rations, wheat bran was rated at $18 per ton, corn meal at $20, ground oats at $25, linseed meal, O. P., at $27, gluten meal at $25, wheat middlings at $20, cottonseed meal at $30, gluten feed at $18, and ground flaxseed at $60 per ton. All hay was rated at $10 per ton, corn stover at $6, corn silage at $3, clover silage at $3, roots at $3, and all green fodder at $2 per ton. These prices are some of them much higher than those at this time prevailing, but it is thought better to assume the one valuation for any food throughout all the trials extended over portions of four seasons than to attempt to follow fluctuations of market price. Enough data are given to allow of recalculation, by any who may desire, of the cost of rations at other prices for foods than those stated.

Table I gives the results obtained in feeding seven cows from November 1st to January 31st. These cows, all young, had been in milk on the average 3.9 months at the beginning of this trial, and were then of the average age of 2.4 years.

During the month of November clover hay was fed morning and night, beets at noon, and a mixed grain (numbered 11) consisting of one part each of wheat bran and linseed meal O. P., and five parts each of corn meal and ground oats. The grain represented 51.1 per cent. of the cost of the ration and supplied 44.2 per cent. of the total digestible nutrients. The beets represented 17 per cent. of the cost of the ration and supplied 15.1 per cent of the total digestible nutrients.

For December mixed clover-and-timothy silage was fed at noon, clover hay morning and night and a grain mixture (No. 13) consisting of two parts wheat bran, four parts ground oats, five parts corn meal and one part linseed meal O. P. The grain represented 52.3 per cent. of the cost of the ration and supplied 43.9 per cent. of the total digestible nutrients. The silage represented 15.1 per cent. of the cost, and supplied 18.2 per cent. of the total digestible nutrients.

For the month of January clover hay was fed at noon, corn silage morning and night and the same mixed grain that was fed in December. The grain represented 51.9 per cent. of the cost of the ration and supplied 43.9 per cent. of the total digestible nutrients. The silage represented 27 per cent. of the cost and supplied 31.5 per cent. of the total digestible nutrients.

There was an average gain in live weight per cow for November of 12 pounds, an average loss during December of 2 pounds and a gain during January of 5 pounds. The greatest daily average yield of milk for the first period was 25 pounds and the smallest 14.8 pounds. The highest average percentage of fat was 6.41 and the lowest 3.35. For the second period the extreme average yields of milk were 23.4 pounds and 14.5 pounds, and the extremes in average percentage of fat 6.19 and 3.25. For the third period the extremes in daily average milk yield were 25.5 pounds and 13.8 pounds, and in average percentage of fat 6.45 and 3.30.

The change in the food from the first period to the second was principally one of clover-and-timothy silage for beets. The change in the grain, intentionally very slight, proved on analysis to be considerable. The results for the first period are given here in the same table with others for convenience of reference hereafter in another connection than that relating to the effects of corn silage.

In changing from the second period to the third when corn silage was substituted for the clover-and-timothy silage and part of the hay the cost of the ration was but slightly increased, the amount of

TABLE I—A.

PERIOD.	Average live weight per cow during period. Lbs.	AVERAGE PER DAY PER COW.						
		Water. Lbs.	Beets. Lbs.	Mixed clover silage. Lbs.	Clover hay. Lbs.	Mixed grain, No. 11. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
Nov. 1 to Nov. 30	787	55.4	18.29	....	10.26	7.31	35.86	17.17
Dec. 1 to Dec. 31.....	792	56.7	Corn silage.	15.28	9.87	No. 13. 7.23	32.38	18.47
Jan. 1 to Jan. 31	793	43.1	27.69	....	6.48	7.29	41.46	17.52

B.

PERIOD.	AVERAGE PER DAY PER COW.								
	Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Crude fibre in food. Lbs.	N. free extract in food. Lbs.	Fats, (ether ext.) in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbo-hydrates in food. (Fats x 2¼.)
Nov. 1 to Nov. 30..........	18.69	.96	2.28	3.70	9.45	.77	16.21	10.96	1 : 6.5
Dec. 1 to Dec. 31	13.91	1.13	2.38	4.54	9.46	.96	17.34	11.15	1 : 6.8
Jan. 1 to Jan. 31	23.94	.90	2.25	3.79	9.68	.90	16.62	11.18	1 : 6.9

C.

Period.	Nutritive ratio.	Per 1,000 Pounds Live Weight Fed.						
		Digestible protein. Lbs.	Digestible fibre. Lbs.	Digestible N. free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Nov. 1 to Nov. 30	1:6.7	1.92	2.17	9.19	.65	13.93	20.60	27444
Dec. 1 to Dec. 31.....	1:8.1	1.67	2.89	8.69	.85	14.08	21.89	28232
Jan. 1 to Jan. 31......	1:8.2	1.65	2.56	9.07	.82	14.10	20.96	28161

D

Period.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. total nitrogen compounds in milk.	Per cent. sugar in milk.	Average Per Day Per Cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Nitrogen compounds in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
Nov. 1 to Nov. 30............	.71	4.32	3.12	4.93	.13	.81	.59	.92	2.45
Dec. 1 to Dec. 31............	.73	4.54	3.42	5.13	.13	.78	.59	.88	2.38
Jan. 1 to Jan. 31............	.77	4.33	3.09	5.84	.14	.77	.55	1.04	2.50

E.

PERIOD.	Total cost of food; average per day per cow. Cents.	Milk yield; average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk solids. Cents.	Cost of food for one pound of fat in milk. Cents.
Nov. 1 to Nov. 30....	16.09	18.74	.92	7.01	21.20	.86	6.57	19.86
Dec. 1 to Dec. 31.....	15.14	17.13	1.08	7.76	23.68	.88	6.36	19.41
Jan. 1 to Jan. 31.....	15.38	17.87	.98	7.01	22.75	.86	6.15	19.97

digestible matter was about the same, the nutritive ratio but a trifle wider, and the fuel value not much changed. There followed a slight increase in the milk flow, and a slight decrease in the per cent. of fat, the amount of fat produced being about the same. No change of any consequence occurred in the cost of milk or of fat.

The composition for each food used during the three months is given in the following tabulated form:

	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	Nitrogen free extract Per cent.	Fats (ether extract) Per cent.	In Water-Free Substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Beets	89.0	1.0	1.5	.8	7.6	0.1	2.17	1.95
Clover hay, November	14.5	5.4	8.9	29.0	38.2	4.0	1.67	1.36
Clover hay, December and January	11.4	6.6	10.4	31.1	35.6	4.9	1.88	1.26
Clover and timothy silage	77.2	1.7	3.3	6.6	9.5	1.7	2.33	1.68
Corn silage	80.2	.9	2.6	4.7	10.3	1.3	2.11	1.11
Grain mixture, No. 11	12.8	3.1	15.0	7.8	56.7	4.6	2.75	2.03
Grain mixture, No. 13	13.6	3.0	11.8	6.4	62.2	3.0	2.19	2.16

In table II are given the results of a feeding trial with eight cows from October 21st to November 30th. The average age of these cows was 3.2 years and they had been in milk on the average 9.5 months at the beginning of this trial.

From October 21st to 31st, mixed hay was fed three times a day and a mixed grain consisting of seven parts wheat bran, five parts ground oats, and three parts each of corn meal and linseed meal, O. P. The grain represented 44.6 per cent. of the cost of the ration and supplied 36.1 per cent. of the total digestible nutrients.

From November 1st to 15th corn silage was fed at noon, mixed hay morning and night and the same mixed grain. The grain represented 47.3 per cent. of the cost of the ration and supplied 35.7 per cent. of the total digestible nutrients. The silage represented 13.4 per cent. of the cost and supplied 22.4 per cent, of the total digestible nutrients.

From November 16th to 30th mixed hay was fed at night and corn silage morning and noon. The grain was the same as for the preceding period. The grain represented 51.4 per cent. of the total cost and supplied 36.4 per cent. of the total digestible nutrients. The silage represented 27.3 per cent. of the cost of the ration and supplied 42.2 per cent. of the total digestible nutrients.

In changing from the first period to the second, when corn silage was substituted for part of the hay the amount of food digestible remained the same although the nutritive ratio was made slightly wider. The cost of the ration was somewhat lessened. A small increase in the milk flow and in the per cent. of fat in the milk followed the change and the cost of the milk and of the fat was somewhat reduced.

The second change to more silage and less hay made the nutritive ratio still wider, due to a lesser amount of protein digestible, there being little change in the amount of the other constituents. A somewhat increased flow of milk followed the second change but there was a falling off in the per cent. of fat. The lower cost of the ration lessened the cost of the milk and fat produced.

There was considerable gain in live weight during the first period and a small average loss during the two following periods. The greatest daily average yield of milk during the first period was 24 pounds and the smallest 8 pounds. The highest average per centage of fat was 6.21 and the lowest 3.05. For the second period the extremes in daily average milk yield were 24.8 pounds and 7·7 pounds and in per centage of fat 6.51 and 2.96. For the third period the extremes in daily average milk yield were 24.3 pounds and 8.5 pounds and in per centage of fat 6.38 and 2.82.

TABLE II—A.

PERIOD.	Average live weight per cow during period. Lbs.	AVERAGE PER DAY PER COW. Water. Lbs.	Corn silage. Lbs.	Mixed hay. Lbs.	Mixed grain No. 21. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
Oct. 21 to Oct. 31	926	75.3	.....	18.94	6.99	25.93	22.61
Nov. 1 to Nov. 15	938	63.8	14.38	12.69	7.00	34.07	21.57
Nov. 16 to Nov. 30	935	46.9	26.98	6.33	7.00	40.31	19.88

B.

PERIOD.	AVERAGE PER DAY PER COW. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Crude fibre in food. Lbs.	N. free extract in food Lbs.	Fats (ether extract) in food. Lbs.	Total organic matter in ration Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fats x 2¼.)
Oct. 21 to Oct. 31	3.32	1.15	2.80	5.25	12.66	.75	21.46	12.88	1:7.0
Nov. 1 to Nov. 15	12.50	1.03	2.57	4.52	12.72	.73	20.54	13.04	1:7.3
Nov. 16 to Nov. 30	20.43	.89	2.29	3.67	12.33	.70	18.99	12.78	1:7.7

C.

PERIOD.	Nutritive ratio.	Per 1,000 Pounds Live Weight Fed.						
		Digestible protein. Lbs.	Digestible fibre. Lbs.	Digestible N. free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Oct. 21 to Oct. 31	1:7.4	1.73	2.70	8.93	.55	13.91	23.17	27171
Nov. 1 to Nov. 15	1:7.9	1.64	2.44	9.24	.58	13.90	21.90	27223
Nov. 16 to Nov. 30	1:8.2	1.56	2.14	9.39	.58	13.67	20.31	26795

D.

PERIOD.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. total nitrogen compounds in milk.	Per cent. sugar in milk.	Average Per Day Per Cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Nitrogen compounds in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
Oct. 21 to Oct. 31.............	.77	4.50	4.18	4.75	.11	.63	.59	.67	2.00
Nov. 1 to Nov. 15..............	.77	4.60	3.77	5 11	.11	.65	.53	.73	2.02
Nov. 16 to Nov. 30............	.75	4.35	4.54	5.48	.11	.63	.56	.80	2.10

E.

PERIOD.	Total cost of food; average per day per cow. Cents.	Milk yield; average per day per cow Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk solids. Cents.	Cost of food for one pound of fat in milk. Cents.
Oct. 21 to Oct. 31.....	17.08	14.07	1.61	11.30	35.89	1.21	8.54	27.11
Nov. 1 to Nov. 15	16.12	14.20	1.52	10.68	33.18	1.14	7.98	24.80
Nov. 16 to Nov. 30 ...	14.83	14.54	1.37	9.47	31.56	1.02	7.06	23.54

The following table shows the composition of each food used :

FOODS.	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	Nitrogen free extract. Per cent.	Fats (ether extract) Per cent.	In Dry Substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Mixed Hay	13.2	4.6	9.0	24.7	46.2	2.3	1.67	1.55
Corn Silage	69.6	1.2	2.3	5.7	20.3	.9	1.21	1.08
Grain Mixture No. 21	11.7	4.0	15.7	8.1	56.1	4.4	2.85	2.68

In table III the average results obtained with six cows from December 1st to January 31st are given. These cows were of the average age of 3.3 years and had been in milk on the average 9.2 months at the beginning of the trial.

During the month of December mixed hay was fed at night, corn silage morning and noon, and a mixed grain (No. 23) composed of six parts wheat bran, five parts ground oats, two parts linseed meal O. P., and two parts cottonseed meal. The grain represented 51.8 per cent. of the cost of ration and supplied 34.4 per cent. of the total nutrients. The silage represented 27.5 per cent. of the cost and supplied 44.3 per cent. of the nutrients.

During the month of January corn silage was fed at noon and mixed hay morning and night, the mixed grain being the same as for the preceding month. The grain represented 51.1 per cent. of the cost of the ration, and supplied 36.2 per cent. of the total nutrients, the silage representing 15.1 per cent. of the cost and supplying 25.9 per cent. of the total nutrients.

There was an average gain in live weight per cow during December of 32 pounds, and during January of 13 pounds. After the change from the first period when silage was fed twice a day and hay once, to the second, when silage was fed but once a day, not so much food was eaten, and the amount of dry matter in the food consumed was consequently less. The nutritive ratio remained the same, and there was no change in the cost of the ration. There was considerable decrease in the total amount of constituents digestible and the fuel value was lower. The falling off in the milk yield was not much more than the normal. The higher percentage of fat made the amount produced about the same. There was considerable increase in the cost of milk, but little in the cost of fat.

For December the greatest daily average milk yield was 24.2 pounds and the smallest 9.4 pounds. The highest average per centage of fat was 6.27 and the lowest 3.15. For January the extremes in daily average milk yield were 20.9 pounds and 8.9 pounds and in average per centage of fat 6.30 and 3.46.

TABLE III — A.

PERIOD.	Average live weight per cow during period. Lbs.	Average Per Day Per Cow.					
		Water. Lbs.	Corn silage. Lbs.	Mixed hay. Lbs.	Mixed grain No. 23. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
Dec. 1 to Dec. 31	879	49.7	27.69	6.23	6.76	40.68	19.69
Jan. 1 to Jan. 31	902	49.6	15.13	10.18	6.64	31.95	19.18

B.

PERIOD.	Average Per Day Per Cow.								
	Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Crude fibre in food. Lbs.	N. free extract in food. Lbs.	Fats (ether extract) in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ration of total protein to total carbohydrates in food. (Fats x 2¼).
Dec. 1 to Dec. 31	20.99	.99	2.49	3.95	11.51	.75	18.70	12.49	1 6.9
Jan. 1 to Jan. 31	12.77	.95	2.29	4.32	10.88	.74	18.23	11.70	1:7.4

C.

PERIOD.	Nutritive ratio.	PER 1,000 POUNDS LIVE WEIGHT FED.						
		Digestible protein. Lbs.	Digestible fibre. Lbs.	Digestible N. free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Dec. 1 to Dec. 31	1:7.1	1.87	2.45	9.23	.67	14.21	21.27	28030
Jan. 1 to Jan. 31......	1:7.1	1.69	2.45	8.23	.61	12.97	20.21	25582

D.

PERIOD.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. total nitrogen compounds in milk.	Per cent. sugar in milk.	AVERAGE PER DAY PER COW.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Nitrogen compounds in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
Dec. 1 to Dec. 31............	.77	4.86	3.63	5.80	.12	.78	.58	.93	2.41
Jan. 1 to Jan. 31............	.73	5.27	3.44	5.98	.11	.77	.50	.88	2.26

E.

PERIOD.	Total cost of food; average per day per cow. Cents.	Milk yield; average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk solids. Cents.	Cost of food for one pound of fat in milk. Cents.
Dec. 1 to Dec. 31.....	15.07	16.08	1.22	8.17	25.24	.94	6.25	19.32
Jan. 1 to Jan. 31.....	15.04	14.62	1.31	8.49	24.91	1.03	6.65	19.53

The composition of each food used is shown in the following table:

FOODS.	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	N. free extract. Per cent.	Fats (ether extract). Per cent.	IN DRY SUBSTANCE.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Corn silage	69.6	1.2	2.3	5.7	20.3	.9	1.21	1.08
Mixed hay (December)	12.9	5.5	9.7	30.0	39.4	2.5	1.77	1.66
Mixed hay (January)	13.2	4.5	7.0	29.2	43.4	2.7	1.30	1.22
Grain No. 23	13.6	4.7	18.5	7.4	50.8	5.0	3.42	3.32

In table IV are given the average results obtained in a trial with seven cows during February and March. The average age was 3.4 years and the average time in milk was 5.5 months.

During February corn silage was fed at noon, mixed hay morning and night, and a mixed grain (No. 24) composed of seven parts wheat bran, five parts wheat middlings, one part linseed meal, O. P. and two parts cottonseed meal. The grain represented 45.3 per cent. of the cost of the ration and the silage 16 per cent. The grain supplied 35.0 per cent. of the nutritive substance and the silage 24.5 per cent.

In March hay was fed at noon, corn silage morning and night and mixed grain the same as before. The grain represented 47.6 per cent. of the cost of the food and the silage 32.0 per cent. The grain supplied 34.4 per cent. of the total nutritive substance and the silage 45.7 per cent. There was not much change in live weight during the trial, there being an average gain in February of four pounds and during March of but one pound. The change in the ration to more silage and less hay made but little reduction in the amount of dry substance, but there was an increase in the amount of digestible matter and the fuel value of the ration became somewhat higher. There was no change in the nutritive ratio. The cost of the ration was made a trifle less. There followed a falling off in the milk yield somewhat less than would be expected from the advance of lactation alone, and but very slight increase in the percentage of fat. There was little change in the cost of milk and fat produced.

For the first period the greatest daily average milk yield was 30.1 pounds, and the smallest 8.8 pounds. The highest average percentage of fat was 6.16 and the lowest 3.03. For the second period the extremes in average daily milk yield were 28.1 pounds and 8.8 pounds, and in average percentage of fat 6.30 and 3.70.

TABLE IV—A.

Period.	Average live weight per cow during period. Lbs.	Average Per Day Per Cow.					
		Water. Lbs.	Corn silage. Lbs.	Mixed hay. Lbs.	Mixed grain No. 24. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
Feb. 1 to Feb. 29	8.36	56.9	14.74	10.71	6.00	31.45	18.73
Mar. 1 to Mar. 31	8.39	42.6	28.79	5.52	6.16	40.47	18.45

B.

Period.	Average Per Day Per Cow.								
	Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Crude fibre in food. Lbs.	N. free extract in food. Lbs.	Fats (ether extract) in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fats x 2¼.)
Feb. 1 to Feb. 29	12.72	.92	2.20	4.29	10.60	.72	17.81	11.48	1:7.5
Mar. 1 to Mar. 31	22.02	.87	2.24	3.53	11.03	.78	17.58	11.98	1:7.3

C.

PERIOD.	Nutritive ratio.	Per 1,000 Pounds Live Weight Fed. Digestible protein. Lbs.	Digestible fibre. Lbs.	Digestible N. free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Feb. 1 to Feb. 29.....	1:7.6	1.69	2.63	8.78	.63	13.73	21.30	27025
Mar. 1 to Mar. 31.....	1:7.6	1.76	2.34	9.46	.72	14.28	20.95	28260

D.

PERIOD.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. total nitrogen compounds in milk.	Per cent. sugar in milk.	Average Per Day Per Cow. Ash in milk. Lbs.	Fat in milk. Lbs.	Nitrogen compounds in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
Feb. 1 to Feb. 29	.65	4.38	3.39	5.65	.13	.88	.68	1.14	2.83
Mar. 1 to Mar. 1	.67	4.44	3.46	6.01	.13	.85	.66	1.15	2.79

E.

PERIOD.	Total cost of food; average per day per cow. Cents.	Milk yield average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk-solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk-solids. Cents.	Cost of food for one pound of fat in milk. Cents.
Feb. 1 to Feb. 29.....	13.82	20.17	.93	6.62	21.28	.69	4.88	15.70
Mar. 1 to Mar. 31....	13.50	19.20	.96	6.61	21.71	.70	4.84	15.89

The following table shows the composition of each food used :

FOODS.	Moisture. Per cent.	Ash. Per cent.	Protein Per cent.	Crude fibre Per cent.	N. free extract Per cent.	Fats. Per cent.	IN DRY SUBSTANCE.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Corn silage	71.0	1.2	2.6	5.4	18.4	1.4	1.40	1.03
Mixed hay	13.2	4.5	7.0	29.2	43.4	2.7	1.30	1.22
Grain No. 24	14.1	4.4	17.8	6.0	54.0	3.7	3.31	3.31

In table V the data secured in a feeding trial with twelve cows during the months of November and December are given. These cows averaged 3.5 years in age, and had been in milk on the average 4.4 months at the beginning of the trial.

There were four periods of feeding, the ration being changed three times. The corn silage fed in the first period was replaced by a somewhat larger amount of beets in the second. In the third period there was a change of grain, making the nutritive ratio narrower, and more beets were fed. In the fourth period corn silage was substituted in lesser amount for the beets of the third period. Owing to a limited supply of beets, the third period was two days shorter than any other.

From November 1st to 15th, inclusive, mixed hay (mostly timothy), was fed at night, and a mixed grain (No. 28) composed of five parts wheat bran, three parts ground oats, and two parts each of linseed meal O. P., and cottonseed meal. The grain represented 47.1 per cent of the cost of the ration, and the silage 36.4 per cent. The grain supplied 27.7 per cent. of the total nutritive substance, and the silage 56.1 per cent.

From November 16th to November 30th, hay and grain were fed as in the preceding period, although in increased amounts, and beets were fed morning and noon. The grain represented 43.9 per cent. of the cost of the ration, and the beets 40.4 per cent. The grain supplied 39.7 per cent. of the nutritive substance, and the beets 41.1 per cent.

From December 1st to 13th, inclusive, beets and hay were fed as in the preceding period. The grain mixture (No. 29) was composed of five parts wheat bran, four parts linseed meal O. P. and one part each of ground oats, wheat middlings, and cottonseed meal. The grain represented 45.6 per cent. of the cost of the ration and the beets 38.9 per cent. The grain supplied 37.0 per cent. of the total nutritive substance and the beets 44.0 per cent.

From December 14th to 31st hay and grain were fed as during the first part of the month, the hay in somewhat smaller amount, and corn silage was fed morning and noon. The grain represented 52.7 per cent. of the cost of the ration and the silage 32.6 per cent. The grain supplied 38.9 per cent. of the total nutritive substance and the silage supplied 45.0 per cent.

During the month of November there was an average loss of 7 pounds in weight and during December an average gain of 48 pounds.

TABLE V—A.

PERIOD.	Average live weight per cow during period. Lbs.	AVERAGE PER DAY PER COW. Water. Lbs.	Corn silage. Lbs.	Beets. Lbs.	Mixed hay. Lbs.	Mixed grain No. 28. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
Nov. 1 to Nov. 15	948.0	58.3	42.83	....	5.80	7.15	55.78	24.72
Nov. 16 to Nov. 30	945.0	47.1	....	50.26	6.72	8.13	65.11	20.26
						No. 29		
Dec. 1 to Dec. 13	955.0	44.5	....	57 99	6.97	8.95	73.91	22.77
Dec. 14 to Dec. 31	979.0	54.2	39.87	....	5.38	8.49	53.74	22.51

B.

PERIOD.	AVERAGE PER DAY PER COW. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Crude fibre in food. Lbs.	N. free extract in food. Lbs.	Fats (ether extract) in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fats x 2¼.)
Nov. 1 to Nov. 15	31.06	1.07	2.76	4.93	14.53	1.43	23.65	15.94	1:8 2
Nov. 16 to Nov. 30	44.85	1.34	2.77	2.87	12.54	.73	18.92	14.17	1:6.2
Dec. 1 to Dec. 13	51.14	1.54	3.44	3.03	13.90	.88	21.23	16.39	1:5.5
Dec. 14 to Dec. 31	31.23	1.08	2.42	4.07	12.77	1.18	21.43	14.84	1:5.7

C.

PERIOD.	Nutritive ratio.	Per 1,000 Pounds Live Weight Fed.						
		Digestible protein. Lbs.	Digestible fibre. Lbs.	Digestible N. free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Nov. 1 to Nov. 15	1 : 8.5	1.93	2.92	10.77	1.19	16.81	24.95	34075
Nov. 16 to Nov. 30	1 : 6.1	2.20	1.45	10.78	.56	14.99	20.02	29203
Dec. 1 to Dec. 13	1 : 5.2	2.89	1.61	12.02	.64	17.16	22.23	33427
Dec. 14 to Dec. 31	1 : 5.5	2.51	2.36	9.35	.94	15.16	21.89	30416

D.

PERIOD.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. total nitrogen compounds in milk.	Per cent. sugar in milk.	Average Per Day Per Cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Nitrogen compounds in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
Nov. 1 to Nov. 15	.72	3.84	3.53	5.15	.16	.86	.79	1.15	2.96
Nov. 16 to Nov. 30	.70	3.89	3.59	5.34	.15	.81	.75	1.11	2.82
Dec. 1 to Dec. 13	.70	4.03	3.73	5.29	.15	.83	.77	1.09	2.84
Dec. 14 to Dec. 31	.73	4.16	3.83	5.35	.14	.81	.75	1.05	2.75

E.

PERIOD.	Total cost of food; average per day per cow. Cents.	Milk yield; average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk solids. Cents.	Cost of food for one pound of fat in milk. Cents.
Nov. 1 to Nov. 15.....	17.63	22.42	1.10	8.35	28.74	.79	5.96	20.50
Nov. 16 to Nov. 30....	21.51	20.74	.98	7.18	25.01	1.04	7.63	26.56
Dec. 1 to Dec. 13......	22.34	20.59	1.11	8.02	27.43	1.08	7.87	26.92
Dec. 14 to Dec. 31....	18.32	19.56	1.15	8.19	27.80	.94	6.66	22.62

After changing from the first period to the second more food was eaten but there was less dry matter in the ration. The cost of the ration was much increased. There was a smaller amount of digestible matter, although there was more digestible protein and the nutritive ratio was made narrower. The fuel value of the ration was noticeably less. Considerably more than the normal decrease in milk flow followed the change in food and the cost of milk and fat production was greater.

For the third period the amount of each food was increased and a change in the grain made a narrower nutritive ratio. There was an increase in each food constituent and in the fuel value of the ration. The cost of the ration was made a little greater. There followed almost no decrease in the milk flow and very slight increase in the cost of milk or fat.

In changing to the fourth period of feeding the cost of the ration was much reduced, less grain and coarse food were eaten. Although the amount of dry matter in the food was not changed less was digestible. The nutritive ratio was a trifle wider and the fuel value was lower. There was about the normal falling off in milk, but the cost of milk and fat produced was considerably less.

During the first period the greatest daily average milk yield was 37.7 pounds, and the smallest 13.2 pounds. The highest average percentage of fat was 6.40 and the lowest 2.60. For the second period the extremes in daily average milk yield were 3.50 pounds and 12.3 pounds, and in average percentage of fat 6.48 and 2.75. For the third period the extremes in milk yield were 38.9 pounds and 12.5 pounds, and in average percentage of fat 6.18 and 2.51. For the fourth period the extremes in milk yield were 36.8 pounds and 11.8 pounds, and in average percentage of fat 6.85 and 2.68.

In the following table is shown the composition of each food.

FOODS.	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	N. free extract. Per cent.	Fats (ether extract). Per cent.	In Dry Substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Corn silage (Nov. 1 to Nov. 15)	68.4	1.2	2.8	5.9	19.8	1.9	1.44	1.26
Corn silage (Dec. 14 to Dec. 31)	74.3	1.1	2.6	5.0	15.6	1.4	1.62	1.07
Mixed hay	11.5	4.6	5.4	28.9	45.4	4.2	.97	.96
Beets	85.0	1.4	1.5	.8	11.0	.3	1.63	1.04
Grain No. 28	15.3	4.1	17.5	10.0	47.8	5.3	3.31	3.06
Grain No. 29	11.7	4.6	24.5	6.2	48.4	4.6	4.43	4.38

In table VI are given the results of a short feeding trial in June with twelve young cows of the average age of 3 years. They had been in milk on the average 7.1 months.

For the first half of the month corn silage was fed in the morning, green alfalfa fodder at noon and mixed hay at night. The grain fed (No. 17) consisted of four parts wheat bran, four parts ground oats, five parts corn meal and two parts gluten meal. The grain represented 52.4 per cent. of the cost of the ration and the silage and green fodder 24.6 per cent. The grain supplied 38.3 per cent. of the digestible nutrients and the silage and green fodder 37.7 per cent.

For the latter half of the month, alfalfa fodder was fed morning and noon and hay at night. The grain was not changed. The grain represented 54.5 per cent. of the cost of the ration and the green fodder 21.7 per cent. The grain supplied 36.2 per cent. and the green fodder 40.9 per cent. of the digestible nutrients.

During the latter period when alfalfa fodder was substituted for the silage, somewhat more food was eaten and there was in consequence a little more digestible matter. The cost of the ration was somewhat lessened. The nutritive ratio was made narrower. There was little change in the milk flow but the milk showed a lower percentage of fat. There was little change in the cost of milk and a slight increase in the cost of fat.

There was an average gain in weight of 21 pounds during the month. For the first period the greatest daily average milk yield was 22.6 pounds and the smallest 11.0 pounds, the highest average percentage of fat was 5.71 and the lowest 2.76. For the last period the extremes in daily average milk yield were 23.9 pounds and 10.0 pounds and in average percentage of fat 6.17 and 2.80.

TABLE VI — A.

PERIOD.	Average live weight per cow during period. Lbs.	Average Per Day Per Cow.						
		Water. Lbs.	Corn silage. Lbs.	Alfalfa fodder. Lbs.	Mixed hay. Lbs.	Mixed grain No. 17. Lbs.	Total food. Lbs.	Total dry matter in food.
June 1 to June 15.....	833.	60.9	12.63	14.91	6.32	6.72	40.58	18.65
June 16 to June 30....	844.	61.6	....	28.86	6.33	6.75	41.94	19.77

B.

PERIOD.	Average Per Day Per Cow.								
	Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Crude fibre in food. Lbs.	N. free extract in food. Lbs.	Fats (ether extracts) in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fats x 2¼.)
June 1 to June 15...........	21.93	1.07	2.97	4.15	9.33	1.16	17.58	11.49	1:5.4
June 16 to June 30..........	22.17	1.27	3.52	4.47	9.30	1.21	18.50	12.14	1:4.7

C.

Period.	Nutritive ratio.	Per 1,000 Pounds Live Weight Fed.						
		Digestible protein. Lbs.	Digestible fibre.	Digestible N. free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
June 1 to June 15	1:5.8	2.22	2.58	8.02	.97	13.79	21.10	27939
June 16 to June 30	1:4.7	2.71	2.63	8.08	.96	14.38	21.93	29012

D.

Period.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. nitrogen compounds in milk.	Per cent. sugar in milk.	Average Per Day Per Cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Nitrogen compounds in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
June 1 to June 15	.75	4.10	3.76	5.20	.13	.71	.65	.90	2.39
June 16 to June 30	.70	3.66	3.43	4.31	.12	.63	.59	.74	2.08

E.

PERIOD.	Total cost of food; average per day per cow. Cents.	Milk yield; average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk solids. Cents.	Cost of food for one pound of fat in milk. Cents.
June 1 to June 15	13.75	17.31	1.08	7.80	26.27	.79	5.75	19.37
June 16 to June 30 ...	13.29	17.19	1.15	9.50	31.38	.77	6.39	21.10

The composition of each food is shown in the following tabulated form:

FOODS.	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	N. free extract. Per cent.	Fats (ether extract). Per cent.
Corn silage	77.6	1.0	3.0	5.4	11.5	1.5
Alfalfa	71.9	2.4	6.6	7.3	10.1	1.7
Mixed hay	10.1	5.9	10.2	32.2	36.1	5.5
Grain No. 17	11.5	3.1	14.4	4.7	60.8	5.5

In table VII are recorded the data obtained in a feeding trial extending from November 1st to January 31st. The figures show the average from six cows 5.1 years old, and 5.7 months in milk on the average, November 1st. The beets of the first month's feeding were replaced by corn silage in the second month, and for the third month less silage was fed and a change in the grain made.

For the first month, November, mixed hay was fed at night and beets morning and noon. The mixed grain (No. 44) consisted of five parts wheat bran, two parts corn meal, two parts gluten meal and one part each of ground oats, wheat middlings, linseed meal O. P. and cottonseed meal. The grain represented 39.7 per cent. of the cost of the ration and the beets 38.9 per cent. The grain supplied 34.2 per cent. of the total nutritive substance and the beets 41.5 per cent.

For December the same hay and mixed grain were fed and corn silage took the place of beets. Of the cost of the ration the grain represented 40.2 per cent. and the silage 42.0 per cent. Of the total nutritive substance 30.9 per cent. came from the grain and 51.0 per cent. from the silage.

In January corn silage was fed at noon, mixed hay morning and night, and a mixed grain composed of four parts of wheat bran, two parts each of linseed meal O. P., cottonseed meal and gluten meal, and one part each of corn meal and wheat middlings. The grain represented 43.7 per cent. and the silage 22.5 per cent. of the cost of the ration. Of the nutritive substance the grain supplied 34.2 per cent. and the silage 28.9 per cent.

There was little change in live weight during the first period, the average loss in weight per cow being one pound. During the second period there was an average gain of 66 pounds, and during the last period an average gain of 40 pounds.

In changing from the first ration to the second there was an increase of the total food and of every digestible constituent. The nutritive ratio was made wider and the fuel value increased. Less hay was eaten and but very little more grain, the change was mostly due to a larger amount of silage being eaten than had been of beets. The cost of the ration was slightly increased. There followed a noticeable increase in the milk flow and in the per cent. of fat in the milk. The cost of milk was somewhat lessened and also the cost of fat.

TABLE VII — A.

PERIOD.	Average live weight per cow during period. Lbs	AVERAGE PER DAY PER COW.						
		Water. Lbs	Corn silage. Lbs.	Beets. Lbs.	Mixed hay. Lbs.	Mixed grain, No. 44. Lbs.	Total food. Lbs	Total dry matter in food. Lbs.
Nov. 1 to Nov. 30	953.	39.8	......	44.71	7.40	6.33	58.44	18.50
Dec. 1 to Dec. 31	985.	43.1	49.23	......	6.27	6.52	62.02	22.69
Jan. 1 to Jan. 31	1039.	59.0	27.26	......	12.28	No.45 6.91	46.45	22.97

B.

PERIOD.	AVERAGE PER DAY PER COW.								
	Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Crude fibre in food. Lbs.	N. free extract in food. Lbs.	Fats (ether extracts) in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fats x 2¼.)
Nov. 1 to Nov. 30	39.94	1.27	2.51	2.78	11.33	.61	17.23	13.00	1.62
Dec. 1 to Dec. 31	39.33	1.00	2.87	4.51	13.27	1.04	21.69	14.82	1.70
Jan. 1 to Jan. 31	23.48	1.11	3.24	5.24	12.36	1.02	21.86	14.20	1.61

C.

PERIOD.	Nutritive ratio.	Per 1,000 Pounds Live Weight Fed.						
		Digestible protein. Lbs.	Digestible fibre. Lbs.	Digestible N. free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Nov. 1 to Nov. 30	1:6.3	1.95	1.48	9.72	.49	13.64	18.08	26537
Dec. 1 to Dec. 31	1:7.4	1.92	2.64	9.63	.85	15.05	22.02	29980
Jan. 1 to Jan. 31	1:6.0	2.10	2.65	8.15	.77	13.67	21.04	27243

D.

PERIOD.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. total nitrogen compounds in milk.	Per cent. sugar in milk.	Average Per Day Per Cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Nitrogen compounds in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
Nov. 1 to Nov. 30	.68	4.03	3.93	5.12	.15	.87	.84	1.10	2.96
Dec. 1 to Dec. 31	.61	4.48	3.87	5.14	.14	1.01	.88	1.16	3.19
Jan. 1 to Jan. 31	.64	4.59	3.96	5.17	.14	1.01	.87	1.14	3.16

E.

PERIOD.	Total cost of food; average per day per cow. Cents.	Milk yield; average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk-solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk-solids. Cents.	Cost of food for one pound of fat in milk. Cents.
Nov. 1 to Nov. 30.......	17.27	21.44	.86	6.25	21.26	.81	5.83	19.85
Dec. 1 to Dec. 31.......	17.58	22.63	1.00	7.11	22.47	.78	5.51	17.41
Jan. 1 to Jan. 31.......	18.18	21.96	1.05	7.27	22.74	.83	5.75	18.00

By a change in the grain for the third period, when less silage was fed and more hay, the nutritive ratio was made narrower, also a little narrower than it had been in the first period. The total dry matter in the ration for the third period was no less, but there was less digestible matter and a little lower fuel value. The cost of the ration was somewhat increased. There was a diminution of the milk flow but much less than the normal and the percentage of fat was slightly increased. There was a small increase in the cost of milk and fat production.

During November the greatest daily average milk yield was 31.2 pounds and the smallest 14.9 pounds. The highest average percentage of fat was 5.90 and the lowest 2.75. For December the extremes in daily average milk yield were 33.1 pounds and 15.4 pounds, and the extremes in average percentage of fat 6.15 and 3.00. For January the extremes in milk yield were 33.9 pounds and 13.2 pounds and in percentage of fat 6.40 and 2.85.

The composition of each food is shown in the following table:

FOODS.	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	N. free extract. Per cent.	Fats (ether extract). Per cent.	IN DRY SUBSTANCE.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Beets	85.4	1.5	1.4	.8	10.8	.1	1.49	.75
Corn silage (Dec.)	76.6	.9	2.1	4.9	14.5	1.0	1.48	1.03
Corn silage (Jan.)	77.0	.9	2.0	4.5	14.6	1.0	1.38	.77
Mixed hay (Nov. and Dec.)	14.0	4.9	7.2	29.0	42.8	2.1	1.35	1.24
Mixed hay (Jan.)	13.9	4.8	7.4	30.0	41.8	2.1	1.38	1.17
Mixed grain No. 44	11.4	3.8	21.3	4.3	52.8	6.4	......	3.66
Mixed grain No. 45	11.3	3.9	25.7	4.8	47.2	7.1	4.63	4.35

The data secured in a feeding trial extending from March 1st to May 15th are given in table VIII. The results are from eight cows which had been in milk on the average 3.2 months by March 1st and averaged 5.2 years of age. There was an increase April 1st in the amount of silage that had been fed during March and a change in the grain and hay that made a "narrower" ration. A second change was made April 15th in which carrots took the place of the silage. On May 1st there was a change back to silage with some change also in the grain.

During March corn silage was fed at noon, timothy hay morning and night and a mixed grain (No. 46) composed of three parts each of wheat bran, linseed meal O. P., cottonseed meal and gluten meal, and one part each of ground oats, corn meal and wheat middlings. The grain represented 38.6 per cent. of the cost of the ration and the silage 25.8 per cent. The grain supplied 24.2 per cent. of the nutritive substance and the silage 38.2 per cent.

From April 1st to 15th corn silage was fed morning and noon, and clover hay at night. The grain (No. 47) consisted of five parts wheat bran, three parts linseed meal O. P., two parts corn meal, two parts gluten meal and one part wheat middlings. Of the cost of the ration the grain represented 41.9 per cent. and the silage 40.7 per cent. Of the total nutritive substance the grain supplied 29.3 per cent. and the silage 53.9 per cent.

For the latter half of April carrots were fed morning and noon, clover hay at night, and the same grain mixture fed during the first half of the month. Of the cost of the ration the grain represented 42.8 per cent. and the carrots 38.8 per cent. Of the nutritive substance the grain supplied 40.8 per cent. and the carrots 35.0 per cent.

From May 1st to 15th, inclusive, corn silage was fed morning and noon and clover hay at night. The grain mixture (No. 48) consisted of four parts wheat bran, two parts linseed meal O. P., two parts cottonseed meal and one part each of wheat middlings and corn meal. Of the cost of the ration the grain represented 43.7 per cent. and the silage 37.9 per cent. Of the nutritive substance the grain supplied 30.4 per cent. and the silage 50.7 per cent.

During March there was an average gain in live weight of 29 pounds. During April there was an average loss of 74 pounds. For the last period of the trial the average gain in weight was about 15 pounds.

TABLE VIII — A.

PERIOD.	Average live weight per cow during period. Lbs.	Average Per Day Per Cow.						
		Water. Lbs.	Corn silage. Lbs.	Carrots. Lbs.	Timothy hay. Lbs.	Mixed grain, No. 46. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
March 1 to March 31	962	71.9	28.15	......	11.66	5.20	45.01	23.60
					Clover hay.	No. 47.		
April 1 to April 15	952	62.2	47.98	......	6.14	6.87	60.99	25.27
April 16 to April 30	915	47.6	......	44.78	6.35	6.90	58.03	16.82
						No. 48.		
May 1 to May 15	908	74.3	43.31	......	6.28	6.63	56.22	23.01

B.

PERIOD.	Average Per Day Per Cow.								
	Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs	Crude fibre in food. Lbs.	N. free extract in food. Lbs.	Fats (ether extract) in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fats x 2¼.)
March 1 to March 31	21.41	1.01	2.73	5.17	13.42	1.27	22.59	15.14	1:7.9
April 1 to April 15	35.72	1.33	3.35	4.73	14.68	1.18	23.94	16.56	1:6.6
April 16 to April 30	41.21	1.16	2.67	2.79	9.50	.70	15.66	11.94	1:5.2
May 1 to May 15	33.21	1.23	3.09	4.43	12.76	1.50	21.78	14.93	1:6.7

C.

PERIOD.	Nutritive ratio.	Per 1000 Pounds Live Weight Fed.						
		Digestible protein. Lbs.	Digestible fibre. Lbs.	Digestible N. free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration Lbs.	Calories of energy in ration. Cal.
March 1 to March 31	1 : 7.6	1.98	3.04	9.69	1.04	15.74	23.48	31749
April 1 to April 15	1 : 6.9	2.37	2.85	11.20	.98	17.39	25.15	34677
April 16 to April 30	1 : 5.1	2.24	1.61	8.62	.58	13.05	17.11	25642
May 1 to May 15	1 : 6.7	2.35	2.75	10.08	1.27	16.44	23.99	35454

D.

PERIOD.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. total nitrogen compounds in milk.	Per cent. sugar in milk	Average Per Day Per Cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Nitrogen compounds in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
March 1 to March 31	.62	4.02	3.46	5.27	.17	1.10	.95	1.44	3.66
April 1 to April 15	.65	4.27	3.66	5.25	.18	1.18	1.01	1.46	3.83
April 16 to April 30	.60	3.95	3.59	5.04	.14	.93	.84	1.18	3.09
May 1 to May 15	.62	3.94	3.58	5.12	.15	.97	.88	1.26	3.26

E.

PERIOD.	Total cost of food; average per day per cow. Cents.	Milk yield; average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water free food consumed for one pound of milk solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk solids. Cents.	Cost of food for one pound of fat in milk. Cents.
March 1 to March 31 . .	16.37	27.32	.86	6.45	21.45	.60	4.47	14.88
April 1 to April 15. . . .	17.69	27.69	.91	6.60	21.42	.64	4.60	14.99
April 16 to April 30. . .	17.34	23.45	.72	5.44	18.09	.74	5.61	18.65
May 1 to May 15	17.13	24.59	.94	7.06	23.72	.70	5.25	17.66

At the first change in the ration there was an increase in the total food, in the total digestible nutrients, and in the fuel value. The nutritive ratio was made narrower and the cost of the ration increased. There was a slight increase in the milk yield, in the per cent. of fat, and also in the cost of milk and fat production. When carrots took the place of silage in the ration for the third period, there was considerable falling off in the amount of dry matter in the food. There was no decrease in the amount of grain or of hay fed, and the principal changes in the composition of the ration were due to the unwillingness or inability of the cows to eat the quantity of carrots desired. There was little decrease in the amount of digestible protein although considerable in the amount of every other constituent. The fuel value was much lower and the nutritive ratio considerably narrower. The cost of the ration was somewhat reduced. There was a decided falling off in the milk flow—much more than the normal decrease, and the per cent. of each constituent in the milk was less. There was an increase in the food cost of milk and fat. Less water-free food, however, was consumed for an equal production of milk or fat, than during the preceding or following periods.

For the third period there was a slight change in the make up of the grain mixture, but almost none in its chemical composition. Corn silage was substituted for the carrots of the preceding period. There was an increase in the amount of dry matter in the food and in the amount digestible of each constituent. The nutritive ratio was made wider and the fuel value much higher. The cost of the ration was a trifle lessened. There followed an increase in the milk flow with but little change in the composition of the milk. The cost of milk was somewhat reduced and also the cost of fat.

For the first period the greatest daily average milk yield was 39.5 pounds and the smallest 12.07 pounds. The highest average percentage of fat was 6.32 and the lowest 2.98. For the second period the extremes in daily average milk yield were 40.1 pounds and 19.0 pounds. The extremes in average percentage of fat were 6.00 and 2.95. For the third period the extremes in average milk yield were 34.0 pounds and 17.9 pounds, and in average percentage of fat 5.70 and 2.95. For the fourth period the extremes in daily average milk yield were 29.6 pounds and 18.2 pounds, and in average percentage of fat 5.75 and 2.80.

Each food used had the composition shown in the following table:

FOODS.	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	N. free extract. Per cent.	Fats (ether extract). Per cent.	In Dry Substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Corn silage (March)	68.7	1.3	2.7	5.4	20.1	1.8	1.40	.87
Corn silage (April)	71.2	1.6	2.5	5.3	18.1	1.3	1.38	.88
Corn silage (May)	73.1	1.4	2.4	5.1	16.0	2.0	1.42	.89
Timothy hay	13.0	3.8	4.5	29.0	46.9	2.8	.82	.75
Clover hay (April)	11.7	5.0	9.5	29.4	41.8	2.6	1.73	1.55
Clover hay (May)	12.6	4.9	7.8	29.2	41.1	4.4	1.42	1.22
Carrots	88.5	1.3	1.1	1.2	7.6	.3	1.59	.81
Mixed grain No. 46	10.6	3.9	27.9	5.2	44.2	8.2	5.00	4.67
Mixed grain No. 47	12.2	3.7	22.9	5.5	49.9	5.8	4.18	3.87
Mixed grain No. 48	11.5	4.8	23.5	5.9	49.0	5.3	4.26	3.69

The data for two short periods in October and November which show the effect of another change of food from beets to corn silage are given in table IX. Eight cows were used that had been in milk on the average 7.3 months and were of the average age of 4.8 years.

During the latter part of October mixed hay was fed at noon, beets morning and night, and a mixed grain (No. 35) consisting of six parts wheat bran, three parts gluten feed, and one part each of corn meal, wheat middlings and linseed meal O. P. The grain represented 40.3 per cent. and the beets 43.6 per cent. of the cost of the ration. The grain supplied 35.2 per cent. and the beets 46.6 per cent. of the total digestible nutrients in the ration. Of the ration for the rest of the month the nutritive ratio had been the same, the same grain and hay had been fed, but green alfalfa and sorghum fodder had been fed instead of beets.

During November corn silage took the place of beets. No change was made in the grain or hay. Of the cost of the ration, the grain represented the same percentage as the silage, that of 41.5. Of the total nutrients the grain supplied 35.0 per cent. and the silage 48.0 per cent.

By the change from beets to silage the amount of dry matter in the food consumed was somewhat increased although there was a falling off in the amount digestible. The nutritive ratio was made wider and the fuel value somewhat less. The cost of the ration was reduced. The diminution in the milk flow following the change in the ration was very slight and the per cent. of fat was higher.

The cost of milk and fat production was lessened. There was some loss in the live weight during October, and during November an average gain of 63 pounds. The greatest daily average milk yield for the first mentioned period was 29.5 pounds and the smallest 9.5 pounds. The highest average percentage of fat was 6.25 and the lowest 2.70. For the last period the extremes in daily average milk yield were 29.2 pounds and 12.3 pounds, and in average percentage of fat 6.45 and 3.10.

In the same table, No. IX, are included for convenience of future reference, the data obtained with these same cows for two periods immediately preceding those just mentioned. During the month of September alfalfa fodder was fed in the morning, mixed hay at noon and corn fodder at night. The mixed grain (No. 34) consisted of five parts wheat bran, five parts corn meal, four parts gluten meal,

TABLE IX — A.

PERIOD.	Average live weight per cow during period. Lbs.	AVERAGE PER DAY PER COW. Water. Lbs.	Corn fodder. Lbs.	Alfalfa fodder. Lbs.	Mixed hay. Lbs.	Mixed grain No. 34. Lb.	Total food. Lbs.	Total dry matter in food. Lbs.
Sept. 1 to Sept. 30	919	69.0	28.99	24.79	5.55	7.35	66.68	25.76
Oct. 1 to Oct. 20	921	65.5	Sorghum. 27.81	24.71	5.51	No. 35. 7.06	65.09	23.35
Oct. 21 to Oct. 31	909	42.6	. . . .	Beets. 50.98	5.65	7.40	64 03	19.65
Nov. 1 to Nov. 30	935	54.4	Corn Silage. 44.75	. . . .	5.49	7.03	57.27	20.90

B.

PERIOD.	AVERAGE PER DAY PER COW. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Crude fibre in food. Lbs.	N. free extract in food. Lbs.	Fats (ether extracts) in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fats x 2¼.)
Sept. 1 to Sept. 30	40 92	1.28	3.31	5.29	14.22	1 66	24.48	16.85	1 : 7.0
Oct. 1 to Oct. 20	41.74	1.33	3.11	4.62	1[illegible].86	1.43	22.02	15.15	1 : 6.7
Oct. 21 to Oct. 31	44.38	1.52	2.45	2.53	12.21	.94	18.13	14.09	1 : 6.9
Nov. 1 to Nov. 30	36.37	1.14	2.38	4.52	11.90	.96	19.76	13.59	1 : 7.8

C.

PERIOD.	Nutritive ratio.	Per 1,000 Pounds Live Weight Fed. Digestible protein. Lbs.	Digestible fibre. Lbs.	Digestible N. free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Sept. 1 to Sept. 30	1:7.2	2.43	2.93	11.64	1.34	18.34	26.64	37265
Oct. 1 to Oct. 20......	1:6.8	2.30	2.62	10.42	1.11	16.45	23.91	33217
Oct. 21 to Oct. 31	1:6.8	2.11	1.42	11.25	.72	15.50	19.94	30529
Nov. 1 to Nov. 30.....	1:8.1	1.71	2.81	9.23	.78	14.53	21.13	28867

C.

PERIOD.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. total nitrogen compounds in milk.	Per cent. sugar in milk.	Average Per Day Per Cow. Ash in milk. Lbs.	Fat in milk. Lbs.	Nitrogen compounds in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
Sept. 1 to Sept. 30	.63	4.12	3.90	5.21	.15	1.00	.95	1.26	3.36
Oct. 1 to Oct. 20	.61	4.40	4.12	5.10	.13	.96	.90	1.11	3.10
Oct. 21 to Oct. 31	.66	4.44	4.26	5.21	.13	.88	.84	1.03	2.88
Nov. 1 to Nov. 30	.65	4.66	4.09	5.08	.13	.92	.82	.99	2.86

E.

PERIOD.	Total cost of food; average per day per cow. Cents.	Milk yield; average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk solids. Cents.	Cost of food for one pound of fat in milk. Cents.
Sept. 1 to Sept. 30....	16.40	24.25	1.06	7.67	25.76	.68	4.88	16.40
Oct. 1 to Oct. 20......	14.74	21.76	1.07	7.53	24.32	.68	4.71	15.35
Oct. 21 to Oct. 31.....	17.53	19.85	.99	6.82	22.33	.88	6.09	19.92
Nov. 1 to Nov. 30......	16.16	19.49	1.07	7.31	22.72	.83	5.65	17.57

two parts ground oats, and one part each of wheat middlings, linseed meal O. P., cottonseed meal, and ground flaxseed. The grain represented 50.3 per cent. of the cost of the ration and the silage 32.8 per cent. Of the total digestible nutrients the grain supplied 30.6 per cent. and the green fodder 55.0 per cent. The extremes in daily average milk yield were 31.9 pounds and 17.7 pounds, and the extremes in average percentage of fat 5.45 and 2.85.

For the first twenty days of October alfalfa fodder was fed in the the morning, sorghum fodder at night and mixed hay at noon. The mixed grain (No. 35) consisted of six parts wheat bran, three parts gluten feed and one part each of corn meal, wheat middlings and linseed meal O. P. Of the cost of the ration the grain represented 45.7 per cent. and the green fodder 35.6 per cent. Of the digestible constituents the grain supplied 31.2 per cent. and the green fodder 52.3 per cent. The extremes in daily average milk yield were 30.6 pounds and 14.5 pounds and in average percentage of fat 6.10 and 2.80. There was an average gain in live weight during September of 18 pounds and an average loss during October of 18 pounds.

In the following table is given the composition of each food used during the three months:

FOODS.	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	N. free extract. Per cent.	Fats (ether extract). Per cent	In Dry Substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Corn fodder	73.4	1.1	2.2	4.8	17.1	1.4	1.34	1.15
Sorghum fodder	75.3	1.0	1.5	5.1	16.0	1.1	1.00	.86
Alfalfa fodder (Sept.)	73.3	2.0	4.7	7.5	10.9	1.6	2.81	2.15
Alfalfa fodder (Oct.)	77.7	2.3	5.2	4.8	8.4	1.6	3.70	2.60
Beets	83.8	2.0	1.9	.9	11.0	.4	1.85	.96
Corn silage	77.2	1.4	1.7	5.7	13.4	.6	1.22	.56
Mixed hay (Sept.)	12.7	4.1	5.1	28.4	45.2	4.5	....	....
Mixed hay (Oct.)	10.9	4.1	4.8	28.5	47.4	4.3	.86	.85
Mixed hay (Nov.)	15.1	4.6	8.5	27.8	40.2	3.8	1.60	1.51
Grain No. 34	10.5	3.3	16.5	6.3	55.3	8.1	2.95	2.92
Grain No. 35	14.1	3.7	16.3	6.2	52.9	6.8	3.03	2.88

The data for two periods of a feeding trial which show the results accompanying an increase in the amount of silage in the ration, two feeds of silage a day and one of hay taking the place of two feeds of hay and one of silage, are given in table X. Seven cows were used in the trial of the average age of 4.6 years and they had been in milk on the average 4.2 months.

From February 16th to 28th, inclusive, corn silage was fed at noon, mixed clover hay morning and night and a mixed grain (No. 37) consisting of six parts wheat bran, five parts gluten feed, two parts cottonseed meal and one part linseed meal O. P. Of the cost of the ration the grain represented 43.8 per cent. and the silage 24.1 per cent. Of the nutritive substance the grain supplied 36.7 per cent. and the silage 40.9 per cent.

During March corn silage was fed morning and noon and mixed clover hay at night. The grain mixture was the same as during February. Of the cost of the ration the grain represented 44.4 per cent. and the silage 34.7 per cent. Of the nutritive substance the grain supplied 36.7 per cent. and the silage 40.9 per cent.

By the change in the ration the nutritive ratio was made a trifle wider, the fuel value slightly less, the dry matter in the food consumed and the amount of digestible nutruients somewhat less. The cost of the ration was reduced. There followed a slight falling off in the milk yield, considerably less, however, than might normally be expected without change of food. The percentage of fat was a trifle lower. Little change occurred in the food cost of milk or fat.

For the month of February there was an average gain in weight of about 36 pounds and during March an average gain of about 4 pounds. From February 16th to 28th the greatest daily average milk yield was 43.0 pounds and the smallest 13.7 pounds. The highest average percentage of fat was 6.00 and the lowest 2.65. During March the extremes in daily average milk yield were 44.0 pounds and 12.1 pounds and in average percentage of fat 6.25 and 2.90.

The data for three periods preceding these two which have just been considered, in which the same cows were used, are included in the same table for convenience. The results will be referred to in some of the following pages.

TABLE X—A.

PERIOD.	Average live weight per cow during period. Lbs.	Average Per Day Per Cow.						
		Water. Lbs.	Corn ilage. Lbs.	Corn stover. Lbs.	Clover hay. Lbs.	Mixed grain No. 36. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
Jan. 1 to Jan. 15	974.0	71.4	26.63	....	10.54	7.11	44.28	20.68
Jan. 16 to Jan. 31	964.0	59.5	24.52	4.58	5.57	7.03	41.70	19.39
						No. 37.		
Feb. 1 to Feb. 15	968.0	62.4	27.82	3.95	5.79	7.60	45.16	20.49
Feb. 16 to Feb. 28	986.0	66.4	27.80	....	11.13	7.44	46.37	21.83
Mar. 1 to Mar. 31	997.0	59.1	37.44	....	6.79	7.07	51.30	19.07

B.

PERIOD	Average Per Day Per Cow.								
	Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Crude fibre in food. Lbs.	N. free extract in food. Lbs.	Fats (ether extract) in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fats x2¼.)
Jan. 1 to Jan. 15	23.60	1.11	2.60	4.44	11.67	.86	19.57	13.04	1:6.9
Jan. 16 to Jan. 31	22.31	1.05	2.44	4.08	11.02	.80	18.34	12.55	1:6.9
Feb. 1 to Feb. 15	24.67	1.17	2.97	4.26	11.03	1.06	19.32	13.20	1:6.0
Feb. 16 to Feb. 28	24.54	1.25	3.12	4.72	11.64	1.10	20.58	13.62	1:6.0
Mar. 1 to Mar. 31	31.23	1.14	2.88	4.05	10.94	1.06	17.93	12.91	1.6.0

C.

PERIOD.	Nutrative ratio.	Per 1,000 Pounds Live Weight Fed.						
		Digestible protein. Lbs.	Digestible fibre. Lbs.	Digestible N. free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Jan. 1 to Jan. 15......	1:6.9	1.80	2.37	8.56	.66	13.39	20.09	26463
Jan. 16 to Jan. 31....	1:7.0	1.72	2.40	8.26	.63	13.02	19.02	25685
Feb. 1 to Feb. 15.....	1:5.8	2.18	2.47	8.12	.87	13.64	19.96	27424
Feb. 16 to Feb. 28....	1:5.7	2.21	2.46	8.28	.86	13.81	20.87	27716
Mar. 1 to Mar. 31.....	1:5.9	2.04	2.23	7.84	.84	12.95	17.98	26069

D.

PERIOD.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. total nitrogen compounds in milk.	Per cent. sugar in milk.	Average Per Day Per Cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Nitrogen compounds in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
Jan. 1 to Jan. 15............	.62	4.50	3.84	5.19	.17	1.20	1.03	1.39	3.79
Jan. 16 to Jan. 31............	.65	4.57	4.02	5.04	.16	1.13	.99	1.24	3.52
Feb. 1 to Feb. 15.............	.67	4.35	3.67	5.06	.18	1.18	.99	1.37	3.72
Feb. 16 to Feb. 28............	.63	4.39	3.60	5.08	.17	1.17	.95	1.35	3.64
Mar. 1 to Mar. 31.............	.60	4.25	3.75	5.08	.16	1.10	.97	1.31	3.54

E.

PERIOD.	Total cost of food; average day per cow. Cents.	Milk average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat in milk. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk-solids. Cents.	Cost of food for one pound of fat in milk. Cents.
Jan. 1 to Jan. 15.....	16.35	26.71	.77	5.46	17.23	.61	4.31	13.63
Jan. 16 to Jan. 31.....	14.84	24.64	.79	5.51	17.16	.60	4.22	13.13
Feb. 1 to Feb. 15......	15.98	27.03	.76	5.51	17.36	.59	4.30	13.54
Feb. 16 to Feb. 28.....	17.30	26.51	.82	6.00	18.66	.65	4.75	14.79
Mar. 1 to Mar. 31.....	16.21	25.83	.74	5.39	17.34	.63	4.58	14.74

The composition of each food used is here shown in tabulated form:

FOODS.	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	N. free extract. Per cent.	(Ether fats extract) Per cent.	IN DRY SUBSTANCE.	
							Total nitrogen. Per cent.	Alluminoid nitrogen. Per cent.
Corn silage	77.9	1.4	2.0	4.8	13.1	.8	1.45	.97
Mixed clover hay	17.9	4.9	8.0	25.5	41.6	2.1	1.57	1.40
Corn stover	27.2	4.8	6.1	22.2	38.5	1.2	1.34	1.08
Mixed grain No. 36	13.7	3.1	17.3	6.6	53.2	6.1	3.21	2.70
Mixed grain No. 37	11.9	4.1	22.5	7.4	45.3	8.8	4.08	3.75

SUMMARY OF FEEDING TRIALS WITH CORN SILAGE.

The feeding trials just reported, although some of them for periods necessarily rather short, were repeated several seasons and the results given are the average from a number of different cows. The indications in general given, therefore, of the value of corn silage can hardly be considered accidental.

The following average of all the analyses made of fourteen different lots of corn silage will give an idea of the general composition of the silage fed :

Per cent. of moisture	73.66
Per cent. of ash	1.22
Per cent. of protein	2.39
Per cent. of true albuminoids	1.61
Per cent. of crude fibre	5.31
Per cent. of N.-free extract	16.12
Per cent. of crude fats (ether extract)	1.30

Corn silage has always been very palatable and has been readily eaten at all seasons of the year, and when fed in conjunction with many other attractive fodders.

In determining the cost of milk for purposes of comparison in the preceding tables the cost of the food eaten was alone considered. The absolute cost of milk or butter production was not given. There would be more variation in the net cost due to different conditions of keeping the cattle and handling the products than in the gross food cost of milk or fat. The manurial values of the foods were not taken into account, although under favorable conditions the net cost to the farm of milk would be much influenced by the fertilizing values of the foods. There would be however, except where especial attention is given to careful handling of manure, only a small proportion of the total possible amount recovered. There were not great variations in the fertilizing values of the different rations fed.

None of the rations fed was extreme. All approximated to those that would be generally considered best suited to the foods composing them. At no time was silage fed exclusively, one or two feeds of silage a day with grain, and generally hay, being given.

When corn silage replaced some other food or the amount of silage in the ration was increased there followed in seven instances a decrease in the cost of milk (five times, the decrease was slight) once there was a slight increase in cost and in one instance little change. There was an increase in the yield of milk in six instances (twice the increase was slight) and in three instances a slight decrease, less than the normal.

When the change was from a ration containing corn silage to one containing less silage or not any, there followed an increase in the cost of milk in four instances and little change once. There was a decrease in the milk yield in four instances (once small—less than normal) and little change in one instance.

When corn silage replaced some other food in the ration or the amount of silage was increased there followed a decrease in the cost of fat in six instances (once but little), a slight increase in cost twice and little change in one instance. There was an increase in the amount of fat in five instances (three times slight), little change in amount three times, and a small decrease once.

When the change was from a ration containing corn silage to one containing less or not any, there followed an increase in the cost of fat in five instances (in three of them the increase was small). There was a decrease in the amount of fat in three instances and little change in amount twice.

When the change in the ration was to more silage or to silage in place of some other food there followed an increase in the per cent. of fat in the milk in six instances, (three times the increase was slight), a decrease in two instances and little change once.

After a change from a ration containing corn silage to one containing less silage or not any, there followed a decrease in the per cent. of fat in the milk in two instances, an increase in two instances (one of them slight), and little change once.

In general there has been an increase in milk flow accompanying the use of corn silage in the ration and at the same time an increase in the amount of fat, the per cent. of fat not diminishing. At the valuations for foods given on page 394 milk has very generally been produced at lower cost and the cost of the production of fat has been lower while corn silage has constituted part of the ration.

Miscellaneous Feeding Trials.

Besides those feeding trials just considered in which the results accompanying the use of corn silage are especially noticed, it is thought well to also report at this time the results obtained in several other feeding periods. These average data are here given for publication in permanent form, so that they may be available for future reference in connection with the data of other feeding trials found in this and the preceding annual report, when we wish to consider the effect of the general composition of the ration on the product from milch cows.

Especial attention is called as in the preceding reports to the relative proportions of the total digestible nutrients supplied by the green fodders of the ration and by the mixed grains, and also to the percentage of the cost of the ration represented. At the prices of foods consumed, there has always been a cheaper supply of nutriment in the green fodder or in silage than in grain. The grain usually supplies a larger proportion of protein and when the amount of this important constituent is lacking in the coarse food, helps adjust the ration to the supposedly proper balance. Alfalfa or oat-and-pea fodder contains however as large a proportion of nitrogenous matter as do ordinary grain mixtures. Equal nutriment is of course always supplied in smaller bulk by grain than by the coarse foods. Owing to the much cheaper supply of nutriment in the green fodders it is important to consider any information which may help us to determine the relative amounts of grain and coarse foods that can be fed to best advantage under different conditions. It is expected that the results of future feeding experiments considered in connection with the data given in these reports will help toward more definite knowledge in this respect.

The data from a short feeding trial of three periods with young cows are given in table XI. The cows were of the average age of 2.3 years and had been in milk a little over three months when the trial began. Hay and mixed grain were fed throughout, but sorghum fodder was fed during the first period, corn fodder during the second and beets during the third.

From October 1st to 10th sorghum fodder was fed at noon, clover hay morning and night and a mixed grain, No. 11, consisting of five parts each of ground oats and corn meal and one part each of wheat bran and linseed meal O. P. Of the cost of the ration the grain represented 57.6 per cent. and the sorghum 13.9 per cent. Of the total digestible nutrients the grain supplied 43.0 per cent. and the sorghum 25.5 per cent. From October 11th to 20th corn fodder took the place of sorghum in the first ration, otherwise there was no change in the food except that somewhat larger quantities of hay

TABLE XI — A.

PERIOD.	Average live weight per cow during period. Lbs.	Average Per Day Per Cow.						
		Water. Lbs.	Sorghum forage. Lbs.	Corn forage. Lbs.	Clover hay. Lbs.	Mixed grain No. 11. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
Oct. 1 to Oct. 10......	811.	62.6	18.01	....	7.43	6.64	32.08	16 27
Oct. 11 to Oct. 20.....	805.	56.8	....	19.35	8.09	7.13	33.57	15.76
Oct. 21 to Oct. 31.....	799.	54.9	Beets. 18.23	....	8.40	7.13	33.76	15.42

B.

PERIOD.	Average Per day Per Cow.								
	Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Crude fibre in food. Lbs.	N. free extract in food. Lbs.	Fats (ether extract) food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protien to total carbohydrates in food (Fats x 2 1-4)
Oct. 1 to Oct. 10..........	15.81	.81	2.20	3.62	8.83	.81	15.46	10.23	1:6.5
Oct. 11 to Oct. 20..........	17.81	.87	2.16	3.84	9.07	.82	14.89	10.54	1;6.8
Oct. 21 to Oct. 31........	18.34	.85	2.09	3.15	8.64	.69	14.57	10.04	1;6.4

C.

PERIOD.	Nutritive ratio.	Per 1,000 Pounds Live Weight Fed.						
		Digestible protein. Lbs.	Digestible fibre. Lbs.	Digestible N. free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Oct. 1 to Oct. 10	1:7.2	1.65	2.16	8.11	.69	12.61	19.06	25083
Oct. 11 to Oct 20	1:7.2	1.70	2.39	8.29	.72	13.09	18.50	26065
Oct. 21 to Oct. 31	1:6.6	1.76	1.83	8.40	.58	12.57	18.24	24749

D.

PERIOD.	Per cent. ash in milk.	Per cent. fat in mlik.	Per cent. total nitrogen compounds in milk.	Per cent. sugar in milk.	Average Per Day Per Cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Nitrogen compounds in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
Oct. 1 to Oct. 10	.72	4.80	3.15	4.90	.13	.84	.55	.86	2.38
Oct. 11 to Oct. 20	.73	4.18	3.33	5.14	.14	.78	.62	.96	2.50
Oct. 21 to Oct. 31	.71	4.30	3.08	5.34	.13	.78	.56	.97	2.44

E.

PERIOD.	Total cost of food; average per day per cow. Cents.	Milk yield; average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk solids. Cents.	Cost of food for one pound of fat in milk. Cents.
Oct. 1 to Oct. 10......	12.98	17.56	.93	6.84	19.37	.74	5.45	15.45
Oct. 11 to Oct. 20	13.99	18.76	.84	6.30	20.21	.75	5.59	17.94
Oct. 21 to Oct. 31	14 95	18.20	.85	6.32	19.77	.82	6.13	19.17

and grain were eaten. The grain represented 57.3 per cent. of the cost and the corn fodder 13.8 per cent. The grain supplied 44.8 per cent. of the total digestible nutrients and the corn fodder 22.0 per cent. For the rest of the month beets were fed in place of corn fodder. The beets represented 18.3 per cent. of the cost of the ration and the grain 53.1 per cent. The beets supplied 16.5 per cent. of the digestible nutrients and the grain 47 per cent. The rations for the three periods did not differ much in composition. The nutritive ratio for the third period was somewhat narrower than for the others. The cost of the ration increased with each change.

There was an average loss in weight during the month of about 18 pounds. The greatest daily average milk yield for the first period was 25.5 pounds and the smallest 14.2 pounds. The highest average percentage of fat was 6.41 and the lowest 3.79. For the second period the extremes in daily average milk yield were 25.5 pounds and 14.1 pounds and in average percentage of fat 5.74 and 3.33. For the third period the extremes in daily average milk yield were 24.6 pounds and 13.5 pounds and in average percentage of fat 6.07 and 3.17.

The following table shows the composition of each food:

FOODS.	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	N. free extract. Per cent.	Fats (ether extract.) Per cent.	In Dry Substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Sorghum fodder	77.1	1.1	3.0	5.3	12.4	1.1	2.07	1.38
Corn fodder	81.3	1.1	1.9	4.8	10.0	.9	1.62	1.16
Beets	89.0	1.0	1.5	.8	7.6	.1	2.17	1.95
Clover hay	14.5	5.4	8.9	29.0	38.2	4.0	1.67	1.36
Mixed grain, No. 11	12.8	3.1	15.0	7.8	56.7	4.6	2.75	2.03

In table XII are the data from two feeding periods which show the results accompanying a change in the ration from oat-and-pea fodder and hay to alfalfa fodder and corn silage, which without much other change in the ration considerably widened the nutritive ratio. Twelve cows were used of the average age of three years They had been in milk on the average about 6.3 months at the beginning of this trial.

From July 1st to 15th oat-and-pea fodder was fed morning and noon and clover hay at night. The mixed grain, No. 17, which was fed during both periods, consisted of five parts corn meal and four parts each of ground oats and wheat bran. The green fodder represented 23.9 per cent. of the cost of the ration and the grain 52.0 per cent. The green fodder supplied 40.3 per cent. of the total digestible nutrients and the grain supplied 37.4 per cent.

From July 16th to 31st corn silage was fed morning and noon and alfalfa fodder at night. The silage and green fodder represented 44.9 per cent. of the cost of the ration and the grain 55.1 per cent. The silage and green fodder supplied 60.4 per cent. of the total digestible nutrients and the grain 39.6 per cent.

There was an average loss in weight per cow of about 4 pounds during the month. For the first period the greatest daily average yield of milk was 31.1 pounds and the smallest 9.9 pounds. The highest average percentage of fat was 5.70 and the lowest 2.30. For the second period the extremes in daily average milk yield were 31.2 pounds and 9.5 pounds, and in average percentage of fat 5.50 and 2.40.

TABLE XII — A.

PERIOD.	Average live weight per cow during period. Lbs.	AVERAGE PER DAY PER COW. Water. Lbs.	Oat and pea fodder. Lbs.	Corn silage. Lbs.	Clover hay. Lbs.	Mixed grain, No 17. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
July 1 to July 15	815	52.6	31.09	......	6.25	6.46	43.80	18.16
July 16 to July 31	813	43.0	Alfalfa. 13.33	28.91	......	6.66	48.90	16 86

B.

PERIOD.	AVERAGE PER DAY PER COW. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Crude fibre in food. Lbs.	N. free extract in food. Lbs.	Fats (ether extract) in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fats x 2¼.)
July 1 to July 15	25.64	1.08	3.00	4.25	8.83	1.00	17.08	11.98	1.51
July 15 to July 31	32.04	.92	2.21	2.88	10.07	.78	15.94	11.62	1.67

C.

Period.	Nutritive ratio.	Per 1,000 Pounds Live Weight Fed.						
		Digestible protein. Lbs.	Digestible fibre. Lbs.	Digestible N. free extract. Lbs.	Digestible fat. Lbs.	Total Digestible nutrient. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
July 1 to July 15	1:5.7	2.34	3.37	8.11	.87	14.70	20.96	29377
July 16 to July 31	1:7.5	1.80	2.10	9.62	.77	14.29	19.61	28397

D.

Period.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. total nitrogen compounds in milk.	Per cent. sugar in milk.	Average Per Day Per Cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Nitrogen compounds in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
July 1 to July 15	.69	3.82	3.37	4.83	.12	.66	.58	.83	2.19
July 16 to July 31	.72	3.64	3.54	4.93	.13	.63	.62	.86	2.24

E.

PERIOD.	Total cost of food; average per day per cow. Cents.	Milk yield; average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk-solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk solids. Cents.	Cost of food for one pound of fat in milk. Cents.
July 1 to July 15....	12.99	17.14	1.06	8.29	27.52	.76	5.93	19.68
July 16 to July 31....	12.64	17.41	.97	7.53	26.76	.73	5.64	20.06

The average composition of each food used is shown in the following table:

FOODS	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	N. free extract. Per cent.	Fats (ether extract). Per cent.	In Dry Substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Oat-and-pea fodder	77.8	1.8	3.5	6.8	8.9	1.2	2.54	1.66
Alfalfa fodder	73.9	2.7	4.6	6.3	11.6	.9	2.83	2.09
Corn silage	74.1	1.2	2.2	6.0	15.5	1.0	1.35	1.19
Clover hay	11.4	5.1	15.6	29.5	34.1	4.3	2.82	1.52
Mixed grain, No. 17	11.5	3.1	14.4	4.7	60.8	5.5	2.60	2.60

In table XIII are given the data for two feeding periods in the second of which beets took the place in the ration that alfalfa fodder had in the first, enough change in the grain being made to keep the nutritive ratio from becoming unusually wide. In this trial seven cows were used, which averaged in age about 5.5 years and had been in milk about 5.8 months.

From October 16th to 31st alfalfa fodder was fed morning and noon and mixed timothy hay at night. The mixed grain, No. 43, consisted of six parts corn meal, five parts wheat bran and one part each of wheat middlings, linseed meal O. P., cottonseed meal and gluten feed. The grain represented 44.6 per cent. of the cost of the ration and the alfalfa 32.0 per cent. The grain supplied 32.1 per cent. of the digestible nutrients and the alfalfa 46.8 per cent.

From November 1st to November 15th mixed timothy hay was fed at night, beets morning and noon and a mixed grain, No. 44, composed of five parts wheat bran, two parts corn meal, two parts gluten meal and one part each of ground oats, wheat middlings, linseed meal O. P. and cottonseed meal. The grain represented 40.1 per cent. of the cost of the ration and the beets 39.5 per cent. The grain supplied 34.6 per cent. of the total digestible nutrients and the beets 42.2 per cent.

The change to beets made a more expensive ration and the efficiency was not increased. There was a slight average loss in weight during both periods. For the first period the greatest daily average milk yield was 32.6 pounds and the smallest 17.1 pounds. The highest average percentage of fat was 5.60 and the lowest 2.70. For the second period the extremes in daily average milk yield were 30.9 pounds and 15.6 pounds, and in average percentage of fat 6.00 and 2.60.

TABLE XIII—A.

PERIOD.	Average live weight per cow during period. Lbs.	Average Per Day Per Cow.						
		Water. Lbs.	Alfalfa fodder. Lbs.	Beets. Lbs.	Mixed timothy hay. Lbs.	Mixed grain No. 43. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
Oct. 16 to 31	972	61.6	46.62	......	6.80	6.40	59.82	22.68
Nov. 1 to 15........................	968	41.2	......	45.59	7.09	No. 44. 6.40	59.08	18.43

B.

PERIOD.	Average Per Day Per Cow.								
	Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Crude fibre in food. Lbs.	N. free extract in food. Lbs.	Fats (ether extract) in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fats x 2¼).
Oct. 16 to 31	37.14	1.55	3.93	4.52	11.66	1.02	21.13	14.53	1:4.7
Nov. 1 to Nov. 15	40.65	1.27	2.51	2.70	11.34	.61	17.16	13.02	1:6.1

C.

PERIOD.	Nutritive ratio.	Per 1,000 Pounds Live Weight Fed.						
		Digestible protein. Lbs.	Digestible fibre. Lbs.	Digestible N. free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Oct. 16 to Oct. 31	1:4.6	2.82	2.35	9.04	.74	14.95	21.74	29553
Nov. 1 to Nov. 15	1:6.3	1.93	1.42	9.63	.48	13.45	17.73	26168

D.

PERIOD.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. total nitrogen compounds in milk.	Per cent. sugar in milk.	Average Per Day Per Cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Nitrogen compounds in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
Oct. 16 to Oct. 31	.63	3.91	3.90	4.95	.15	.90	.89	1.13	3.07
Nov. 1 to Nov. 15	.65	3.81	3.97	5.23	.14	.82	.85	1.13	2.94

E.

PERIOD.	Total cost of food; average per day per cow. Cents.	Milk yield; average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk solids. Cents.	Cost of food for one pound of fat in milk. Cents.
Oct. 16 to Oct. 31......	14.56	22.91	.99	7.39	25.20	.64	4.74	16.18
Nov. 1 to Nov. 15......	17.32	21.53	.86	6.25	22.48	.80	5.89	21.12

The foods used had the composition shown in the following table :

FOODS.	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	N. free extract. Per cent.	Fats (ether extract). Per cent.	In Dry Substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Alfalfa fodder	76.5	2.3	5.5	4.8	9.7	1.2	3.73	2.94
Beets	85.4	1.5	1.4	0.8	10.8	0.1	1.49	0.75
Mixed timothy hay (Oct.)	11.6	4.1	4.2	29.6	48.5	2.0	.76	.69
Mixed timothy hay (Nov.)	14.0	4.9	7.2	29.0	42.8	2.1	1.35	1.24
Mixed grain No. 43	10.8	3.2	16.8	4.2	60.0	5.0	3.02	2.94
Mixed grain No. 44	11.4	3.8	21.3	4.3	52.8	6.4	3.85	3.66

In table XIV are recorded the data of a feeding trial during May and June, including four periods of feeding. Seven cows were used in this trial of 5.1 years average age. They had been in milk on the average about 4.7 months at the beginning. In the second period alfalfa fodder took the place of the corn silage and clover hay of the first, some change also being made in the grain. In the third period hay was again fed in place of some of the green alfalfa, and in the fourth period corn silage replaced the hay and part of the alfalfa of the ration for the third period. By the first change in the ration the nutritive ratio was made narrower. By the second change the nutritive ratio was not much affected; but the third change was from a "narrower" to a much "wider" ration, with considerable increase in the total food owing to the greater palatability of the corn silage over the clover hay.

From May 1st to 15th corn silage was fed morning and noon and clover hay at night. The mixed grain No. 48 consisted of four parts wheat bran, two parts linseed meal O. P., two parts cottonseed meal, and one part each of corn meal and wheat middlings. The grain represented 43 per cent. of the cost of the ration and the silage 38.3 per cent. The grain supplied 29.8 per cent. of the digestible nutrients and the silage 51.1 per cent.

From May 16th to 31st alfalfa fodder was fed three times daily, The mixed grain, No. 49, consisted of four parts wheat bran, three parts corn meal, and one part each of wheat middlings, linseed meal O. P. and cottonseed meal. The grain represented 49.0 per cent. of the cost of the ration and the alfalfa 51.0 per cent. The grain supplied 36.1 per cent. of the total digestible nutrients and the alfalfa 63.9 per cent.

From June 1st to 15th alfalfa fodder was fed morning and noon clover hay at night and the same grain mixture that was used in the preceding period. The grain represented 45.2 per cent. of the cost of the ration and the alfalfa 35.1 per cent. The grain supplied 36.3 per cent. of the total digestible nutrients and the green fodder 47.7 per cent.

From June 16th to 30th corn silage was fed morning and night and alfalfa fodder at noon. No change was made in the grain. The grain represented 41.7 per cent. of the cost of the ration and the silage and green fodder 58.3 per cent. The grain supplied 26.7 per cent. and the silage and green fodder 73.3 per cent. of the total digestible nutrients.

TABLE XIV — A.

PERIOD.	Average live weight per cow during period. Lbs.	AVERAGE PER DAY PER COW. Water. Lbs.	Corn silage. Lbs.	Alfalfa forage. Lbs.	Clover hay. Lbs.	Mixed grain, No. 48. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
May 1 to May 15	931	76.6	43.51	....	6.35	6.49	56.35	22.99
						No. 49.		
May 16 to May 31	943	59.7	....	72.59	....	6.67	79.26	19.64
June 1 to June 15.....	962	93.5	....	54.31	6.11	6.70	67.12	21.59
June 16 to June 30 ...	988	78.6	44.43	30.22	....	6.61	81.26	25.85

B.

PERIOD.	AVERAGE PER DAY PER COW. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Crude fibre in food. Lbs.	N. free extract in food. Lbs.	Fats (ether extract) in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fat x 2¼.)
May 1 to May 15	33.36	1.23	3.07	4.45	12.75	1.49	21.76	14.89	1:6.7
May 16 to May 31	59.62	1.72	4.11	3.40	9.15	1.26	17.92	13.09	1:3.7
June 1 to June 15..........	45.53	1.69	4.00	4.30	10.34	1.26	19.90	13.09	1:4.4
June 16 to June 30.........	55.41	1.46	3.34	5.11	14.40	1.54	24.39	17.51	1:6.9

C.

PERIOD.	Nutritive ratio.	Per 1,000 Pounds Live Weight Fed.						
		Digestible protein. Lbs.	Digestible fibre. Lbs.	Digestible N. free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories in energy in ration. Cal.
May 1 to May 15	1:6.7	2.27	2.70	9.81	1.22	15.99	23.37	32639
May 16 to May 31	1:3.9	3.10	1.87	7.97	.94	13.88	19.00	28035
June 1 to June 15	1:4.1	2.86	1.53	8.34	.88	13.61	20.69	27391
June 16 to June 30....	1:7.4	2.28	3.07	11.15	1.22	17.72	24.69	35838

D.

PERIOD.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. total nitrogen compounds in milk.	Per cent. sugar in milk.	Average Per Day Per Cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Nitrogen compounds in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
May 1 to May 15............	.61	3.65	3.41	5.14	.16	.93	.87	1.31	3.27
May 16 to May 31...........	.61	3.87	3.63	4.91	.16	.99	.93	1.26	3.34
June 1 to June 15...........	.61	3.69	3.43	5.05	.15	.93	.86	1.27	3.21
June 16 to June 30..........	.62	3.95	3.48	4.90	.16	1.04	.91	1.29	3.40

E.

PERIOD.	Total cost of food; average per day per cow. Cents.	Milk yield; average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk solids. Cents.	Cost of food for one pound of fat in milk. Cents.
May 1 to May 15.....	17.03	25.45	.90	7.03	24.72	.67	5.21	18.31
May 16 to May 31.....	14.23	25.57	.77	5.88	19.84	.56	4.26	14.37
June 1 to June 15.....	15.48	25.07	.86	6.73	23.22	.62	4.82	16.65
June 16 to June 30.....	16.59	26.28	.98	7.60	24.86	.63	4.88	15.95

During May there was an average gain in live weight of 2.3 pounds and during June of 51 pounds. The cost of the ration for the second period was less than that of any other, and this ration was more efficient than any except that for the last period, when a considerably larger amount of food was consumed. There was more dry matter in the food eaten when corn silage was fed, and the fuel value of the ration correspondingly higher.

For the first period the greatest daily average yield in milk was 29.6 pounds and the smallest 18.2 pounds. The highest average percentage of fat was 5.35 and the lowest 2.80. For the second period the extremes in daily average milk yield were 31.7 pounds and 16.4 pounds and the extremes in average percentage of fat 5.30 and 2.80. For the third period the extremes in daily average milk yield were 30.5 pounds and 17.2 pounds and in average percentage of fat 5.50 and 3.00. For the third period the extremes in daily average milk yield were 32.7 pounds and 17.3 pounds and in average percentage of fat 5.60 and 2.75.

The composition of each food is shown in the following tabulated form :

FOODS.	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	N. free extract Per cent.	Fats (ether extract.) Per cent.	In Dry Substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Corn silage (May)	73.1	1.4	2.4	5.1	16.0	2.0	1.42	.89
Corn silage (June)	72.0	1.4	2.5	5.9	16.4	1.8	1.42	.95
Alfalfa fodder (May 16 to June 15)	81.1	2.0	4.0	4.2	7.4	1.3	3.35	2.58
Alfalfa fodder (June 16 to June 30)	75.0	1.9	3.4	7.1	11.2	1.4	2.19	1.82
Clover hay (May)	12.6	4.9	7.8	29.2	41.1	4.4	1.42	1.22
Clover hay (June)	11.8	5.4	10.1	27.3	41.6	3.8	1.83	1.61
Mixed grain, No. 48	11.5	4.8	23.5	5.9	49.0	5.3	4.26	3.69
Mixed grain, No. 49	11.3	4.1	18.1	5.2	56.5	4.8	3.26	2.97

PIG FEEDING.

Several lots of pigs of different breeds and crosses have, during the past two years, been fed under similar conditions from birth. They were fed with the sow until they had learned to eat readily from a trough. During these two seasons the thoroughbred pigs fed were Poland China, Berkshire, Tamworth and Yorkshire, and the crossbred pigs were Tamworth-Duroc and Tamworth-Poland China.

Enough pigs have been kept at all times to consume all the skim milk from the dairy. Occasionally the supply of skim milk has been low, and there has been little to use at times when experiments in manufacture of cheese were being made. Generally a liberal allowance of skim milk has been fed to the growing pigs and to the breeding stock.

The rations fed were nearly alike for pigs of the same age except that the amount of food was varied according to the capacity of different lots. For the first four weeks after farrowing and while the sow was with the pigs she was fed wheat bran and skim milk. After this time a mixture of wheat bran and wheat middlings was fed with the skim milk and this ration was continued for a short time with the pigs after the sow was removed. Corn meal was then added to the mixed grain and a series of grain mixtures fed in which the proportion of corn meal was increased as the time for marketing approached. The different grain mixtures, numbered for convenience 1, 2, 3, 4 and 5, were composed by weight as follows: No. 1, of equal parts wheat bran and wheat middlings; No. 2, equal parts of wheat bran, wheat middlings and corn meal; No. 3, four parts corn meal, one part each of wheat bran and wheat middlings; No. 4, ten parts corn meal and one part each of wheat bran and wheat middlings; No. 5, twenty parts corn meal, two parts wheat bran and one part wheat middlings.

In estimating the cost of food wheat bran was rated at $18 per ton, wheat middlings at $20 dollars per ton, corn meal at $20 per ton and skim milk at 25 cents per 100 pounds. These prices are somewhat higher than would accord with those ruling in the markets at the present writing. It is thought better to use these same valuations, however, as they had been used in estimating the cost of pork produced in former feeding trials. The data reported will allow of recalculation of cost at any other prices.

The pigs were fed three times a day, about one-third of the daily ration being given at each feeding. After one feeding the grain and milk intended for the next were mixed and allowed to stand for the few hours intervening. Charcoal was fed in small quantity once a week. Except in the winter the pigs were allowed the liberty of small open yards. The pens indoors had wooden floors The pigs were generally fed with the sow for about six weeks The pigs, and also the sow while with them, were weighed once a week. The skim milk and grain were weighed out for each feeding.

The results obtained in the feeding trials are given in accompanying tables averaged in periods of several weeks according to the rations fed. There is given for each period the total cost of all food consumed for each pound gain in weight made by the pigs. Generally there was considerable loss in the weight of the sow while suckling the pigs. This would be an immediate loss if the sow should be sold, or if kept for breeding would normally be restored at an expense of food in excess of that required for maintenance. The food cost of the gain in weight made by the pigs while fed with the sow, making allowance for the cost of restoring any weight lost at the same time by the sow, is also given with the tabulared data. The average loss in weight by eight of the sows was somewhat over 37 pounds, and the average cost of food at the prices mentioned, for restoring this weight, was 4.40 cents per pound. This was determined by feeding each sow separately after she was removed from the pigs. For a few days after removal the sow was fed sparingly on mostly dry food, until the secretion of milk had about ceased, and then the amount of food was rapidly increased. The gain in weight was as a rule made very quickly.

The first set of tables show the records of pigs fed during the summer of 1894. These were Tamworth, Poland China, Tamworth-Duroc cross, Tamworth-Poland China cross, and Berkshire. The Berkshire pigs were not farrowed until June, so that they were fed for a somewhat shorter time than the others, and during colder weather for the last periods of the trial. The pigs of the Tamworth-Duroc cross were farrowed earlier in the spring than the others and were fed somewhat longer. The other lots farrowed during April were all fed for 196 days.

The cost of all the food eaten by the pigs of Tamworth-Duroc cross made the cost of all the gain for the whole time of feeding 4.58 cents per pound. Excluding the last period the cost was 4.48 cents. The cost for the whole time, 196 days, for the Poland China pigs was at the rate of 3.78 cents per pound gain; for the Tamworth, 3.63 cents; for the Tamworth-Poland China cross, 3.72 cents; and during the 186 days that the Berkshire pigs were fed, 3.66 cents per pound gain.

TAMWORTH.

Average per day for each 100 pounds live weight fed.

Number of pigs.	Number days in period.	Average live weight per pig at beginning of period. Lbs.	PERIOD.	Gain in weight of pigs. Lbs.	Loss or gain in weight of sow. Lbs.	Wheat bran. Lbs.	Mixed grain No. 1. Lbs.	Mixed grain No. 2. Lbs.	Skim milk. Lbs.	Total food. Lbs.	Nutritive ratio.	Total water-free food. Lbs.	Total cost of food. Cts.	Pounds of water-free food consumed for each pound gain in total live w't. Lbs.	Cost of food for each pound gain in weight of pigs. Cts.	Cost per pound gain in weight of pigs, considering the cost of any loss in weight of sow. Cts.
3	28	2.1	April 13 to May 11	+.57	—.08	1.29	....	....	11.45	12.74	1:2.5	2.21	4.02	4.51	7.05	7.67
3	7	16.7	May 11 to May 18	+.43	+.71	....	2.14	....	9.81	11.95	1:3.0	2.78	4.48	2.44	10.42	*3.93
3	28	19.7	May 18 to June 15....	1.81	....	....	1.86	....	11.98	13.84	1:2.8	2.75	4.76	1.52	2.63	....
3	28	33.3	June 15 to July 13	1.96	....	....	....	1.82	12.40	14.22	1:3.1	2.75	4.86	1.40	2.46	....
3	28	59.0	July 13 to Aug. 10....	1.31	....	....	No. 3. 1.99	....	9.32	11.31	1:3.8	2.60	4.29	1.98	3.27	....
3	28	85.7	Aug. 10 to Sept. 7....	1.12	....	....	....	No. 4. 2.52	5.98	8.50	1:5.1	2.72	3.99	2.43	3.56	....
3	28	116.3	Sept. 7 to Oct. 5	1.30	....	....	No. 5. 2.60	....	4.10	6.70	1:5.7	2.64	3.60	2.03	2.77	....
3	21	168.0	Oct. 5 to Oct. 26	.85	....	....	3.94	....	....	3.94	1:8.2	3.41	3.90	4.01	3.41	....

* Cost of total gain in live weight.

POLAND CHINA.

Average per day for each 100 pounds live weight fed.

Number of pigs.	Number days in period.	Average live weight per pig at beginning of period. Lbs.	PERIOD.	Gain in weight of pigs. Lbs.	Loss or gain in weight of sow. Lbs.	Wheat bran. Lbs.	Mixed grain No. 1. Lbs.	Mixed grain No. 2. Lbs.	Skim milk. Lbs.	Total food. Lbs.	Nutritive ratio.	Total water-free food. Lbs.	Total cost of food. Cts.	Pounds of water-free food consumed for each pound gain in total live weight. Lbs.	Cost of food for each pound gain in weight of pigs. Cts.	Cost per pound gain in weight of pigs, considering the cost of any loss in weight of sow. Cts.
5	28	3.4	April 28 to May 26 ...	+.68	—17	1.22	....	....	8.78	10.00	1:2.6	1.89	3.29	3.71	4.84	5.94
5	7	16.2	May 26 to June 2.....	+.47	—51	....	2.06	....	7.37	9.43	1:3.2	2.48	3.80	......	8.09	12.86
5	28	18.2	June 2 to June 30	1.59	....	....	1.64	....	11.24	12.88	1:2.8	2.49	4.37	1.57	2.75	......
5	28	29.0	June 30 to July 28 ...	1.93	....	....	....	2.81	11.13	13.94	1:3.6	3.49	5.49	1.81	2.84	......
5	28	50.2	July 28 to Aug. 25....	1.59	....	....	No. 3. 3.20	....	8.54	11.74	1:4.5	3.55	5.28	2.23	3.32	......
5	28	79.2	Aug. 25 to Sept. 22...	1.42	....	....	....	No. 4. 3.39	5.89	9.28	1:5.7	3.46	4.83	2.44	3.40	......
5	28	117.8	Sept. 22 to Oct. 20....	1.24	....	....	No. 5. 4.24	....	.99	5.23	1:7.7	3.76	4.45	3.03	3.59	......
5	21	167.0	Oct. 20 to Nov. 10....	.80	....	....	4.16	....	....	4.16	1:8.2	3.60	4.12	4.50	5.15	......

TAMWORTH–DUROC CROSS.

Average per day for each 100 pounds live weight fed.

Number of pigs.	Number days in period.	Average live weight per pig at beginning of period. Lbs.	PERIOD.	Grain in weight of pigs. Lbs.	Loss or gain in weight of sow. Lbs.	Wheat bran. Lbs.	Mixed grain, No. 1. Lbs.	Mixed grain, No. 2. Lbs.	Skim milk. Lbs.	Total food. Lbs.	Nutritive ratio.	Total water-free food. Lbs.	Total cost of food. Cts.	Pounds of water-free food consumed for each pound gain in total live weight. Lbs.	Cost of food for each pound gain in weight of pigs. Cts.	Cost per pound gain in weight of pigs considering the cost of any loss in weight of sow. Cts.
5	28	2.2	March 24 to April 21..	+.16	—.10	1.02	....	....	7.84	8.86	1:2.6	1.62	2.88	2.70	18.00	20.75
2	14	8.2	April 21 to May 5.....	+.20	+.21	....	1.25	....	6.71	7.96	1:2.9	1.72	2.87	4.20	14.35	*7.00
2	14	14.5	May 5 to May 19......	3.30	....	....	2.53	....	11 47	14.00	1:3.0	3.28	5.27	.99	1.60	....
2	35	23.0	May 19 to June 23....	2.21	....	....	....	2.16	14.03	16 19	1:3.1	3.20	5.60	1.44	2.53	....
2	28	51.5	June 23 to July 21....	1.33	....	....	No. 3. 2.25	....	12.45	14.70	1:3.6	3.11	5.32	2.34	4.00	....
2	28	75.0	July 21 to Aug. 18....	1.12	....	....	....	No. 4. 1.93	10.01	11.94	1:3.9	2.60	4.41	3.32	3.94	....
2	28	103.0	Aug. 18 to Sept. 15...	1.31	....	....	No. 5. 2.36	....	7.28	9.64	1:4.7	2.73	4.16	2.08	3.18	....
2	28	148.5	Sept. 15 to Oct. 13....	.94	....	....	3.06	....	2 44	5.50	1:6.7	2.88	3.64	3.06	3.87	....
2	28	193.0	Oct. 13 to Nov. 10....	.50	....	....	2.66	....	....	2.66	1:8.2	2.30	2.64	4.60	5.28	....

* Cost of total gain in live weight.

TAMWORTH–POLAND CHINA CROSS.

Average per day for each 100 pounds live weight fed.

Number of pigs.	Number days in period.	Average live weight per pig at beginning of period. Lbs.	PERIOD.	Gain in weight of pigs. Lbs.	Loss or gain in weight of sow. Lbs.	Wheat bran. Lbs.	Mixed grain No. 1. Lbs.	Mixed grain No. 2. Lbs.	Skim milk. Lbs.	Total food. Lbs.	Nutritive ratio.	Total water-free food. Lbs.	Total cost of food. Cts.	Pounds of water-free food consumed for each pound gain in total live weight. Lbs.	Cost of food for each pound gain in weight of pigs. Cts.	Cost per pound gain in weight of pigs, considering the cost of any loss in weight of sow. Cts.
6	28	2.1	April 30 to May 28....	+.55	—.10	.90	....	....	6.37	7.27	1:2.6	1.39	2.40	3.09	4.36	5.16
6	7	16.0	May 28 to June 4.....	+.55	—.78	....	1.48	....	6.09	7.57	1:3.1	1.86	2.93	5.81	5.33	11.56
6	28	17.2	June 4 to July 2......	1.64	....	....	1.48	....	10.41	11.89	1:2.7	2.27	4.01	1.38	2.45	....
6	28	27.2	July 2 to July 30.....	2.47	....	....	....	2.44	9.76	12.20	1:3.6	3.04	4.80	1.23	1.94	....
6	28	53.0	July 30 to Aug. 27....	1.39	....	....	No. 3. 3.38	....	7.89	11.27	1:4.7	3.66	5.29	2.63	3.81	....
6	28	77.7	Aug. 27 to Sept. 24...	1.52	....	....	....	No. 4. 3.41	5.62	9.03	1:5.6	3.45	4.78	2.27	3.14	....
6	28	118.8	Sept. 24 to Oct. 22....	1.15	....	....	No. 5. 4.24	....	.70	4.94	1:7.8	3.74	4.37	3.25	3.80	....
6	21	162.2	Oct. 22 to Nov. 12....	.57	....	....	3.79	....	....	3.79	1:8.2	3.28	3.76	5.75	6.60	....

BERKSHIRE.

Average per day for each 100 pounds live weight fed.

Number of pigs.	Number days in period.	Average live weight per pig at beginning of period. Lbs.	PERIOD.	Gain in weight of pigs. Lbs.	Loss or gain in weight of sow. Lbs.	Wheat bran. Lbs.	Mixed grain No. 1. Lbs.	Mixed grain No. 2. Lbs.	Skim milk. Lbs.	Total food. Lbs.	Nutritive ratio.	Total water-free food. Lbs.	Total cost of food. Cts.	Pounds of water-free food consumed for each pound gain in total live weight. Lbs.	Cost of food for each pound gain in weight of pigs. Cts.	Cost per pound gain in weight of pigs, considering the cost of any loss in weight of sow. Cts.
5	18	3.2	June 27 to July 15....	+.41	—74	.46	....	....	6.40	6.86	1:2.3	1.01	2.01	......	4.90	7.94
5	28	9.6	July 15 to Aug. 15....	+2.44	....	....	1.30	....	22.02	23.32	1:2.3	3.22	6.73	1.32	2.76	....
5	28	19.4	Aug. 15 to Sept. 12...	2.32	....	....	....	2.36	12.99	15.35	1:3.3	3.27	5.53	1.40	2.38	....
5	28	37.4	Sept. 12 to Oct. 10 ...	1.65	....	....	No. 3. 4.03	....	4.42	8.45	1:5.6	3.89	5.06	2.36	3.07	....
4	28	60.2	Oct. 10 to Nov. 7.....	.65	....	....	....	No. 4. 3.61	.20	3.81	1:7.9	3.11	3.63	4.78	5.58	....
4	21	73.0	Nov. 7 to Dec. 5......	.84	....	....	No. 5. 3.74	....	....	3.74	1:8.2	3.24	3.71	3.86	4.42	....
4	35	87.0	Dec. 5 to Jan. 9......	.75	....	....	2.27	....	3.28	5.55	1:5.9	3.27	3.07	3.03	4.09	....

The second set of tables give the records of feeding trials of pigs for some weeks during the cold weather in the fall and early winter months. The pigs were Poland China, Tamworth, Yorkshire, Tamworth-Poland China cross and Tamworth-Duroc cross. Some of the Tamworth and Poland China pigs were also fed through the winter, and, considering the unusually cold weather of the winter, 1894-'95, compared favorably with the pigs fed during the summer. The Tamworths seemed better able to endure the cold weather however. The pens although dry and sheltered were very cold. The food cost of all grain for the whole winter was for the Poland China pigs 4.22 cents per pound and for the Tamworths 3.95 cents. For the first four weeks, while fed with the sow the Yorkshire pigs made the most economical growth and the Tamworth the most costly. The Tamworth sow however gave very little milk and the pigs were at much disadvantage for some weeks on this account. For the first month after removal of the sow the Tamworth pig made growth at the same cost as the Yorkshire and more rapidly. The cost of growth made in the same periods by each of the other lots of pigs will be found in the tables.

The average weight per pig at birth was for the Poland China 3.1 pounds; Tamworth-Poland China cross, 2.7 pounds; Tamworths Duroc cross, 2.4 pounds; Tamworth, 2.3 pounds; Yorkshire, 1.9 pounds. The average weights at different periods of feeding are shown in the tables.

POLAND CHINA.

Average per day for each 100 pounds live weight fed.

Number of pigs.	Number days in period.	Average live weight per pig at beginning of period. Lbs.	PERIOD.	Gain in weight of pigs. Lbs.	Loss or gain in weight of sow. Lbs.	Wheat bran. Lbs.	Mixed grain No. 1. Lbs.	Mixed grain No. 2. Lbs.	Skim milk. Lbs.	Total food. Lbs.	Nutritive ratio.	Total water-free food. Lbs.	Total cost of food. Cts.	Pounds of water-free food consumed for each pound gain in total live weight. Lbs.	Cost of food for each pound gain in weight of pigs. Cts.	Cost per pound gain in weight of pigs, considering the cost of any loss in weight of sow. Cts.
7	28	3.1	Oct. 1 to Oct. 29......	+.70	—.08	1.92	....	....	7.06	8.98	1:3.0	2.34	3.49	3.77	4.98	5.49
6	21	12.7	Oct. 29 to Nov. 19....	+.63	+.14	....	2.35	....	5.71	8.06	1:3.4	2.56	3.36	3.35	5.81	*4.36
6	28	22.0	Nov. 19 to Dec. 17....	1.95	....	....	2.13	....	9.20	11.33	1:3.1	2.72	4.34	1.39	2.22	....
6	28	37.8	Dec. 17 to Jan. 14....	1.13	....	....	....	2.22	8.89	11.11	1:3.5	2.77	4.36	2.45	3.86	....
6	28	52.0	Jan. 14 to Feb. 11....	.34	....	....	No. 3. 1.66	....	6.39	8.05	1:3.8	2.06	3.23	6.06	9.50	....
2	28	76.0	Feb. 11 to March 11 ..	.89	....	....	....	No. 4. 1.73	6.94	8.67	1:4.3	2.17	3.44	2.44	3.87	....
2	28	97.5	March 11 to April ..8..	1.02	....	....	No. 5. 1.96	....	7.83	9.79	1:4.4	2.46	3.90	2.41	3.82	....
2	35	132.7	April 8 to May 13	.76	....	....	2.62	....	2.48	5.10	1:6.4	2.54	3.22	3.34	4.24	....

* Cost of total gain in weight.

TAMWORTH.

Average per day for each 100 pounds live weight fed.

Number of pigs.	Number days in period.	Average live weight per pig at beginning of period. Lbs.	PERIOD.	Gain in weight of pigs. Lbs.	Loss or gain in weight of sow. Lbs.	Wheat bran. Lbs.	Mixed grain No. 1. Lbs.	Mixed grain No. 2. Lbs.	Skim milk. Lbs.	Total food. Lbs.	Nutritive ratio.	Total water-free food. Lbs.	Total cost of food. Cts.	Pounds of water-free food consumed for each pound gain in total live weight. Lbs.	Cost of food for each pound gain in weight of pigs. Cts.
10	28	2.3	Sept. 19 to Oct. 17	+.75	+.03	1.66	....	....	9.89	11.55	1:2.7	2.38	3.96	3.05	5.28
10	14	9.4	Oct. 17 to Oct. 31	+1.06	+.05	....	2.02	....	8.18	10.20	1:3.1	2.53	3.96	2.28	3.74
10	28	15.5	Oct. 31 to Nov. 28	2.21	....	....	2.20	....	11.76	13.96	1:2.9	3.03	5.02	1.37	2.27
5	28	39.6	Nov. 28 to Dec. 26	1.38	....	....	....	3.04	8.47	11.51	1:3.9	3.44	5.06	2.49	3.67
5	28	59.6	Dec. 26 to Jan. 23	1.51	....	....	No. 3. 2.94	....	6.78	9.72	1:4.7	3.21	4.58	2.13	3.03
5	28	91.2	Jan. 23 to Feb. 20	.91	....	....	....	No. 4. 2.69	6.12	8.81	1:5.2	2.93	4.15	3.22	4.56
5	28	117.8	Feb. 20 to March 20	1.14	....	....	No. 5. 2.86	....	6.38	9.24	1:5.3	3.11	4.42	2.73	3.88
4	35	162.6	March 20 to April 24	.71	....	....	2.41	....	4.95	7.36	1:5.4	2.57	3.63	3.62	5.11

YORKSHIRE.

Average per day for each 100 pounds live weight fed.

Number of pigs.	Number days in period.	Average live weight per pig at beginning of period. Lbs.	PERIOD.	Gain in weight of pigs. Lbs.	Loss or gain in weight of sow. Lbs.	Wheat bran. Lbs.	Mixed grain No. 1. Lbs.	Mixed grain No. 2. Lbs.	Skim milk. Lbs.	Total food. Lbs.	Nutritive ratio.	Total water-free food. Lbs.	Total cost of food. Cts.	Pounds of water-free food consumed for each pound gain in total live weight. Lbs.	Cost of food for each pound gain in weight of pigs. Cts.
8	28	1.9	Oct. 13 to Nov. 10	+1.15	+.16	1.10	....	....	11.26	12.36	1:2.5	2.03	3.80	1.55	3.30
8	14	9.4	Nov. 10 to Nov. 24	+.57	....	....	1.83	....	9.40	11.23	1:3.0	2.48	4.09	4.35	4.09
6	28	11.8	Nov. 24 to Dec. 22	1.93	....	....	1.50	....	11.84	13.34	1:2.8	2.42	4.38	1.25	2.27
6	21	21.5	Dec. 22 to Jan. 12	1.47	....	....	....	1.91	11.34	13.25	1:3.2	2.74	4.68	1.86	3.18

TAMWORTH–POLAND CHINA CROSS.

Average per day for each 100 *pounds live weight fed.*

Number of pigs.	Number days in period.	Average live weight per pig at beginning of period. Lbs.	PERIOD.	Gain in weight of pigs. Lbs.	Loss or gain in weight of sow. Lbs.	Wheat bran. Lbs.	Mixed grain No. 1. Lbs.	Skim milk. Lbs.	Total food. Lbs.	Nutritive ratio.	Total water-free food. Lbs.	Total cost of food. Cts.	Pounds of water-free food consumed for each pound gain in total live weight. Lbs.	Cost of food for each pound gain in weight of pigs. Cts.	Cost per pound gain in weight of pigs, considering the cost of any loss in weight of sow. Cts.
8	28	2.7	Oct. 1 to Oct. 29	+.61	—.15	1.29	....	5.07	6.36	1:2.7	1.60	2.43	3.48	3.98	5.07
8	21	12.4	Oct. 29 to Nov. 19..........	+.81	+.13	....	2.31	5.71	8.02	1:3.4	2.54	3.62	2.70	4.47	*3.85
8	7	21.3	Nov. 19 to Nov. 26..........	2.46	....	....	2.38	7.53	9.91	1:3.3	2.78	4.14	1.13	1.68	......

*Cost of total gain in weight.

TAMWORTH–DUROC CROSS.

Average per day for each 100 pounds live weight fed.

Number of pigs.	Number days in period.	Average live weight per pig at beginning of period. Lbs.	PERIOD.	Gain in weight of pigs. Lbs.	Loss or gain in weight of sow. Lbs.	Wheat bran. Lbs.	Mixed grain No. 1. Lbs.	Skim milk. Lbs.	Total food. Lbs.	Nutritive ratio.	Total water-free food. Lbs.	Total cost of food. Cts.	Pounds of water-free food consumed for each pound gain in total live weight. Lbs.	Cost of food for each pound gain in weight of pigs. Cts.	Cost per pound gain in weight of pigs, considering the cost of any loss in weight of sow. Cts.
6	28	2.4	Sept. 1 to Sept. 29	+.57	+.14	1.02	....	7.00	8.02	1:2.6	1.55	2.67	2.18	4.68	*3.76
6	14	14.0	Sept. 29 to Oct. 13..........	+.79	—.36	....	1.55	5.00	6.55	1:3.2	1.81	2.72	4.21	3.44	5.45
6	14	23.2	Oct. 13 to Oct. 27..........	1.78	....	....	2.66	12.01	14.67	1:3.0	3.45	5.53	1.94	3.11	....
4	14	32.8	Oct. 27 to Nov. 10	1.26	....	....	2.19	10.66	12.85	1:3.0	2.91	4.74	2.31	3.76	....

* Cost of total gain in weight.

In the third set of four tables are shown the results from feeding trials with four lots of pigs made during the past season. The cost of all food eaten by the Poland China pigs during the 224 days for which records are given made the cost of all gain 3.44 cents per pound. For the Yorkshire pigs during the same period the cost of growth was 3.34 cents per pound; for the Tamworths, 3.81 cents, and for the pigs of Tamworth-Duroc cross, 3.39 cents per pound. The cost of growth of pigs during the first month while fed with the sow was least with the Yorkshires, as in the former trial, and highest with the Tamworths. The growth for the first month or so after removal from the sow was at least cost with the Poland China pigs.

The average weight per pig at birth was for the Poland China pigs 2.9 pounds; for the Tamworths, 2.6 pounds; for the Tamworth-Duroc cross, 2.2 pounds, and for the Yorkshires, 2.0 pounds. The average total gain per pig made during the thirty-two weeks of the trial was for the Tamworths a little over 222 pounds; for the Tamworth-Duroc cross a little less than 209 pounds; for the Poland Chinas nearly 192 pounds, and for the Yorkshires 158 pounds.

The data for each period of feeding are given in the following tables:

POLAND CHINA.

Average per day for each 100 pounds live weight fed.

Number of pigs.	Number days in period.	Average live weight per pig at beginning of period. Lbs.	PERIOD.	Gain in weight of pigs. Lbs.	Loss or gain in weight of sow. Lbs.	Wheat bran. Lbs.	Mixed grain No. 1. Lbs.	Mixed grain No. 2. Lbs.	Skim milk. Lbs.	Total food. Lbs.	Nutritive ratio.	Total water-free food. Lbs.	Total cost of food. Cts.	Pounds of water-free food consumed for each pound gain in total live weight. Lbs.	Cost of food for each pound gain in weight of pigs. Cts.	Cost per pound gain in weight in pigs, considering the cost of any loss in weight of sow. Cts.
6	28	2.9	April 9 to May 7......	+.46	—.28	1.06	....	....	6.20	7 26	1 : 2.7	1.52	2.50	8.44	5.43	8.11
4	14	14.5	May 7 to May 21.....	+.41	—.51	1.71	....	....	5.94	7.65	1 : 3.0	2.06	3.02	....	7.36	12.48
4	14	20.5	May 21 to June 4.....	2.18	....	....	1.36	....	10.67	12.03	1 : 2.7	2.20	3.96	1.01	1.82	.....
4	28	27.7	June 4 to July 2.....	1.37	....	....	....	1.37	11.03	12.40	1 : 2.9	2.24	4.08	1.61	2.98	.....
4	28	42.0	July 2 to July 30.....	1.08	....	....	No. . 1.31	....	8.38	9.69	1 ; 3.5	1.93	3.38	1.79	3.13	.....
4	28	55.6	July 30 to Aug. 27...	.91	....	....	....	No. 4. 1.70	6.90	8.60	1 : 4.3	2.11	3.40	2.24	3.62	.....
4	28	72.7	Aug. 27 to Sept. 24...	1.05	....	....	No. 5. 2.42	....	4.23	6.65	1 : 5.6	2.40	3.46	2.29	3.30	.....
4	28	98.2	Sept. 24 to Oct. 22....	1.34	....	....	3.04	....	3.46	6.50	1 : 6.2	2.97	3.87	2.22	2.89	.....
4	28	143.5	Oct. 22 to Nov. 19....	1.08	....	....	3.42	....	1.10	4.52	1 : 7.5	3.07	3.66	2.84	3.39	.....

TAMWORTH.

Average per day for each 100 pounds live weight fed.

Number of pigs.	Number days in period.	Average live weight per pig at beginning of period. Lbs.	PERIOD.	Gain in weight of pigs. Lbs.	Loss or gain in weight of sow. Lbs.	Wheat bran. Lbs.	Mixed grain No. 1. Lbs.	Mixed grain No. 2. Lbs.	Skim milk. Lbs.	Total food. Lbs.	Nutritive ratio.	Total water-free food. Lbs.	Total cost of food. Cts.	Pounds of water-free food consumed for each pound gain in total live weight. Lbs.	Cost of food for each pound gain in weight of pigs. Cts.
3	28	2.6	April 15 to May 13	+.18	+.05	1.17	....	....	6.60	7.77	1:2.7	1.65	2.70	7.17	15.00
2	7	12.5	May 13 to May 20	+.18	+.28	1.49	....	....	6.24	7.73	1:2.9	1.89	2.90	4.11	16.11
2	21	15.0	May 20 to June 10	2.24	....	....	1.67	....	14.64	16.31	1:2.6	2.85	5.25	1.27	2.34
2	28	24.0	June 10 to July 8	1.59	....	....	....	1.29	9.59	10.88	1:3.0	2.03	3.64	1.28	2.29
2	28	38.0	July 8 to Aug. 5	1.25	....	....	No. 3. 1.21	....	8.08	9.29	1:3.4	1.82	3.21	1.46	2.57
2	28	57.0	Aug. 5 to Sept. 2	1.06	....	....	....	No. 4. 1.61	7.79	9.40	1:4.0	2.11	3.55	1.99	3.35
2	28	76.5	Sept. 2 to Sept. 30	1.37	....	....	No. 5. 2.71	....	5.45	8.16	1:5.4	2.87	4.05	2.09	2.96
2	28	112.2	Sept. 30 to Oct. 28	1.44	....	....	3.91	....	3.70	7.61	1:6.5	3.74	4.79	2.60	3.33
2	28	169.0	Oct. 28 to Nov. 25	1.02	....	....	3.35	....	.98	4.33	1:7.6	2.99	3.56	2.93	3.49

YORKSHIRE.

Average per day for each 100 pounds live weight fed.

Number of pigs.	Number days in period.	Average live weight per pig at beginning of period.	PERIOD.	Gain in weight of pigs. Lbs.	Loss or gain in weight of sow. Lbs.	Wheat bran. Lbs.	Mixed grain No. 1. Lbs.	Mixed grain No. 2. Lbs.	Skim milk. Lbs.	Total food. Lbs.	Nutritive ratio.	Total water-free food. Lbs.	Total cost of food. Cts.	Pounds of water-free food consumed for each pound gain in total live weight. Lbs.	Cost of food for each pound gain in weight of pigs. Cts.	Cost per pound gain in weight of pigs, considering the cost of any loss in weight of sow. Cts.
9	28	2.0	April 15 to May 13 ...	+.82	—.28	1.38	....	....	10.26	11.64	1:2.6	2.18	3.80	4.04	4.63	6.14
9	7	9.0	May 13 to May 20	+.90	—.28	1.76	....	....	9.41	11.17	1:2.7	2.43	3.93	3.92	4.37	5.73
9	21	10.8	May 20 to June 10 ...	2.11	....	....	1.30	....	13.04	14.31	1:2.6	2.37	4.49	1.12	2.13	....
9	28	16.7	June 10 to July 8	1.52	....	....	....	1.51	12.79	14.30	1:2.7	2.53	4.66	1.66	3.07	....
4	28	27.6	July 8 to Aug. 5	1.59	....	....	No. 3. 1.71	....	11.04	12.75	1:3.4	2.53	4.44	1.59	2.79	....
4	28	43.5	Aug. 5 to Sept. 2.....	.96	....	....	....	No. 4. 1.72	8.91	10.62	1:3.9	2.32	3.93	2.42	4.09	....
4	28	57.0	Sept. 2 to Sept. 30 ...	1.29	....	....	No. 5. 2.35	....	5.25	7.60	1:5.2	2.52	3.64	1.97	2.82	....
4	28	81.2	Sept. 30 to Oct. 28 ...	1.53	....	....	3.49	....	4.04	7.53	1:6.2	3.41	4.47	2.23	2.92	....
4	28	125.0	Oct. 28 to Nov. 25....	.88	....	....	2.97	....	1.11	4.08	1:7.4	2.68	3.22	2.92	3.66	....

TAMWORTH–DUROC CROSS.

Average per day for each 100 pounds live weight fed.

Number of pigs.	Number days in period.	Average live weight per pig at beginning of period. Lbs.	PERIOD.	Gain in weight of pigs. Lbs.	Loss or gain in weight of sow. Lbs.	Wheat bran. Lbs.	Mixed grain No. 1. Lbs.	Mixed grain No. 2. Lbs.	Skim milk. Lbs.	Total food. Lbs.	Nutritive ratio.	Total water-free food. Lbs.	Total cost of food. Cts.	Pounds of water-free food consumed for each pound gain in total live weight. Lbs.	Cost of food for each pound gain in weight of pigs. Cts.	Cost per pound gain in weight of pigs, considering the cost of any loss in weight of sow. Cts.
4	28	2.2	April 13 to May 11 ...	+.39	—.21	1.01	....	....	5.92	6.93	1:2.7	1.44	2.39	8.00	6.13	8.50
4	7	14.2	May 11 to May 18	+.39	—.12	1.31	....	....	5.61	6.92	1:2.9	1.68	2.58	6.22	6.62	7.97
4	21	17.4	May 18 to June 8.....	2.05	....	....	1.63	....	12.22	13.85	1:2.7	2.58	4.60	1.26	2.24	......
4	28	26.6	June 8 to July 6	1.66	....	....	....	1.55	12.36	13.91	1:2.9	2.52	4.59	1.52	2.77	......
4	28	43.0	July 6 to August 3 ...	.63	....	....	No. 3. .82	....	3.96	4.78	1:3.8	1.09	1.80	1.73	2.86	......
4	28	64.2	Aug. 3 to Aug. 31....	1.08	....	....	....	No. 4. 1.94	7.82	9.76	1:4.2	2.39	3.87	2.21	3.58	......
4	28	87.5	Aug. 31 to Sept. 28...	1.03	....	....	No. 5. 2.26	....	3.49	5.75	1:5.8	2.29	3.11	2.22	3.02	......
4	28	117.0	Sept. 28 to Oct. 26 ...	1.12	....	....	2.86	....	3.17	6.03	1:6.3	2.78	3.62	2.48	3.23	......
4	28	160.0	Oct. 26 to Nov. 23....	.97	....	....	3.22	....	.81	4.03	1:7.7	2.87	3.39	2.96	3.49	......

POULTRY.

Experiments in poultry feeding have been continued during the past year and records for a breeding experiment continually kept. The data obtained in some feeding trials with laying hens will probably soon be published in a bulletin, and also the results of some feeding trials with chicks and capons.

A bulletin, in which are recorded some feeding trials made during the preceding year, has been published. The bulletin was as follows:

Among the very many unsettled questions concerning the feeding of fowls, one of the frequently recurring ones is that in regard to the relative amounts of ground and whole grain that can be fed to best advantage. This question is in certain respects so broad that carefully kept records of a great many feeding trials in which the conditions have been under control must be available before it can be restricted to narrow limits. In the belief that they will be of use in considering this question and that they may be added to the available facts relating to the general subject of poultry feeding, the results of one of a series of feeding experiments being made at this Station are published in this bulletin form.

In this trial four lots of pullets were used, two of White Leghorns and two of Buff Cochins. For convenience they are referred to as pens 1, 2, 3 and 4. Pens 1 and 2 were Leghorns and pens 3 and 4 were Cochins. The two pens of Leghorns each containing at the start sixteen pullets, were as nearly alike as it was possible to select them, all of the birds being from the same lot of chicks hatched and grown at this Station. The two pens of Cochins were also alike, each containing at the start nine pullets, which were selected from those hatched and reared under the same conditions. The Leghorns were of a "strain" well recommended as layers, and were vigorous and healthy from the shell, so that any insufficient egg production can well be attributed to the conditions under which the birds were kept and to the food, rather than to inherent lack of laying capacity. During the spring months the Cochins, which became broody, were allowed to sit on nests or about the floor of the pen at will, no attempt being made to break up sitters.

The records of feeding here given began November 23d. The average date of hatching for the Cochins was May 21st, and the average date of hatching for the Leghorns was June 15th. There was not opportunity to hatch the chicks earlier in the spring so that the pullets were hardly matured enough to lay well during the first part of the feeding trial.

Pens No. 1 and No. 3 were given for the morning feed each day a mixture of ground grain moistened. Of this mixed grain which was moistened with hot water and fed warm during cold weather, and moistened with ordinary water during hot weather, all was offered that was readily eaten. Later in the day some kind of whole grain or cracked corn was fed, scattered in clean straw to induce exercise.

Pens 2 and 4 were fed whole grain of different kinds—the corn being cracked. This was scattered in the straw on tight floors and none was left uneaten.

The fowls in all the pens were fed twice each week all the cut bones they would eat. Skim milk was fed to all during part of the trial. Green alfalfa or corn silage or soaked, chopped hay was fed at noon, the moistened chopped hay being fed warm to pens 1 and 3. Plenty of limestone grit and oyster shells were kept always in each pen.

The pens were all in one house separated by partitions, each pen having floor space of 10 x 12 feet. The small, open yards attached to Nos. 1 and 2 covered about 240 square feet each, and those of Nos. 3 and 4 about 160 square feet each. The yards were covered with coal ashes.

Although at the start it was considered best to have a good number to average from, it is probable that the sixteen birds in each of pens 1 and 2 were too many for best results, for during the winter months they were necessarily kept altogether indoors. The average floor space per fowl in these pens was less than eight square feet and the average space in the open yard about sixteen square feet. The only hens at this Station that have laid from ten to twelve dozen eggs each per year have had an average of twenty square feet floor space in the pen and seventy-five square feet yard space per fowl. It is probable that the best results in egg production can not be secured where the space of open run available per hen is much less than seventy-five or one hundred square feet. For a feeding experiment, however, in which it is necessary to account for all food obtained, it is not possible to allow extended range. Somewhat more room than that given to the fowls in this feeding trial would be desirable, but no larger yards were available. Under the conditions of continuous confinement necessary for the whole year, however, the egg yields were not too low, and as the conditions for all the pens were alike, except the one difference of food, the results are strictly comparable. The results from pens 2 and 4 having no grain except the dry and unground, can be directly compared with those from pens 1 and 3 having all the ground and moistened grain that would be eaten at one of two feedings each day. The only limitations necessary in conclusions drawn from the comparison are those always inherent in any conclusion from a single trial.

As it was not possible to give the benefit of grass runs, all green food had to be fed cut, in troughs. It is fed in this way to some disadvantage, for, except at the risk of a large proportion of waste, it is difficult to feed as liberally as would be desired at some times on account of rapid wilting and drying. Although all the cut bone was fed twice a week that the fowls would eat, the calculated nutritive ratios of the rations were wider than desired, but with the whole grains obtainable it was not possible to make a narrow grain ration for pens 2 and 4. The nutritive ratio of the ration for pens 1 and 3 was kept about that of the ration for pens 2 and 4, although it did usually run somewhat narrower. With the ordinary available, and indeed with almost any whole grain that can be obtained, it is not possible to feed a largely grain ration, having a nutritive ration so narrow as is by many considered necessary. In order to feed a very narrow ration it becomes necessary to use an excessive amount of meat or to substitute some of the highly nitrogenous grain by-products for part of the whole grain. The necessity, however, for a ration so much more nitrogenous than can be had when using a good proportion of whole grain is not by any means established, although it seems probable that for laying hens a ration somewhat narrower than can be had from whole grain alone is essential.

The mixed grain fed to pens 1 and 3 was made to correspond closely to the combination of whole grain being fed at the same time to pens 2 and 4. With the exception of using wheat bran and middlings instead of ground wheat, the same grains were fed ground in the mixture that were fed whole in the contrasted ration The ground grain mixture No. 1, fed until January 24th, consisted of equal parts by weight of wheat bran, wheat middlings, corn meal, ground oats and ground barley. The grain mixture No. 2, fed from January 24th to July 25th, contained the same grains used in No. 1 with ground buckwheat added, equal parts of each. The mixture No. 3 consisted of three parts of ground flaxseed and one part each of wheat bran, wheat middlings, corn meal, ground oats, ground barley and ground buckwheat. The moisture in the grain mixtures varied somewhat according to the season, but the average per cent. of moisture in mixture No. 1 was 14.5 per cent.; in No. 2 until April 25th, 15 per cent.; after April 25th 9.9 per cent., and in mixture No. 3 10.2 per cent.

The accompanying table shows the average composition of each food.

FOODS.

Average per cent. of moisture.		Average Composition of Water-free Substance.				
		Per cent. of ash.	Per cent. of protein.	Per cent. of fibre.	Per cent. of N. free extract.	Per cent. of fats.
14.5	Mixed grain No. 1	3.3	13.3	6.5	73.2	3.7
12.0	Mixed grain No. 2	3.7	14.4	6.1	71.6	4.2
10.2	Mixed grain No. 3	3.5	15.6	6.4	66.9	7.6
12.0	Wheat	2.0	12.5	2.4	80.9	2.2
12.6	Cracked corn	2.4	10.0	1.7	81.5	4.4
11.4	Oats	3.8	13.2	10.7	66.2	6.1
15.0	Buckwheat	4.0	11.2	12.0	70.5	2.3
10.7	Barley	2.8	13.4	4.0	77.6	2.2
9.2	Flaxseed	3.9	24.3	5.3	35.4	31.1
33.3	Cut bone	34.7	31.3	....	2.8(?)	31.2
90.5	Skim milk	7.4	33.7	....	53.6	5.3
75.3	Corn silage	6.3	8.3	23.2	59.1	3.1
16.0	Alfalfa hay	11.7	25.8	23.0	36.9	2.6
74.1	Alfalfa forage	8.8	18.7	25.1	42.8	4.6

The records of feeding and the results obtained, which follow in tabulated form, are calculated, for comparison, to the average per fowl in periods of four and five weeks. The whole trial covered a period of 357 days, so nearly a year that in discussing the results as a whole they are referred to as those for the year.

The digestibility of the different constituents by fowls not being known, the nutritive ratios given are only approximate, but serve to show the relative composition of the rations. The actual total amounts of the several classes of constituents existing in the rations fed at different periods through the year are also given. In determining the cost of the rations wheat was rated at the average of 57.6 cents per bushel, corn at 50.1 cents, oats at 37.9 cents, barley at 61.4 cents, and buckwheat at 56.1 cents per bushel; wheat bran at $16 per ton, wheat middlings at $17, corn meal at $19.20, ground oats at $24, ground barley at $25.60, ground buckwheat at $23.36, alfalfa hay at $9.60, alfalfa forage at $2, and corn silage at $3 per ton. Skim milk was rated at 24 cents per 100 pounds, cut bone at 80 cents, oyster shells at $1, and stone grit at $1 per 100 pounds: flaxseed, ground or unground, at 2½ cents per pound.

PEN NO. 1—PART OF GRAIN RATION GROUND AND MOISTENED—AVERAGE PER DAY PER FOWL.

No. days in period.	PERIOD.	Mixed grain. Ozs.	Wheat Ozs.	Cracked corn. Ozs.	Oats. Ozs.	Buck-wheat. Ozs.	Barley. Ozs.	Fresh bone. Ozs.	Skim milk. Ozs.	Corn silage. Ozs.	Alfalfa hay. Ozs.	Oysters shell. Ozs.	Grit (lime-stone). Ozs.
		No. 1.											
35	Nov. 23 to Dec. 27	.92	.79	.49	....	....	....	.29	1.63	.13	....	....	.....
28	Dec. 27 to Jan. 24	1.41	.81	.56	....	....	....	.29	1.62	.13	....	....	.....
		No. 2.											
28	Jan. 24 to Feb. 21	1.38	.72	.50	.21	....	....	.29	1.03	....	.06	.11	.08
35	Feb. 21 to Mar. 28	1.07	1.11	.54	.19	....	....	.29	1.04	....	.06	.07	.03
28	Mar. 28 to Apr. 25	1.23	1.29	.45	.21	....	....	.29	.61	....	.06	.16	.01
										Alfalfa forage.			
28	April 25 to May 23	1.29	.78	.41	.25	....	....	.33	....	.29	.03	.09	.02
28	May 23 to June 20	1.06	.47	.40	.22	....	....	.33	....	.29	....	.05	.01
35	June 20 to Ju'y 25	1.07	.59	.40	.33	....	....	.33	....	.43	....	.04	.01
		No. 3.											
28	July 25 to Aug. 22	1.09	.64	.34	.37	....	....	.33	....	.43	....	.05	.01
28	Aug. 22 to Sept. 19	1.17	.27	.30	.26	.20	.25	.33	....	.43	....	.03	.01
28	Sept. 19 to Oct. 17	1.48	.30	.28	.31	.16	.33	.33	....	.43	....	.05	.08
28	Oct. 17 to Nov. 14	.84	.22	.17	.19	.19	.21	.33	....	.43	....	.01	.08

PEN NO. 1 — PART OF GRAIN RATION GROUND AND MOISTENED.

Number of fowls in pen.	Number days in period.	PERIOD.	Average live weight per fowl at beginning of period.	Average gain or loss in weight per fowl during period.	Average Per Day Per Fowl.					Approximate nutritive ratio.
					Total ash in food.	Total protein in food.	Total fibre in food.	Total N. free extract in food.	Total fats in food.	
			Lbs.	Lbs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	
16	35	Nov. 23 to Dec. 27	2.9	+.28	.13	.35	.08	1.59	.14	1:5.7
16	28	Dec. 27 to Jan. 24	3.1	+.58	.15	.41	.11	1.96	.15	1:5.9
16	28	Jan. 24 to Feb. 21	3.7	—.14	.15	.42	.13	1.90	.16	1:5.7
16	35	Feb. 21 to March 28	3.6	—.35	.15	.43	.12	2.02	.16	1:5.8
16	28	March 28 to April 25	3.2	+.16	.15	.45	.13	2.17	.16	1:5.9
14	28	April 25 to May 23	3.4	—.47	.17	.41	.14	1.87	.17	1:5.8
14	28	May 23 to June 20	3.0	......	.15	.34	.16	1.42	.15	1:5.7
14	35	June 20 to July 25	3.0	—.04	.16	.37	.14	1.64	.16	1:5.8
14	28	July 25 to Aug. 22	2.9	+.28	.16	.39	.14	1.62	.19	1:5.7
14	28	Aug. 22 to Sept. 19	3.2	+.03	.16	.39	.16	1.60	.19	1:5.4
14	28	Sept. 19 to Oct. 17	3.2	+.20	.18	.45	.18	1.85	.22	1:5.7
14	28	Oct. 17 to Nov. 14	3.4	—.22	.15	.31	.13	1.20	.16	1:5.4

PEN NO. 1 — PART OF GRAIN RATION GROUND AND MOISTENED.

Number of fowls in pen.	PERIOD.	Average Per Fowl.			Lbs. of water-free food per day for each 100 lbs. live weight fed.	Cost of food per day for each 100 lbs. live weight fed.	Eggs Produced During Period. Average Per Fowl.		Lbs. of water-free food consumed for each pound of eggs produced.	Cost of food for one pound of eggs produced.
		Total food per day.	Total water-free food per day.	Total cost of food per day.			Number.	Weight.		
		Ozs.	Ozs.	Cts.	Lbs.	Cts.		Ozs.	Lbs.	Cts.
16	Nov. 23 to Dec. 27	4.25	2.29	.17	4.7	5.7	.81	1.43	......	......
16	Dec. 27 to Jan. 24	4.72	2.78	.21	5.1	6.1	1.87	3.76	......	......
16	Jan. 24 to Feb. 21	4.19	2.76	.22	4.8	6.1	6.44	12.93	5.98	7.52
16	Feb. 21 to March 28	4.30	2.87	.22	5.2	6.4	14.75	29.89	3.36	4.16
16	March 28 to April 25	4.14	3.06	.23	5.8	7.0	15.44	31.09	2.76	3.36
..	April 25 to May 23	3.38	2.76	.20	5.4	6.1	14.43	28.87	2.68	3.04
..	May 23 to June 20	2.77	2.22	.16	4.6	5.2	7.21	14.64	4.25	4.80
14	June 20 to July 25	3.15	2.46	.17	5.3	6.0	10.50	20.99	4.10	4.64
14	July 25 to Aug. 22	3.20	2.50	.21	5.1	6.8	5.86	12.07	5.80	7.84
14	Aug. 22 to Sept. 19	3.21	2.50	.22	4.9	6.8	4.14	8.40	8.33	11.68
14	Sept. 19 to Oct. 17	3.62	2.87	.26	5.4	7.9	4.29	8.96	8.97	13.12
14	Oct. 17 to Nov. 14	2.58	1.94	.17	3.7	7.9	.21	.42	......	......

PEN NO. 2 — GRAIN IN RATION DRY AND WHOLE.

Average per day per fowl.

No. days in period.	PERIOD.	Wheat. Ozs.	Cracked corn. Ozs.	Oats. Ozs.	Buck-wheat. Ozs.	Barley. Ozs.	Flax seed. Ozs.	Fresh bone. Ozs.	Skim milk. Ozs.	Corn silage. Ozs.	Alfalfa hay. Ozs.	Oyster shells. Ozs.	Grit (lime-stone). Ozs.
35	Nov. 23 to Dec. 27	.84	.72	.38	....	.38	....	.28	1.96	.13	....	....	.....
28	Dec. 27 to Jan. 24	.86	.81	.44	....	.85	....	.28	2.19	.13	....	....	.....
28	Jan 24 to Feb. 21	.88	.68	.33	.81	.54	....	.28	1.35	....	.06	.08	.04
35	Feb. 21 to Mar. 28	1.55	.63	.42	.52	.59	....	.28	1.42	....	.06	.10	.06
28	Mar. 28 to Apr. 25	1.24	.48	.53	.42	.49	....	.28	.77	....	.06	.13	.02
										Alfalfa forage.			
28	Apr. 25 to May 23	1.23	.42	.61	.41	.65	....	.35	....	.15	.04	.08	.01
28	May 23 to June 20	.79	.54	.48	.21	.51	....	.35	....	.31	....	.09	.01
35	June 20 to July 25	1.54	.75	.53	.25	.52	....	.35	....	.46	....	.02	.00
28	July 25 to Aug. 22	.82	1.00	.48	.32	.41	.16	.35	....	.46	....	.03	.01
28	Aug. 22 to Sept. 19	.56	.55	.53	.38	.46	.19	.35	....	.46	....	.01	.01
28	Sept. 19 to Oct. 17	.49	.49	.50	.42	.53	.13	.35	....	.46	....	.01	.01
28	Oct. 17 to Nov. 14	.41	.46	.46	.46	.49	.15	.35	....	.46	....	.02	.....

PEN NO. 2—GRAIN IN RATION DRY AND WHOLE.

Number fowls in pen.	Number days in period.	PERIOD.	Average live weight per fowl at beginning of period.	Average gain or loss in weight per fowl during period.	AVERAGE PER DAY PER FOWL.					Approximate nutritive ratio.
					Total ash in food.	Total protein in food.	Total fibre in food.	Total N.-free extract in food.	Total fats in food.	
			Pounds.	Pounds.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	
16	35	Nov. 23 to Dec. 27	2.9	+.34	.13	.37	.08	1.72	.14	1:5.7
16	28	Dec. 27 to Jan. 24	3.3	+.52	.15	.45	.11	2.18	.16	1:5.8
16	28	Jan. 24 to Feb. 21	3.8	—.03	.16	.45	.17	2.25	.16	1:6.1
16	35	Feb. 21 to March 28	3.7	—.33	.17	.51	.17	2.61	.17	1:6.2
16	28	March 28 to April 25	3.4	+.10	.15	.43	.16	2.19	.15	1:6.2
13	28	April 25 to May 23	3.6	—.39	.17	.45	.17	2.27	.17	1:6.3
13	28	May 23 to June 20	3.2	—.14	.15	.36	.13	1.76	.15	1:6.2
13	35	June 20 to July 25	3.0	+.21	.17	.48	.17	2.52	.18	1:6.5
13	28	July 25 to Aug. 22	3.2	+.27	.17	.44	.16	2.17	.22	1:6.3
13	28	Aug. 22 to Sept. 19	3.5	+.05	.16	.40	.17	1.77	.21	1:6.0
13	28	Sept. 19 to Oct. 17	3.6	—.27	.16	.38	.16	1.72	.19	1:6.0
13	28	Oct. 17 to Nov. 14	3.3	—.05	.16	.37	.16	1.61	.19	1:5.9

PEN NO. 2 — GRAIN IN RATION DRY AND WHOLE.

Number of fowls in pen.	PERIOD.	Average per fowl. Total food per day.	Average per fowl. Total water-free food per day.	Average per fowl. Total cost of food per day.	Pounds of water-free food per day for each 100 pounds live weight fed.	Cost of food per day for each 100 pounds live weight fed.	Eggs produced during period. Average per fowl. Number.	Eggs produced during period. Average per fowl. Weight.	Pounds of water-free food consumed for each pound of eggs produced.	Cost of food for one pound of eggs produced.
		Ozs.	Ozs.	Cts.	Lbs.	Cts.		Ozs.	Lbs.	Cts.
16	Nov. 23 to Dec. 27	5.81	2.45	.19	4.9	6.2	1.56	2.90	......	......
16	Dec. 27 to Jan. 24	6.68	3.05	.22	5.4	6.3	4.19	7.95	10.74	12.48
16	Jan. 24 to Feb. 21	4.93	3.19	.26	5.2	6.8	7.06	13.69	6.52	8.48
16	Feb. 21 to March 28	5.47	3.62	.29	6.3	8.1	16.25	32.16	3.94	5.12
16	March 28 to April 25	4.27	3.08	.25	5.5	7.0	13.44	26.22	3.29	4.16
13	April 25 to May 23	3.86	3.23	.25	6.0	7.3	11.54	23.28	3.88	4.80
13	May 23 to June 20	3.19	2.55	.19	5.1	6.2	10.15	20.52	3.48	4.16
13	June 20 to July 25	4.40	3.52	.25	7.1	8.1	7.08	14.11	8.73	10.08
13	July 25 to Aug 22	4.00	3.16	.24	5.8	7.1	6.23	13.07	6.77	8.32
13	Aug. 22 to Sept. 19	3.48	2.70	.22	4.8	6.3	4.62	9.65	7.83	10.24
13	Sept. 19 to Oct. 17	3.37	2.61	.21	4.8	6.1	2.31	4.82	15.16	19.20
13	Oct. 17 to Nov. 14	3.24	2.49	.20	4.7	6.1	......	......	......	......

PEN NO. 3 — PART OF GRAIN RATION GROUND AND MOISTENED.

Average per day per fowl.

No. days in period.	PERIOD.	Mixed grain. Ozs.	Wheat. Ozs.	Cracked corn. Ozs.	Oats. Ozs.	Buck-wheat. Ozs.	Barley Ozs.	Fresh bone. Ozs.	Skim milk. Ozs.	Corn silage. Ozs.	Alfalfa hay. Ozs.	Oyster shells. Ozs.	Grit (lime-stone). Ozs.
		No. 1.											
35	Nov. 23 to Dec. 27	1.12	1.23	.89	....	....	....	.51	1.65	.22	....	....	.....
28	Dec. 27 to Jan. 24	1.98	1.01	.90	....	....	....	.38	2.71	.22	....	....	.....
		No. 2.											
28	Jan. 24 to Feb. 21	1.95	.87	.73	.38	....	....	.38	2.12	....	.11	.27	.07
35	Feb. 21 to March 28	1.40	1.28	.73	.36	....	....	.38	1.55	....	.11	.20	.02
28	March 28 to April 25	1.08	.94	.56	.40	....	....	.43	1.23	....	.13	.03	.01
										Alfalfa forage.			
28	April 25 to May 23	1.12	.37	.33	.58	....	....	.43	....	.13	.06	.01	.01
28	May 23 to June 20	1.48	.49	.42	.46	....	....	.43	....	.25	....	.05	.01
35	June 20 to July 25	1.85	.81	.46	.38	....	....	.43	....	.50	....	.02	.01
		No. 3.											
28	July 25 to August 22	1.12	.80	.41	.42	....	....	.43	....	.50	....	.03	.02
28	Aug. 22 to Sept. 19	1.00	.32	.23	.17	.32	.28	.43	....	.50	....	.04	.03
28	Sept. 19 to Oct. 17	1.51	.31	.33	.30	.33	.36	.43	....	.50	....	.01	.03
28	Oct. 17 to Nov. 14	1.88	.37	.34	.35	.30	.29	.43	....	.50	....	.03	.03

PEN NO. 3 — PART OF GRAIN RATION GROUND AND MOISTENED.

Number of fowls in pen.	Number days in period.	PERIOD.	Average live weight per fowl at beginning of period.	Average gain or loss in weight per fowl during period.	Average Per Day Per Fowl. Total ash in food.	Total protein in food.	Total fibre in food.	Total N. free extract in food.	Total fats in food.	Approximate nutritive ratio.
			Lbs.	Lbs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	
9	35	Nov. 23 to Dec. 27	5.6	+.52	.21	.51	.11	2.34	.21	1:5.8
9	28	Dec. 27 to Jan. 24	6.1	+1.20	.20	.59	.16	2.78	.21	1:5.8
9	28	Jan. 24 to Feb. 21	7.3	—.28	.22	.61	.19	2.70	.23	1:5.5
9	35	Feb. 21 to March 28	7.1	—.35	.20	.57	.17	2.62	.21	1:5.7
8	28	March 28 to April 25	6.8	—.26	.20	.49	.15	2.07	.20	1:5.4
8	28	April 25 to May 23	6.5	—.20	.18	.39	.15	1.61	.19	1:5.5
8	28	May 23 to June 20	6.3	—.28	.19	.44	.16	1.90	.20	1:5.7
8	35	June 20 to July 25	6.1	+.04	.21	.53	.20	2.38	.22	1:5.9
8	28	July 25 to Aug. 22	6.1	—.27	.18	.45	.16	1.85	.23	1:5.7
8	28	Aug. 22 to Sept. 19	5.8	—.21	.23	.39	.16	1.49	.20	1:5.3
8	28	Sept. 19 to Oct. 17	5.6	+.25	.20	.50	.21	2.05	.25	1:5.6
8	28	Oct. 17 to Nov. 14	5.9	+.30	.21	.56	.23	2.30	.28	1:5.7

PEN No. 3 — PART OF GRAIN RATION GROUND AND MOISTENED.

Number fowls in pen.	PERIOD.	Average Per Fowl.			Pounds of water-free food per day for each 100 pounds live weight fed.	Cost of food per day for each 100 pounds live weight fed.	Eggs Produced During Period. Average Per Fowl.		Pounds of water-free food consumed for each pound of eggs produced.	Cost of food for one pound of eggs produced.
		Total food per day.	Total water-free food per day.	Total cost of food per day.			Number.	Weight. Ozs.		
		Ozs.	Ozs.	Cts.	Lbs.	Cts.			Lbs.	Cts.
9	Nov. 23 to Dec. 27	5.62	3.37	.25	3.6	4.2	......	......	......	......
9	Dec. 27 to Jan. 24	7.20	3.93	.30	3.7	4.4	3.00	5.61	......	......
9	Jan. 24 to Feb. 21	6.54	3.94	.32	3.4	4.5	9.00	17.40	6.34	8.32
9	Feb. 21 to March 28	5.81	3.77	.29	3.4	4.2	9.22	17.93	7.36	9.12
8	March 28 to April 25	4.77	3.11	.23	2.9	3.5	7.62	14.86	5.86	7.04
8	April 25 to May 23	3.02	2.52	.18	2.4	2.8	2.63	5.41	13.04	15.04
8	May 23 to June 20	3.53	2.89	.21	2.9	3.4	8.00	15.74	5.14	5.92
8	June 20 to July 25	4.43	3.54	.25	3.6	4.1	6.88	13.08	9.47	10.56
8	July 25 to Aug. 22	3.68	2.87	.24	3.0	3.9	6.00	11.05	7.27	9.44
8	Aug. 22 to Sept. 19	3.25	2.47	.21	2.7	3.6	3.13	5.53	12.51	17.12
8	Sept. 19 to Oct. 17	4.07	3.21	.28	3.5	5.0	3.00	5.75	......	......
8	Oct. 17 to Nov. 14	4.46	3.57	.33	3.7	5.4	1.13	2.24	......	......

PEN NO. 4—GRAIN IN RATION DRY AND WHOLE.

Average per day per fowl.

No. days in period.	PERIOD.	Wheat. Ozs.	Cracked corn. Ozs.	Oats. Ozs.	Buck-wheat. Ozs.	Barley. Ozs.	Flax seed. Ozs.	Fresh bone. Ozs.	Skim milk. Ozs.	Corn silage. Ozs.	Alfalfa hay. Ozs.	Oyster shells. Ozs.	Grit (lime-stone). Ozs.
35	Nov. 22 to Dec. 27	1.33	1.31	.53	....	1.27	....	.51	2.56	.22	....	....	.....
28	Dec. 27 to Jan. 24	1.67	1.38	.62	....	1.12	....	.38	3.39	.22	....	....	.....
28	Jan. 24 to Feb. 21	1.02	.60	.43	.82	.62	....	.38	2.05	....	.11	.55	.22
35	Feb. 21 to March 28	1.78	.87	.44	.69	.97	....	.38	2.31	....	.11	.42	.01
28	March 28 to April 25	1.27	.42	.33	.14	.81	....	.43	1.22	....	.13	.03	.01
										Alfalfa forage.			
28	April 25 to May 23	.65	.35	.58	.48	.35	....	.43	....	.13	.06	.01	.01
28	May 23 to June 20	.78	.49	.67	.65	.48	....	.44	....	.26	....	.07	.01
35	June 20 to July 25	1.10	.73	.64	.62	.64	....	.49	....	.57	....	.02	.03
28	July 25 to Aug. 22	.86	.95	.41	.27	.26	.12	.49	....	.57	....	.03	.03
28	Aug. 22 to Sept. 19	.69	.64	.61	.54	.54	.27	.49	....	.57	....	.02	.02
28	Sept. 19 to Oct. 17	.55	.62	.68	.83	.75	.15	.49	....	.57	....	.02	.01
28	Oct. 17 to Nov. 14	.76	.74	.69	.61	.66	.16	.49	....	.57	....	.06	.01

PEN NO. 4 — GRAIN IN RATION DRY AND WHOLE.

Number of fowls in pen.	Number days in period.	PERIOD.	Average live weight per fowl at beginning of period.	Average gain or loss in weight per fowl during period.	AVERAGE PER DAY PER FOWL. Total ash in food.	Total protein in food.	Total fibre in food.	Total N.-free extract in food.	Total fats in food.	Approximate nutritive ratio.
			Lbs.	Lbs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	
9	35	Nov. 23 to Dec. 27	5.6	+1.26	.24	.66	.15	3.22	.25	1:5.9
9	28	Dec. 27 to Jan. 24	6.8	+.09	.22	.70	.17	3.52	.24	1:6.0
9	28	Jan. 24 to Feb. 21	6.9	—.25	.20	.53	.20	2.47	.19	1:5.8
9	35	Feb 21 to March 28	6.7	+.03	.23	.68	.22	3.40	.22	1:6.0
8	28	March 28 to April 25	6.8	—.78	.19	.49	.13	2.16	.18	1:6.5
8	28	April 25 to May 23	6.1	—.10	.17	.37	.16	1.63	.17	1:5.9
7	28	May 23 to June 20	6.0	+.29	.19	.43	.19	2.06	.19	1:6.2
7	35	June 20 to July 25	6.2	—.35	.22	.53	.22	2.57	.22	1:6.2
7	28	July 25 to Aug. 22	5.9	+.13	.20	.44	.15	1.99	.23	1:6.0
7	28	Aug. 22 to Sept. 19	6.0	+.12	.22	.51	.21	2.17	.28	1:5.9
7	28	Sept. 19 to Oct. 17	6.1	+.13	.23	.53	.24	2.38	.26	1:6.0
7	28	Oct. 17 to Nov. 14	6.3	+.35	.22	.54	.23	2.43	.26	1:6.1

PEN NO. 4 — GRAIN IN RATION DRY AND WHOLE.

No. fowls in pen.	PERIOD.	Average per fowl. Total food per day.	Average per fowl. Total water-free food per day.	Average per fowl. Total cost of food per day.	Pounds of water-free food per day for each 100 pounds live weight fed.	Cost of food per day for each 100 pounds live weight fed.	Eggs produced during period. Average per fowl. Number.	Eggs produced during period. Average per fowl. Weight. Ozs.	Pounds water-free food pound of eggs produced.	Cost of food for one pound of eggs produced.
		Ozs.	Ozs.	Cts.	Lbs.	Cts.			Lbs.	Cts.
9	Nov. 23 to Dec. 27	7.73	4.53	.36	4.6	5.8	1.22	2.31	.....	.....
9	Dec. 27 to Jan. 24	8.78	4 84	.38	4.4	5.5	12.00	22.54	6.01	7.52
9	Jan. 24 to Feb. 21	6.03	3.58	.34	3.2	4.9	4.78	9.25	10.84	16.16
9	Feb. 21 to March 28	7.55	4.74	.40	4.4	5.9	17.78	34.50	4.81	6.40
8	March 28 to April 25	4.75	3.14	.24	3.1	3.8	7.37	14.60	6.00	7.52
8	April 25 to May 23	3.03	2.49	.19	2.6	3.2	1.75	3.63	.....	.....
7	May 23 to June 20	3.77	3.06	.24	3.1	3.9	9.42	18.60	4 61	5.60
....	June 20 to July 25	4.79	3.70	.28	3.8	4.6	10.28	19.57	6.72	8.00
7	July 25 to Aug. 22	3.93	3.01	.22	3.1	4.7	6.00	11.57	7.28	8.64
....	Aug. 22 to Sept. 19	4.35	3.39	.27	3.5	4.5	3.43	6.79	13.98	18.08
....	Sept. 19 to Oct. 17	4.64	3.63	.29	3.0	4.7	3.58	6.66	.....	.....
....	Oct. 17 to Nov. 14	4 68	3.68	.29	3.6	4.5	2.71	5.61	.....	.....

The mixed ground grain which was fed moistened to the two pens constituted on the average for the year 37.2 per cent. of the total food excepting skim-milk for pen No. 1, the Leghorns, and 37 per cent. for pen No. 3, the Cochins.

The average amount of water-free substance in the food taken per day per fowl for the whole year was 2.58 ounces with the pen of Leghorns, No. 1, having the moistened ground grain. For the pen No. 2, having only whole grain, the daily average was 2.98 ounces, an excess in consumption over that of the first lot of 15.5 per cent.

For pen No. 1, the cost of food per hen for the year was 72.11 cents. The average number of eggs was 85.95 and the average total weight of eggs 173.45 ounces, each pound of eggs being produced at the cost for food of 6.66 cents. One pound of eggs was produced for every 5.31 pounds of water-free food consumed. The cost of food for every dozen eggs was 10.04 cents. Rating the eggs laid during each period at the average wholesale market price for the period, the total value of eggs laid per hen was 116.7 cents.

For pen No. 2 the cost of food per hen was 82.69 cents. The average number of eggs was 84.43 and the average total weight 168.37 ounces, one pound of eggs being produced for every 6.33 pounds of water-free food consumed. The food cost for each pound of eggs was 7.84 cents and the cost per dozen 11.74 cents. The average wholesale market value of eggs laid per hen was 117.7 cents.

For the pen of Cochins, No. 3, having the moistened grain food, the average amount of water-free substance in the food consumed per day per fowl for the whole year was 3.28 ounces and for the pen No. 4, having whole grain 3.70 ounces, an excess in consumption by the latter over the former of 12.8 per cent.

For pen No. 3, the cost of food per hen for the year was 91.85 cents, the average number of eggs was 59.61 and the average total weight of eggs 114.60 ounces, one pound of eggs for every 10.22 pounds of water-free substance in the food. The average cost of each pound of eggs was 12.82 cents and the cost per dozen was 18.48 cents. The average wholesale market value of eggs produced was 84.7 cents.

For pen No. 4, the cost of food per hen for the year was 105.06 cents. The average number of eggs was 80.32, and the average total weight of eggs 155.69 ounces, one pound of eggs for every 8.47 pounds of water-free substance in the food. The food cost of each pound of eggs was 10.79 cents, and the cost per dozen was 15.70 cents. The average wholesale market value of eggs laid was 124.56 cents.

Although all the pens were fed liberally, and had all that was needed to satisfy the appetite, the two pens fed the moistened ground grain were satisfied with a lesser amount of dry substance in the food than the two corresponding pens. The cost of the ration containing the ground grain was also less. With the Leghorns the cost of the whole grain ration was 14.7 per cent. the greater and with the Cochins 14.4 per cent. the greater.

The egg yields for the pens of Leghorns were practically alike, but the average live weight was nearly all the time greater for the pen having the whole grain, except at the start, when the average weights were equal. This fairly constant difference in weight, however, was not enough to correspond to the difference in amount of dry matter in the food eaten, and as it was the more efficient, the indications were that the ground grain ration was more fully digested than that of whole grain.

By pen No. 1 one pound of eggs was produced for every 5.31 pound of water-free substance in the food on the average for the year, and by pen No. 2 one pound of eggs for 6.33 pounds of water-free substance in the food. For eight weeks during the best part of the laying season one pound of eggs was obtained from pen No. 1 for every 2.72 pounds of water-free food, and, during the same time, one pound from pen No. 2 for every 3.57 pounds of water-free food. During 119 days, pen No. 1 produced eggs at the rate of one pound for every 3.12 pounds of water-free food consumed, and pen No. 2 at the rate of one pound for every 3.67 pounds of water-free food. There were small losses in live weight with each pen during these periods — about equal in amount. For the whole year, however, and during shorter periods when the egg yield was greatest, pen No. 1 produced eggs from less food than did pen No. 2. The market value of eggs for the year from pen No. 1 exceeded the cost of food by 61.9 per cent., and the value of eggs from pen No. 2 exceeded the cost of food by 42.4 per cent.

With the Cochins, pen No. 3, having the ground grain, gave much the poorer egg yield. The egg production for either pen, however, was so much below what is possible for the same consumption of food with the smaller breeds that the relation of food eaten to the weight of eggs produced by these two pens is a doubtful indication of the relative digestibility of the two rations. It is possible that the ration fed to No. 3 was a trifle too liberal in amount for fowls of a breed so inactive and liable to excessive fat. During the first two months although the dry substance in the ration for pen No. 3 was about 22 per cent. less than pen No. 4, the average gain in live weight was considerably greater. The average live weight was also greater during most of the laying season, but toward the end of the year pen No. 4 attained to the highest in average live weight. It appears probable that the better results from the Cochins having whole grain may be due to the fact that by feeding the grain in straw it was possible to insure considerable exercise, while in feeding the ground grain ration less opportunity was afforded to induce any activity. The more rapid increase in weight at the beginning even on less food, seems to show this.

On the average for the year there were 10.22 pounds of water-free substance in the food eaten by pen No. 3 for each pound of eggs laid and in the food for No. 4 — 8.47 pounds of water-free food for one pound of eggs. During the period when the yield of eggs for the food consumption was the best, pen No. 3 consumed 5.14 pounds of water-free food for each pound of eggs produced and pen No. 4 — 4.61 pounds of water-free food for one pound of eggs. For No. 3 the market value of the eggs laid was less than the cost of food, For No. 4 the market value of the eggs exceeded the cost of the food by 18.6 per cent.

The Cochins are generally classed as indifferent layers and with good reason. Narrow confinement, however, affects them less unfavorably than it does such breeds as the Leghorn and possibly for this reason the one pen of Cochins No. 4 nearly equalled in total average egg production, the pens of Leghorns. The average product from the two pens of Cochins was considerably short of that from the Leghorns, but a comparison between the results from the better laying pen of Cochins and the pen of Leghorns which was fed a similar ration is of interest as showing the relative profits from hens of large and small breeds, when the egg yields are about equal, and the egg yield from the smaller fowls does not exceed the usual yield from the larger. This comparison is made simply because of the opportunity of comparing the profit over food for large and small hens when the egg products are equal and the rations alike, and not as a comparison between the breeds, for the necessary conditions were such as to much more unfavorably affect the Leghorns than the cochins. The pen of Cochins, also, which layed the better is compared with the pen of Leghorns which gave the poorer egg yield.

The pen of Cochins had on the average for the year 8.47 pounds of dry substance in the food for each pound of eggs laid while the Leghorns required only 6.33 pounds of food. The best rate of production for any period made by the Cochins was one pound of eggs for every 4.61 pounds of water-free food, and the best for any period made by the Leghorns was one pound of eggs for 3.29 pounds of food. The average cost per pound of eggs laid by the Cochins was 10.79 cents and of those laid by the Leghorns 7.84 cents, the food cost of the production being over 37.6 per cent. greater for the Cochins. Although the egg yield was somewhat less from the Cochins than from the Leghorns, a greater proportion of the total product was obtained at the season when prices were better, so that the average market value of the product for the year was greater with the Cochins and the market value per dozen about 11.4 per cent. higher. The excess of market value of eggs over the cost of food was 18.6 per cent. for the Cochins and 42.4 per cent. for the Leghorns.

For the production of eggs only,—considering the cost of growing or the purchase price per fowl for two lots of pullets alike and the same as their market value, when hens, at the end of the year,—the smaller fowls would show the greater profit over the cost of food. But taking into consideration the cost of growing and the poultry value of the fowls at the end of the year, the relation of profit would be different. The average net cost per Leghorn pullet, grown in the ordinary way, was a little over fourteen cents at the beginning of this feeding trial. The cost of eggs for hatching and of food for sitting hens made the average cost of each chick when hatched 2.15 cents. The average cost of food, including the cost of hatching, to grow one pullet and one cockerel (the sexes as a rule average about equal in number) until the time of separating them was 23.84 cents. The average wholesale market value per cockerel was 24.72 cents. Deducting the market value of the cockerel and adding the cost of food per pullet from the time of separating the sexes until November 23d, made the net cost per pullet under the ordinary practical farm conditions 14.3 cents. The cost of food for the year made the average net outlay per hen 97 cents. The market value of eggs added to the poultry value per hen,— three and one-fourth pounds average live weight at eight cents per pound,— amounts to 143.7 cents, which exceeds the total cost by 48.2 per cent.

The average cost per Cochin chick when hatched was 3.56 cents. The total cost, including hatching, for a pullet and cockerel was 46.54 cents, and the average wholesale market value of the cockerel when the sexes were separated was 54.24 cents. The average total net cost per pullet November 23d was 12.9 cents. The cost of food for the year made the average net outlay per hen 117.96 cents. The market value of the eggs added to the poultry value per hen (six and three-fifths pounds average live weight at eight cents per pound), amounted to 177.4 cents, an excess over the total cost of 50.4 per cent. This makes the showing somewhat the more favorable to the larger fowls. In practice the cost of keeping through the few last months, including the molting season, would be saved and the final poultry value of the hens probably greater, for they would be sold earlier in the season.

SUMMARY.

1. Two lots of laying hens, of large and small breeds respectively, having their grain food only dry and whole, ate more food at greater cost per fowl and for the live weight than did two similar lots having about 37 per cent. of their grain ground and moistened.

2. A pen of Leghorns, which had for the year 37 per cent of ther food ground and moistened grain, produced eggs at a greater profit than did an exactly similar pen fed whole grain.

3. Of two like pens of Cochins, the one fed whole grain produced eggs at much less cost than did the pens having ground grain, which result is attributed partly to the exercise assured in feeding whole grain.

4. With the kinds of whole grain ordinarily available it is not possible to feed a largely grain ration having as narrow a nutritive ratio, that is — containing as large a proportion of the nitrogeneous food constituents, as is perhaps necessary for best results from laying hens.

5. By using some of the highly nitrogenous by-products with ground grain it is possible to feed a somewhat narrow ration without feeding an excessive amount of meat.

6. With hens fed similar rations, when the hens of smaller breeds ive only the same egg yield as the hens of larger breeds, the eggs are more cheaply produced by the smaller hens; but taking into consideration the cost of raising and the ultimate poultry value of the hens, the profits will be equal or more favorable for the larger hens.

REPORT OF THE MYCOLOGIST.

F. C. STEWART, M. S.

REPORT OF THE MYCOLOGIST.

BY F. C. STEWART, M. S.

During the past year the mycologist has been occupied chiefly with the study of carnation rust and methods of combating it. A preliminary report upon these investigations will be published in bulletin form in the near future. A bulletin on potato diseases is also nearly finished.

Considerable time has been devoted to collecting and mounting plants; both flowering plants and fungi. It is the desire of the mycologist to build up the herbarium as rapidly as possible, particularly in the group of parasitic fungi.

Addresses were delivered before Farmers' Institutes at the following places in south-eastern New York: Southampton, Southold, Mattituck, Huntington, Mineola, Riverhead, Farmingdale, Jamaica, Suffern, Mt. Kisco, Brewster, Newburg, Unionville, Washingtonville, New Paltz and Walden.

The correspondence of the mycologist has not been as large as it should have been. It is earnestly requested that farmers report to the Station any new plant disease or any unusual outbreak of the common plant diseases which may come under their observation. All queries will receive prompt and careful attention.

The following subjects are discussed in this report:

I. Two Destructive Lily Diseases;
II. Prevention of Cabbage Club-Root;
III. Spraying Tomatoes;
IV. A Disease of Norway Maples;
V. Witches' Brooms on Cherry Trees;
VI. Observations on *Exobasidium Peckii* and *Ramularia cylindriopsis*;
VII. Inoculation Experiments with *Gymnosporangium macropus*;
VIII. "Belted" Apples and Pears;
IX. A New Leaf-Spot Disease of Apples.

I. TWO DESTRUCTIVE LILY DISEASES.

Soon after my arrival upon Long Island in December, 1894, Mr. C. H. Allen, President of the New York Florists' Club, directed my attention to a lily disease which was causing serious trouble to lily growers in the vicinity of New York City. The Easter lily, a variety of *Lilium longiflorum*, Thunb., known to florists as *Lilium Harrisii*, suffered most, but *L. longiflorum* also was slightly affected. Visits to various growers showed that the trouble was a general one. Florists say that it has been known for several years, and that it has been gradually growing worse until at the present time it threatens the complete destruction of the Easter lily industry unless a remedy can be found. In the green-houses of Mr. James Dean, a large grower at Bay Ridge, N. Y., about forty per cent. of the plants were ruined and probably not more than five per cent. were wholly free from it. That it is also prevalent in Bermuda is shown by the reports coming from there, and by cut flowers sent to the New York market. However, it is likely that in Bermuda the disease is confused with another common one known as the "Bermuda lily disease," or "Ward's lily disease," which is discussed in another part of this article.

The disease under consideration is characterized as follows: Very soon after the leaves start, they show blotches and streaks of light yellow. As the plant develops, the yellow blotches are gradually replaced by numerous small, irregular, dead spots, giving the leaf the appearance of having been gnawed by small insects. The flowers are spotted in the same manner. The whole plant presents a sickly, yellowish, rusty appearance, making it unsalable. In many cases the plants never flower; in others the flowers are distorted. The disease progresses very slowly. The bulb appears to be normal, but the tips of the feeding roots are found to be dead. If a healthy plant is knocked out of its pot, the ball of dirt appears white all over the outside with growing rootlets. A diseased plant similarily treated shows very few white rootlets.

The cause is obscure. A microscopic study of the leaf spots shows that they are not insect injuries. The cuticle of the leaf is unbroken, and, moreover, no insect is constantly associated with the disease. However, it is likely that Aphids are in some cases the cause of the distorted flowers. At the beginning I strongly suspected that the trouble was due to bacteria. All of the symptoms point to bacteria in the tissues; but the microscope reveals neither fungus mycelium nor bacteria in the stem or in the diseased spots on the leaves. To determine this, a large number of cultures were made of the aerial parts of diseased plants. Lily agar was used as a culture medium. Cultures made from leaves and buds developed various fungi and bacteria, but no one species appeared constantly. Cultures made from the interior of stems of diseased plants either developed nothing or only occasional colonies of fungi and bacteria admitted by accident. From all this, it appears that the cause is not to be found above ground. In an examination of the bulb, the first objects to attract the observer's attention are certain circular, depressed spots of brown color. These contain the mycelium of some fungus which was not determined. They are not constantly associated with the disease and probably have no connection with it. Cultures made from the dead root tips developed numerous colonies of two species of bacteria: *First*, A very large, motile, spore-producing *Bacillus*. A single plant inoculated with this germ showed no disease, and it was afterward ascertained that the *Bacillus* is a common one in green-houses, on the roots of carnations, callas, dracaenas and other plants, even where no lilies are grown; *Second*, A small, motile *Bacillus*. A quantity of this germ was grown in sterilized lily juice and an inoculation experiment made. In Mr. Dean's green-house four healthy plants were selected. On April 26 three of these plants were removed from their pots, and their white young roots sprayed thoroughly with the lily juice containing the *Bacillus*. The plants were then returned to the pots and a quantity of the lily juice poured around the base of each plant. The fourth plant was kept as a check. As late as June 5 none of the plants showed any trace of the disease. Here the investigation was discontinued for the time being.

Dr. Halsted[1] has reported a lily disease (probably the same) which he thinks is due, primarily, to a leaf-attacking fungus belonging to the genus *Phyllosticta*. He also found a species of *Vermicularia* and mites, which he thinks may in some cases account for the loss of vigor. I, too, found on the bulbs *Vermicularia* and mites, but by no means constantly and seldom in sufficient numbers to account for the damage.

Some florists maintain[2] that the disease is due to a loss of vigor

1 New Jersey Agricultural Experiment Station Report, 1894, p. 372.
2 See discussion in Florists' Exchange for 1895.

resulting from the practice in Bermuda of cutting flowers from bulbs which are afterwards sent North to be used for winter forcing. There is no experimental evidence either for or against this theory, but it seems highly improbable that the cutting of the flowers has any important bearing on the disease. Nor is it likely that the disease is due to faulty cultural methods either here or in Bermuda. The history of the disease is opposed to such a view. When the cause is accurately determined it will probably be found to be some living organism in the soil which prevents the roots from performing their proper functions. Upon this hypothesis are based the following suggestions for treatment:

First. For potting use soil which has never been used for growing lilies or other bulbous plants.

Second. Previous to potting soak the bulbs one and one-half hours in a weak solution of corrosive sublimate, prepared by dissolving one and one-half ounces of corrosive sublimate in ten gallons of water. This is the treatment recommended by Prof. Bolley for potato scab. It does not appear to injure the plants.

A second destructive lily disease is the one widely known as the "Bermuda lily disease." This disease attacks several varieties of lilies grown in the open air, particularly *Lilium candidum*. In all parts of the world where *L. candidum* is grown, the "Bermuda lily disease" is the most serious drawback to its cultivation.

It manifests itself as circular or elliptical orange-brown spots on the leaves, stem, pedicels and buds. In severe attacks the leaves are killed, many of the buds rot and the flowers which open are badly disfigured.

Our knowledge of this disease rests principally upon the investigations of Prof. H. Marshall Ward [3] in England on *Lilium candidum* and those of Mr. A. L. Kean [4] in Bermuda on *Lilium Harrisii*.

These investigators proved beyond all doubt that the disease is caused by a parasitic fungus, *Botrytis sp.* To this same genius belong the gray moulds so common on a great many plants, particularly green-house plants.

The fungus consists of vegetative threads (mycelium) which run in all directions through the tissues of the plant, and of branched spore-stalks (conidiophores) which rise above the surface of the leaf and produce at their tips clusters of oval spores. When mature

3 A lily disease, Annals of Botany, Vol. II, No. VII, Nov. 1888, p. 319.

The lily disease in Bermuda, Botanical Gazette, Vol. XV, No. I, January, 1890, p. 8.

these spores may fall upon some part of a lily plant and there germinate, producing a slender, colorless germ-tube. The tip of the germ-tube excretes a soluble ferment which dissolves cellulose and thus the fungus easily gains access to the interior of the plant where it feeds upon the tissues.

In the course of its development, the mycelium in places becomes twisted into hard, dark, seed-like bodies called sclerotia (sing. sclerotium). It is probable, but not demonstrated, that in the following spring the sclerotia produce, as in certain other species of *Botrytis*, trumpet-shaped bodies bearing on their expanded tips a second kind of spores in sacks. It is supposed that the fungus passes the winter in the sclerotium condition.

Although the fungous nature of the disease has been known since 1888 there has been scarcely any experimentation with remedies. Mr. Kean noticed that lilies growing under oleander bushes suffered less from the disease and hence he suggested as a possible remedy, that some other plant with high and spreading foliage be planted with the lilies in alternate rows in order to prevent dew from collecting on the lilies. An abundance of moisture is required for the germination of the *Botrytis* spores. I understand that some lily growers in Bermuda spray with Bordeaux mixture but I think that there are no recorded experiments with this fungicide.

The following experiments were made at Floral Park, N. Y., on the premises of Mr. C. H. Allen. Three species, *Lilium candidum*, L., *L. Batemanii* and *L. speciosum*, Thunb., were treated with Bordeaux mixture made according to the formula:

Sulphate of copper	6 pounds.
Fresh lime	4 "
Water	45 gallons.

1. A bed of *Lilium candidum* lilies sixty feet long and four feet wide was divided into two equal parts. One part was untreated; the other was sprayed three times — June 7, June 24 and July 6. At the time of the first spraying the disease was already far advanced. Half way up the stems the leaves were nearly all dead and the remainder badly spotted. At the time of the third spraying there was scarcely a living leaf to be found on the untreated part while on the sprayed part there were still a good many green

leaves. The disease was slightly checked. About July 20 the bulbs were dug and appeared entirely normal but it is likely that they were deficient in starch.

2. Two other beds of *Lilium candidum* of about the same size as the first were sprayed twice — June 24 and July 6. A small adjacent bed, equally diseased, was left as a check. The disease was well advanced before spraying was commenced. The sprayed beds showed green leaves considerably longer than the check.

3. Two equal beds of *Lilium Batemanii* were selected. Every plant showed the disease on nearly every leaf. One bed was untreated; the other was sprayed three times — July 6, July 19 and August 2. On August 2 there were 45 live plants on the sprayed bed against five live plants on the unsprayed bed.

4. Three beds of *Lilium speciosum*, in fairly good health, were selected. The leaves showed diseased spots here and there. One-half of each bed was sprayed four times, July 19, August 2, August 15 and August 27. By September 20 the disease had made no advance on two of the beds since July 19. On the third bed the untreated portion was badly diseased, while on the sprayed portion the disease had made no advance.

In none of these experiments did spraying do the plants any practical benefit, but in all cases sprayed plants held their foilage a little longer than unsprayed, indicating that the disease was checked. Had treatment been commenced before the disease had become established, the difference between treated and untreated plants would undoubtedly have been much greater. It is a general truth that preventive treatment is more successful than curative treatment. Moreover, the weather from June 27 to August 2 was very wet and cloudy, furnishing ideal conditions for the development of the fungus, while at the same time the Bordeaux mixture was badly washed off.

From the results of the above experiments it seems likely that the following treatment will prove effectual in preventing the Bermuda lily disease:

Commencing with the appearance of the leaves, spray thoroughly with Bordeaux mixture at intervals of ten days or two weeks, until the flowers begin to open. With the opening of the flowers spraying must be discontinued as it will spot them.

II. PREVENTION OF CABBAGE CLUB-ROOT.

The disease of cabbage, cauliflower, etc., known as club-root, is too well known to need any description. In all parts of the world where cabbage is grown this disease is troublesome, and probably it is nowhere worse than in the market-garden region of southeastern New York. In different countries it passes under different names. Club-root, club-foot and clump-foot are some of the names used in America.

So far as known, it attacks only plants which belong to the mustard family, *Cruciferae*. The cabbage and its varieties (cauliflower, kale, Brussels sprouts and kohl-rabi) and the turnip (*Brassica rapa*) suffer most. In Russia the candytuft (*Iberis umbellata*) and stock (*Matthiola incana*) are attacked. Dr. Halsted has recently shown that the disease sometimes occurs on the radish (*Raphanus sativus*) and the two common weeds, shepherd's purse (*Capsella Bursa-pastoris*) and hedge mustard (*Sisymbrium vulgare*). Further investigations will probably show that it infests other cruciferous plants.

While everyone is familiar with the appearance of club-root there may be some who do not know its cause. Formerly various theories were set forth to account for it. Some claimed that it was due to insects, and there are farmers at the present time who believe in the insect theory. The true nature of the disease was discovered about twenty years ago by a botanist named Woronin. He proved conclusively that the disease is due to a microscopic organism of simple organization, which lives within the cells of the cabbage root. This minute parasite feeds upon the starch in the root, and by irritating the tissues produces the characteristic distortions. Woronin named it *Plasmodiophora Brassicae*.[1] It belongs to a group of organisms called *Myxomycetes* or slime moulds, very few of which are parasites. Most of the species inhabit decaying wood.

As for remedies, it is obvious that no spray or powder or other treatment applied to the leaves can do any good whatever. The seat of the difficulty is below ground, and no fungicide applied to the parts above ground can reach the disease. Of the various substances applied to the soil, lime has given the best results, and we may consider it established that lime is a preventive of this trouble-

1 For figures and description see Journal of Mycology, Vol. VII, pp. 79-88. Also, New Jersey Agr'l Exp. Sta. Report for 1893, pp. 332-345.

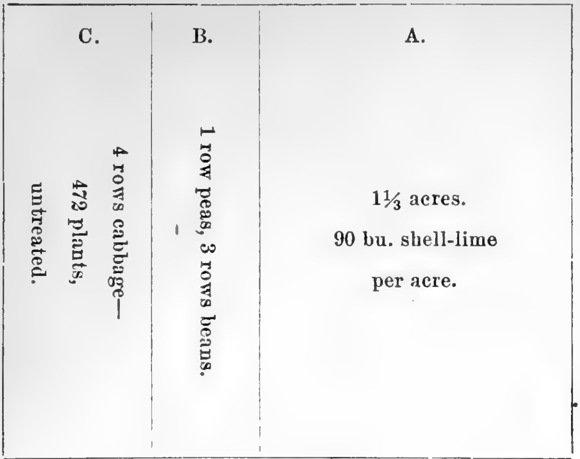
some disease. A recent experiment[2] made at the New Jersey Experiment Station shows that kainit, wood-ashes and gas-lime are worthless as preventives of club-root in both turnips and cabbages. Moreover, kainit and gas-lime wrought injury to the turnip plants. Gas-lime injured cabbages also, but kainit stimulated the growth of cabbages. Half-strength Bordeaux mixture and half-strength ammoniacal copper carbonate solution applied to the soil at the rate of 4,320 gallons per acre of turnips did not prevent club-root nor harm the plants; but one-half this amount, viz., 2,160 gallons per acre, did serious injury to cabbage and did not prevent club-root. Corrosive sublimate solution (one part corrosive sublimate to two thousand parts water), applied at the rate of 4,320 gallons per acre, lessened the amount of club-root in turnips and did not harm the plants, but one-half the quantity of the same solution applied to cabbages seriously injured the plants and is therefore not to be recommended, although it reduced the amount of club-root. (It appears that the cabbage is a more delicate plant than the turnip.) Air-slacked stone-lime gave good results with both turnips and cabbages. Seventy-five bushels per acre is recommended. One hundred and fifty bushels slightly injured both turnips and cabbages.

A large grower of cabbage at Bayside, N. Y., Mr. R. E. Forbell, has for several years successfully used shell lime as a preventive of cabbage club-root. This shell lime is made by burning the shells of clams and oysters, and can be bought at the kiln for about seven cents per bushel.

While the extended experience of Mr. Forbell had convinced him of the efficacy of shell lime, the writer thought to place the matter beyond doubt by making an experiment. Accordingly the following experiment was planned by the writer and carried out by Mr. Forbell.

---

[2] New Jersey Exp. Sta. Bull. No. 108, pp. 6–8. Same in New Jersey Exp. Sta. Report for 1894, pp. 278–289.



PLAN OF EXPERIMENT.

The field selected for the experiment had never before been limed. In 1892 it was planted to cabbage; in 1893, to potatoes, followed by Siberian kale or "sprouts," which "clubbed" badly, and being very cheap the whole crop was plowed under in the spring of 1894; in 1894 the field was planted to sweet corn.

In March, 1895, Plot A was treated with shell-lime at the rate of 75 bushels per acre, applied broadcast and the ground plowed. About April 15, the ground was plowed a second time and marked. On April 29, about fifteen bushels more lime per acre were scattered in the row and the plants set.

Plot C was used as a check and left untreated. In order to make sure that during cultivation none of the lime from Plot A should be carried over to Plot C, a space of four rows was left between the two plots. Plot C was planted about May 3, with 472 plants from the same seed-bed as the plants used in Plot A. The variety was Flat Dutch.

As the season advanced the plants on Plot A grew vigorously and produced an excellent crop. The plants on Plot C showed the characteristic "flagging" of the leaves due to club-root and many of them died without heading. When harvested in July only 60 marketable heads could be found. An examination of the roots of the plants on the two plots showed that about 90 per cent. of the plants on each plot had "clubbed," but with this difference, however: On Plot A the enlargements were found principally on the small roots, seldom on the main root; while on Plot C the main root was generally affected.

From a practical standpoint the experiment may be summed up as follows: On soil treated with 90 bushels of shell-lime per acre an excellent crop of cabbage was grown while on soil not limed, 472 plants produced only 60 marketable heads.

It is probably best to apply the lime two or three months before planting, and where lime is applied two or more years in succession it is likely that a smaller quantity will be required with still greater success in preventing club-root.

While experiments show that by the application of lime cabbages can be grown year after year on the same ground without serious injury from club-root, the practice is not to be recommended. By a proper system of crop rotation the same end may be attained without the expense of applying lime. The system of rotation should be such that neither cabbage nor other cruciferous crops are grown on the same ground oftener than once in three years.

As far as possible all cabbage refuse should be destroyed. Upon the decay of the infested cabbage plant there are set free myriads of spores which are capable of living in the soil until the following spring when they will germinate and attack the next crop of cabbage plants. If cabbage refuse is fed to animals the spores of the disease will be carried back to the field in the manure if it is not thoroughly rotted. There is a popular belief that hog manure causes club-root. Such is not possible, except in cases where the hogs have been fed on the refuse of infested plants.

In this connection I wish to record an observation which indicates that even the leaves of cabbage may contain the disease in considerable quantity. In July, 1894, Mr. Forbell planted a certain field of late cabbage. The following winter the trimmings (consisting of leaves only) of these cabbages were spread over the field on which they grew. In the spring of 1895, the field was planted to potatoes, and these were followed by Siberian kale or "sprouts." When examined in November 1895, the kale was so badly "clubbed" that it was nearly worthless. Mr. Forbell thinks that the cabbage leaves are responsible for the severity of the disease. He assures me that he has practiced this rotation (cabbage, potatoes, kale — applying lime before the cabbage) for several years and has never had the kale badly "clubbed" except in this case where cabbage leaves were spread over the ground. The idea that the

Plasmodiophora infest the leaves as well as the roots is not a new one. Woronin demonstrated it long ago. Our own observations show its bearing upon practical agriculture.

The hot-bed where the seedling plants are grown should receive careful attention. In preparing it, no soil should be used which has ever grown any of the plants subject to club-root. A small quantity of air-slacked lime should be mixed with the soil as an additional precaution. At time of setting, all plants which show the least sign of the disease should be discarded. When once the disease has gained entrance into the tissues there is no remedy for it.

III. SPRAYING TOMATOES.

There are several fungous diseases of field tomatoes. On the whole, most damage is perhaps done by "black rot," which attacks the fruit; but during the past season on Long Island this disease has given less trouble than another one caused by a species of *Cylindrosporium*. Dr. Halsted[1] reports a *Cylindrosporium* disease of tomatoes as being abundant in New Jersey in 1894. On Long Island it has been very common and caused great loss. Both early and late tomatoes were attacked. Shortly after the fruit began to ripen the leaves turned brown and dried up, as if the plants were suffering from lack of water, which could not have been, as there was an abundance of rain. It was a frequent sight to see whole fields of tomato plants with the foliage nearly all dead while still loaded with immature fruit, which would finally take on color, but was necessarily of very inferior quality. An examination of the diseased leaves showed that very little of the ordinary leaf-blight fungus, *Macrosporium Solani*, E. & M., was present. Occasionally the cinnamon-brown leaf-mould fungus, *Cladosporium fulvum*, Cke., was found, but the majority of the damage was due to a species of *Cylindrosporium*. This appears to be a new disease economically. The "black rot" of the fruit, caused chiefly by *Macrosporium Tomato*, Cke., is a destructive disease, but not as common as usual on Long Island the past season. Early tomatoes do not suffer to any considerable extent. With late tomatoes it is observed that the first fruits to ripen are most subject; also, varieties differ greatly in their susceptibility to the disease. Those

1 New Jersey Agr'l Exp. Sta. Report for 1894, p. 361.

varieties which have a tender skin and show a tendency to crack near the blossom end are more likely to be attacked by "black rot" and also by a white mould, *Fusarium*.

Spraying tomatoes has not been practiced to any considerable extent, although it is likely that it can be done with profit. Howell[2] in South Carolina and Rolfs[3] in Florida report excellent results from the use of Bordeaux mixture against "black rot." Howell sprayed three times with Bordeaux mixture at intervals of two weeks, beginning when the first fruits were three fourths of an inch in diameter. On the sprayed plants only 4 per cent. of the fruit rotted, while unsprayed plants produced 60 per cent. of rotten fruit. Rolfs recommends that the first treatment be made when the flower buds begin to form.

It is not worth while to record in detail our own experiments because "black rot" was almost wholly absent from the field where most of the experiments were conducted. The previous year tomatoes on this field suffered severely from "black rot" but curiously enough the same variety on the same ground the past season showed only a trace of the disease. These were medium late tomatoes. Very late tomatoes of the variety Stone in another field showed considerable rot. It appears that "black rot" thrives best in dry weather. July and August 1894 were dry and "black rot" was abundant. In 1895, July and August were wet, July *very* wet, and no "black rot" was to be found on the same field. September and October 1895 were dry and the late tomatoes ripening during these months rotted considerably. Dr. Halsted's observation[4] that, "the more completely the fruit of a plant was sheltered by the foliage the smaller was the percentage of rot," points in the same direction. This is an exception to the general rule that moisture favors the development of fungi.

The very late tomatoes, sprayed three times, August 2, 15 and 27, had first fruits two-thirds grown at the latter date. They suffered much less from rot than did the unsprayed. In all cases spraying was discontinued when the fruit began to ripen. Up to this time sprayed plants were much better in foliage than unsprayed, but later the *Cylindrosporium* killed both sprayed and unsprayed. It is evident that the *Cylindrosporium* disease can not be controlled

2 U. S. Dep't of Agr., Sec. of Veg. Pathology, Bull. No. 11, 1890, pp. 61-65.
3 Florida Exp. Sta. Bull. No. 21, 1893.
4 New Jersey Agr'l Exp. Sta. Bull. No. 108, p, 19.

with Bordeaux mixture unless spraying is continued after the fruit begins to ripen. It is interesting to note that sprayed plants seemed to be very distasteful to the hordes of Colorado potato beetles which attacked tomatoes late in the season. The same thing was observed where potato plants were sprayed with Bordeaux mixture. Bordeaux is of more value as a check to insects than is generally supposed.

Between the first appearance of blossoms and the ripening of the first fruits, tomato plants grow very rapidly. Therefore, it is necessary during this period to spray oftener than is recommended for most plants. They should be sprayed at least once in ten days in order to keep the foliage well protected.

There is is no danger whatever in eating tomatoes which have been sprayed with Bordeaux mixture, but consumers prefer to buy clean fruit and run no risk. Hence, tomatoes grown for the market should not be sprayed with Bordeaux mixture after they begin to ripen. Of course, if necessary, the spots can be removed with a cloth moistened with water containing a small amount of vinegar or acetic acid. Should it become necessary to spray for the *Cylindrosporium* disease while the fruit is ripening some fungicide which does not spot the fruit must be used. Perhaps ammoniacal copper carbonate solution can be used.

To state the whole matter briefly:

1. "Black rot" of tomatoes is caused chiefly by the fungus, *Macrosporium Tomato.*

2. It can probably be controlled with Bordeaux mixture.

3. Beginning when the blossoms appear spray at intervals of ten days until the fruit begins to ripen.

4. "Black rot" is most severe in dry weather.

5. A new disease caused by *Cylindrosporium* sp. has been destructive to tomato foliage the past season.

6. If necessary to spray for *Cylindrosporium* after the fruit is ripe, try ammoniacal copper carbonate solution.

7. Bordeaux mixture is very distasteful to Colorado potato beetles.

IV. A DISEASE OF NORWAY MAPLES.

In July of the past season my attention was called to a disease which was injuring Norway maples (*Acer platanoides*, L.) at the nursery of Isaac Hicks and Son, Westbury, N. Y. In a lot of several thousand young trees, from four to six feet in height, scarcely a tree could be found but what was more or less diseased. Early in July the young leaves on the terminal twigs take on a yellowish-green color and then blacken and die at the tips as if slightly frosted. Some of the very youngest leaves may be entirely dead. From this time on to the end of the growing season the majority of the young shoots are killed as fast as they appear. Upon the death of the terminal shoot, the two lateral buds (the leaves are opposite) develop into shoots each of which after growing a short distance is in its turn killed part way back and develops two lateral shoots. By the repetition of this process there is formed a compact, much-branched "head" which must be pruned away before growth commences the following season.

The cause of the trouble is a fungus, *Gleosporium apocryptum*,[1] E. & E., the numerous spores of which appear on the dead shoots and on the under surface of the leaves, as a cinnamon-brown powder: Another member of the same genus, *Gleosporium nervisequum*,[2] (Fckl.) Sacc., causes a similar fasciation of the twigs of large sycamore trees — a disease exceedingly common in south-eastern New York. The maple *Gleosporium* is confined entirely to young trees, and is, therefore, troublesome chiefly in nurseries. Rapid growing trees appear to be more subject to it than trees making slow growth.

There is good reason for believing that the disease can be prevented by spraying with Bordeaux mixture or some of the other compounds of copper; but at least three applications would probably be necessary and Mr. Hicks is of the opinion that it is less expensive to prune away the diseased heads than to spray three times.

V. WITCHES' BROOMS ON CHERRY TREES.[1]

In Europe the cultivated cherries, *Prunus Avium* and *P. Cerasus*, are attacked by a disease which the Germans call Hexenbesen (witches' brooms). The fungus which causes it is closely related to the leaf-curl fungus of the peach. Formerly it was considered to be identical with the disease on the peach, but Prof. Sadebeck, in a recent monograph,[2] makes it a distinct species, giving it the name

1 Identified by Mr. J. B. Ellis. Described in Journ. of Mycology, Vol. IV, p. 52.

2 Described and figured in U. S. Dept. of Agr. Report for 1888, p. 387.

1 This article appeared in "Garden and Forest" for July 3, 1895.

2 Die parasitischen Exoasceen.

Exoascus Cerasi. Although the English cherry, *P. Avium*, is commonly cultivated in the eastern United States, and has been thoroughly naturalized, the disease was not observed upon it here until Mr. Thomas Meehan reported it from Germantown, Pennsylvania, in 1886. The specimens which he collected were distributed in "North American Fungi," No. 2286, under the name *Exoascus Wiesneri.* So far as I can learn it has been found upon the cultivated cherry in no other locality in America until I found it this spring on Long Island, in five different places, namely; Queens, Westbury, Floral Park, Cutchogue and Flatbush. It appears to be widespread on Long Island.

The disease manifests itself by causing the leaves to become reddish and wrinkled before they attain full size. By May 23 the under surfaces of the leaves are covered by a white, mealy layer which is composed of the spore sacs (asci) of the fungus. Dr. Robinson says[3] that the asci occur on both surfaces, but Prof. Atkinson found them only on the under surface in the Germantown specimens. I have examined a large quantity of the Long Island material, and in no case have I found asci on the upper surface. After the white layer makes its appearance the leaves dry up and fall off in a few days. Later, new leaves come out. The affected branches produce no flowers. Where flower-buds should be found twigs appear instead, and the repetition of this process brings about the "broom."

Probably the scarcity of the disease in America is due to our climate being unfavorable to it. Mr. Meehan states that it does not seem to spread. This is strange, because, according to Mrs. F. W. Patterson,[4] the same fungus occurs in America on *Prunus serotina*, *P. Americana*, *P. Virginiana*, *P. demissa*, *P. hortulana* and *P. Pennsylvanica.* The form on *P. serotina* is common, and why should it not thrive on *P. Avium?*

In case the disease should show a tendency to become troublesome, it could probably be controlled by cutting out and destroying the "brooms" before the spores come to maturity. This can easily be done, the diseased twigs being indicated by the red color at least a week before the spores mature.

It should be remembered that the fungus is perennial in the twigs, hence the disease may be transmitted by grafts.

3 Notes on the genus *Taphrina*, Ann. Bot. I, p. 169.

4 A Study of North American Parasitic Exoasceae. Bull. Lab. Nat. Hist. State University of Iowa, Vol. III, No. 3, p. 121.

VI. OBSERVATIONS ON EXOBASIDIUM PECKII, HALS., AND RAMULARIA CYLINDRIOPSIS, PK., IN HERB.

Exobasdium is a genus of parasitic fungi which for the most part attack plants belonging to the Heath Family, *Ericaceae*, producing conspicuous enlargements of the branches, leaves or inflorescence. The only species of economic importance is *Exobasidium Vaccinii* which deforms cranberry plants. This species occurs on several other plants of the same family. A few cranberries are grown in the vicinity of Riverhead and Baiting Hollow, Long Island, N. Y., where I have sought for *E. Vaccinii* the past season but failed to find it.

June 15, 1895, while collecting on Hempstead Plains near Westbury Station, N. Y., I observed that *Andromeda Mariana*, the "stagger-bush" or "calf-kill," which is very abundant in this region, was severely attacked by a fungus which distorted the leaves and inflorescence. On the leaves it produced circular, discolored areas which were convex above and concave beneath. The spots were frequently as much as three-fourths of an inch in diameter, yellowish-brown above and powdery-white beneath. The flowers, which in the normal condition are bell-shaped and nodding, were perfectly upright and showed a decided tendency to split into divisions like a polypetalous flower. The flowers were also much enlarged. I collected a quantity of the fungus and sent some to Prof. Peck who identified it as *Exobasidium Peckii*, Hals., first reported[1] in 1893 from New Jersey by Dr. Halsted. The chief interest which attaches to these observations is the discovery that the fungus attacks the leaves as well as the inflorescence. Dr. Halsted says:[2] "This species is remarkable in being confined almost entirely to the inflorescence." From my observations it appears to be as abundant on the leaves as on the inflorescence.

On June 29 while collecting more of the *Exobasidium Peckii*, I noticed another fungus on *Andromeda Mariana*. It resembled the Exobasidium in giving the under surface of the leaf a white, powdery appearance, but differed from it in not producing any distortion of the leaf. It generally appeared at the base of a leaf, gradually

---

1. New Jersey Agr'l Exp. Station Report for 1893, p. 434. Also, Proc. Am. Asso. Adv. of Science, 1893.

2 *l. c.*

spreading toward the tip, and frequently, young lateral shoots would be completely killed by it. Under the microscope it proved to be quite different from the *Exobasidium*. Prof. Peck, to whom it was referred, pronounced it a new species of *Ramularia* and named it *Ramularia cylindriopsis*.

VII. *INOCULATION EXPERIMENTS WITH GYMNOSPORANGIUM MACROPUS, LK.

The family of true rusts, *Uredineæ*, is very interesting to the mycologist and important to the agriculturist. It contains about twenty-seven genera and a multitude of species all of which are strict parasites living within the tissues of their hosts. Several of the species produce destructive diseases in cultivated plants; as examples, note the rust of wheat, oats and other grasses (*Puccinia graminis*, Pers.), blackberry rust (*Caeoma luminatum*, Schw.), and carnation rust (*Uromyces caryophyllinus*, (Schrank) Schœter). Thus far, all attempts to cultivate the rusts upon artificial media have failed. Consequently, the life histories of some species are imperfectly known. The determination of the life histories of some species is made yet more difficult because of the fact that they do not complete their development upon a single species of host-plant, but inhabit different species at different stages in their development. The life history of the common wheat rust, *Puccinia gramiis*, so frequently used to illustrate this peculiarity of rusts, is so familiar to readers of botanical literature that it is unnecessary to repeat it here. It is sufficient to state that wheat rust has three stages, two of which are found upon the wheat or some other grass plant and the third upon the common barberry (*Berberis*).

The species of *Gymnosporangium* belong to this class of pleomorphic rusts. There are two forms, representing two stages in the development of the fungus. Until about ten years ago these two forms were supposed to be distinct species and were given separate names. The *Gymnosporangium* form (considered to be the higher form) inhabits, exclusively, species of the *Cupressineae*, a group of the family of cone-bearing trees, *Coniferae*. The other form has received the name *Roestelia*. It is found on the apple and allied plants belonging to the tribe *Pomeae* of the family *Rosaceae*.

*By F. C. Stewart and G. W. Carver. Read before the Iowa Academy of Sciences, Des Moines, Iowa, January 2, 1896.

In the United States there are nine species of *Gymnosporangium.* Chiefly through the investigations of Drs. Farlow and Thaxter all of them have been connected with their corresponding species of *Roestelia.*

Gymnosporangium macropus, Lk., the particular species under consideration, is confined exclusively to the red cedar, *Juniperus Virginiana*, L. Its *Roestelia* form is known as *Roestelia pirata*, Thax., and is found on cultivated apple (*Pirus malus*, L.), wild crab (*Pirus coronaria*, L.) and Juneberry (*Amelanchier*). The *Gymnosporangium* may be found in the autumn upon the twigs of red cedar where it appears in the form of small brown balls about the size of peas. In May of the following spring these balls enlarge and during rainy weather put out several orange-colored, gelatinous horns. At this time the balls are very conspicuous objects and are universally known as "cedar apples." The gelatinous horns contain numerous two-celled spores on long pedicels. The spores germinate *in situ*, each one producing several minute secondary spores which are readily carried by the wind. When these secondary spores chance to fall upon the leaves of apple or other suitable plant, they germinate and enter the tissues. In about three weeks, small yellow spots appear on the upper surface of the apple leaf. This is the *Roestelia*, and when it is mature the spots will be one-fourth to one-half inch in diameter, yellow above and with tooth-like projections beneath. Within the projections are formed round one-celled spores (aecidiospores) which may be carried to a cedar where they will germinate and repeat the life cycle.

The connection of *Gymnosporangium macropus* with *Roestelia pirata* has been established beyond question by Dr. Thaxter.[1] The inoculation experiments here reported were not undertaken for the purpose of obtaining further information concerning the relationship existing between the two forms of the fungus, but rather to ascertain why the cultivated apple in central Iowa should be free from *Roestelia.* Although the field has been thoroughly canvassed nearly every season during the past twenty-five years, no species of *Roestelia* has ever been taken on any variety of cultivated apple in the vicinity of Ames, Iowa.[1a] More than this, repeated efforts to

---

1 On certain cultures of *Gymnosporangium* with notes on their *Roesteliae*, Am. Acad. Arts and Sciences, 1886, p. 259.

1*a* Prof. Pammel writes that he has never known or heard of *Roestelia* on any cultivatep variety of apple in Iowa.

artificially inoculate various varieties of cultivated apples with *Gymnosporangium macropus* have failed. In the spring of 1886, Dr. Halsted [2] inoculated *G. macropus* on two varieties of cultivated apple (Rawles Janet and Talman Sweet), wild crab (*Pirus coronaria* [3]), pear, mountain ash, *Pirus semipinnata*, several species of hawthorn and two forms of Juneberry on the grounds of the Iowa Agricultural College, Ames, Iowa. In no case did *Roestelia* appear on the cultivated apples. He says:[4] "The individual experiments numbered among the hundreds, and in every case there was a perfect failure of the *Gymnosporangium* spores to grow except with the crab apple, where the inoculation was most emphatic." Further inoculations were made the following season, 1887. He says: [5] "During the present season cultural experiments with the native cedar have been carried out by special students. It is an easy matter to inoculate the wild crab with this, but only failures have attended tests upon other plants."

In 1893 Prof. L. H. Pammel [6] made some inoculation experiments at Ames. A tree of the variety Tetofsky had been top-worked with Fluke crab, which is an improved variety of *Pirus coronaria*. *G. macropus* was inoculated upon both parts of the tree, on the same day, with the same cedar apple. In due course of time, *Roestelia* appeared in abundance upon the Fluke crab portion of the tree, but not a single leaf of the Tetofsky portion was affected. Inoculations were also made upon pear, Japan quince (*Cydonia Japonica*), cultivated apple and shadbush (*Amelanchier almifolia*), but these all proved failures.

The above is, in brief, the history of the experiments at Ames previous to 1894. It appears to be well established that at Ames, Iowa, the cultivated apple is wholly exempt from the *Roestelia* disease, which is very abundant and destructive in New England and in some of the Southern States. The red cedar does not grow spontaneously in Central Iowa, but it is frequently planted. There are several specimens in different parts of the Agricultural College grounds, some of them standing in close proximity to apple trees.

2 Bulletin of the Iowa Agricultural College, from the Botanical Department. November, 1886, pp. 59-64.

3 Bailey considers the wild *Pirus* of Iowa to be specifically distinct from *P. coronaria*. He has named it *Pirus Ioensis*. See L. H. Bailey: Notes from a Garden Herbarium VI; The Soulard Crab and its Rise. The American Garden, Vol. XII, p. 469.

4 *l. c.* p. 63.

5 Bulletin from the Botanical Dept. of the Iowa Agricultural College, February, 1888, p. 91.

6 Diseases of Foliage and Fruit. Report of Iowa State Hort. Soc., Vol. XXVIII, 1893, p. 470.

Gymnosporangium macropus is fairly abundant, the amount varying according to the nature of the season as regards moisture. It is usually sufficiently abundant to thoroughly inoculate the wild crab trees. There is only one species of *Gymnosporangium*, and only one species of *Roestelia* at Ames. A second species of *Gymnosporangium*, *G. globosum*, Farl., has been found but once by Prof. Pammel.[7] This species occurs in Wisconsin, as indicated by Prof. Trelease,[8] and may be more common in Eastern Iowa. It has not, however, been found since, and Prof. Pammel writes us that it may have been a chance introduction from material sent to Dr. Halsted. So far as we know, only one species of *Roestelia* has been found at Ames. This fact tends to simplify matters considerably. Were it not for the fact that *Pirus coronaria* is so generally affected with *Roestelia* and so easily inoculated artificially, we would at once conclude that the immunity of the cultivated apple is due to the climatic conditions in Iowa being unfavorable to the growth of *Roestelia*. It is well known that the range of some fungi is limited by slight differences in climate; for example, the potato-blight fungus, *Phytophthora infestans*, De By., which causes great losses in some parts of the United States, has, I believe, never been collected in the state of Iowa. The climate there is too dry for it.

Another way to account for the facts is to suppose that certain varieties of apples are not susceptible to the disease, and that only non-susceptible varieties are grown at Ames. This theory comes nearest to accounting for all of the facts. There are two chief objections to it. First, the college orchard contains a large number of varieties, and it is a remarkable circumstance that they should all be *Roestelia*-resistant. However, it should be noted that most of them are Russian varieties. Second, as a case of varietal differences in susceptibility to fungus attacks it is unparalleled.

In the spring of 1894 we started some inoculation experiments at Ames. *Pirus coronaria*, eleven varieties of cultivated apples and the previously mentioned Tetofsky tree top-worked with Fluke crab, were inoculated with the native *G. macropus* and with *G. macropus* from Cambridge, Mass., communicated by Mr. B. M. Duggar. All were complete failures. The spring and summer were unusually dry. This probably accounts for the failures with

7 Journal of Mycology, Vol. VII., p. 102.

8 A Preliminary List of the Parasitic Fungi of Wisconsin, p. 29.

Fluke crab and wild crab. Natural cultures of *Roestelia* on wild crab were rare.

In the spring of 1895, one of us being on Long Island, N. Y., and the other at Ames, Iowa, we again undertook some experiments with *G. macropus.* We will speak first of the experiments on Long Island. They were conducted in the nursery of Isaac Hicks & Son, at Westbury, N. Y. On May 18, four varieties were inoculated with New York *G. macropus* — Yellow Transparent, Red Astrachan, Ben Davis and Red Pippin. The first three were two-year-old nursery trees; the last was a large tree. Many leaves on one tree of each variety were smeared, both sides, with the gelatinous spore-masses of *G. macropus.* The results were as follows: Yellow Transparent showed no sign whatever of *Roestelia.* Both Red Astrachan and Ben Davis showed yellow spots which appeared like the beginning of *Roestelia*, but none of them developed. Red Pippin produced the *Roestelia*, but the spores did not mature properly and the fungus presented a stunted appearance. On May 24, six varieties were inoculated with Iowa *G. macropus* — Yellow Transparent, Red Astrachan, Ben Davis, Red Pippin, Maiden's Blush and Wealthy. All were two-year-old nursery trees except the Red Pippin. One tree of each was inoculated as before. The results were as follows: Yellow Transparent and Red Pippin showed no signs of *Roestelia.* Red Astrachan and Ben Davis started *Roestelia* spots which never matured. Maiden's Blush and Wealthy developed numerous *Roestelia* spots and matured the aecidiospores thoroughly. As no bags were used to cover the inoculated leaves, it can not be said *positively* that the *Roestelia* on Maiden's Blush and Wealthy resulted from the Iowa *G. macropus*, but the conditions were such as to warrant the above conclusions. In the case of Red Pippin, there can be no doubt as to which inoculation produced the *Roestelia.* A large tree which stood at a considerable distance from the other inoculated trees, was inoculated on one side with New York *G. macropus* and on the other side with Iowa *G. macropus.* The leaves of the branch inoculated with New York *G. macropus*, and a few other leaves in the immediate neighborhood, produced *Roestelia*, while the remainder of the tree showed not a *Roestelia* spot. It is also practically certain that all of the *Roestelia* found in connection with these experiments was the *Roestelia* of *G. macropus.* Careful search was made in

Mr. Hicks' nursery and in orchards at Floral Park and Queens, Long Island, but no *Roestelia* on cultivated apple was found anywhere on Long Island during the season of 1895, except at Flushing, where a few specimens were taken by Mr. F. A. Sirrine.

The following table presents, in a condensed form, the results of the experiments on Long Island:

VARIETY.	Material used.*	Condition June 15.	Condition June 29.	Condition August 21.
Yellow Transparent.	Iowa *G. macropus*. N. Y. *G. macropus*.	No *Roestelia*. No *Roestelia*.	No *Roestelia*. No *Roestelia*.	No *Roestelia*. No *Roestelia*.
Red Astrachan.	Iowa *G. macropus*. N. Y. *G. macropus*.	Yellow spots on a few leaves. Yellow spots on a few leaves.	No further development. No further development.	No further development. No further development.
Ben Davis.	Iowa *G. macropus*. N. Y. *G. macropus*.	Not observed. Not observed.	Yellow spots on a few leaves. Yellow spots on a few leaves.	No further development. No further development.
Red Pippin.	Iowa *G. macropus*. N. Y. *G. macropus*.	No *Roestelia*. No *Roestelia*.	No *Roestelia*. *Roestelia* appearing.	No *Roestelia*. Partially developed.
Maiden's Blush.	Iowa *G. macropus*.	*Roestelia* appearing.	Continuing to develop.	Aecidia well developed.
Wealthy.	Iowa *G. macropus*.	*Roestelia* appearing.	Continuing to develop.	Aecidia well developed.

* All inoculations with N. Y. *G. macropus* were made May 18. All inoculations with Iowa *G. macropus* were made May 24.

The experiments at Ames, Iowa, were conducted at the Agricultural College. May 26, 1896, *G. macropus* from New York was inoculated on Yellow Transparent, Grimes' Golden, Duchess of Oldenburg, Whitney's No. 20 and *Pirus coronaria*. A large number of leaves on one tree of each variety were inoculated. In each case, some of the leaves were rubbed on both surfaces with the moistened cedar-apple horns, while others were inoculated by making punctures with a sterilized scalpel. On the same date, other trees of the same varieties were inoculated in the same manner with *G. macropus* collected in Iowa. All of the inoculations, except those on *Pirus coronaria*, failed. But the *Pirus coronaria* trees were so completely covered with *Roestelia* that scarcely a single perfect leaf could be found. What part of this was due to artificial inoculation, and what part to natural inoculation, it is impossible to say. It simply shows that the season was a favorable one for *Roestelia*.

The results of our experiments at Ames are entirely in accord with those obtained by Dr. Halsted and Prof. Pammel. Taken in connection with our experiments on Long Island, they show that some varieties (notably Yellow Transparent) are wholly exempt from *Roestelia pirata* and that there is good reason for believing that the absence of *Roestelia* from cultivated apples in Iowa is not due wholly to unfavorable climatic conditions, but chiefly to the fact that the varieties grown there are not susceptible to the disease. The severe climate of this section has obliged orchardists to abandon all except the most hardy varieties. These are mostly either Russian varieties or varieties which have originated in the North-West. However, the fact can not be overlooked, that Wealthy, a variety shown by our experiments to be very susceptible on Long Island, is frequently planted in Iowa, Wisconsin and Minnesota and is there exempt from *Roestelia*. We have by no means a complete solution of this curious problem.

In the Long Island experiments it is interesting to note, that while some varieties showed themselves wholly exempt and others were very susceptible, there were also varieties which presented intermediate degrees of susceptibility — Yellow Transparent showed no sign of *Roestelia*; Maiden's Blush and Wealthy contracted the disease readily and matured aecidiospores; on Ben Davis and Red Astrachan the *Roestelia* started to grow but never reached maturity; on Red Pippin only part of the aecidiospores matured.

There are few fungous diseases of cultivated plants which are equally destructive to all of the varieties of the species which they attack. Usually some varieties are much more severely attacked than are others. Some varieties may be but slightly affected while others are ruined. Observant fruit growers know that Flemish Beauty "scabs" worse than most other varieties of pears, while the fungus which produces the leaf-blight and cracking of the pear (*Entomosporium maculatum*), has a preference for the variety. White Doyenné. Wheat growers know that some varieties of wheat are more liable to rust than are others. These are but a few examples. Many more might be mentioned. In the case of *Roestelia pirata*, this preference for certain varieties is carried to extremes. We know of no other fungus which attacks some varieties of a species so severely and yet can not even be *inoculated* upon a large number of other varieties of the same species. Carnation rust, *Uromyces Caryophyllinus*, (Schrank) Schroeter, perhaps most nearly approaches it. This rust is exceedingly destructive to some varieties of carnations, while several other varieties are nearly exempt from its attacks. One variety (Wm. Scott) is notably immune. We know of but one well authenticated case in which the true rust (*Uromyces*) has been found upon this variety, although we have repeatedly observed it growing in green-houses where other varieties were badly rusted.

In the present state of knowledge concerning the conditions of parasitism it is impossible to completely explain the immunity of varieties. The structure and chemical composition of a variety are intimately associated with its susceptibility or non-susceptibility to the attacks of a particular fungus; but what is the relative importance of these or what part is played by the mysterious factor called "inherent vigor," we do not know.

In conclusion we will record our observations on the effect of moisture on the prevalence of *Gymnosporangium* and *Roestelia.*

In the spring of 1894 *G. macropus* was fairly abundant at Ames, but the spring and summer were very dry, and as a consequence of the drought, *Roestelia pirata* on *Pirus coronaria* was rare. As previously stated, even attempts at *inoculation* of *P. cononaria* failed that season. In the spring of 1895, showers were frequent during the month of May. This season *Roestelia* was so abundant on *P. coronaria* that it was difficult to find leaves which were *not* affected. Everywhere, the wild crab trees were conspicuous because of the *Roestelia* on their leaves.

On Long Island, the summer of 1894 was very dry. The red cedar grows spontaneously here and is very common. May 15, 1895, we searched very carefully through a large grove of red cedars standing near an orchard and found only *three* cedar apples. At Westbury, N. Y., a red cedar standing in the midst of a nursery, bore only *two* cedar apples. At Queens, N. Y., three red cedar trees grew on one side of a road on the other side of which was an orchard. Not a single cedar apple could be found on the cedars.

VIII. "BELTED" APPLES AND PEARS.

During the past two seasons, apples and pears in New York State have been affected in a peculiar way. Fruits, otherwise perfect, were surrounded near the apex by a russet zone. In some cases this zone was very narrow, while in others it occupied as much as one-third of the entire surface of the fruit; generally, it extended clear to the calyx, but sometimes, (particularly on apples) a small area immediately surrounding the calyx retained — the normal color of the fruit.

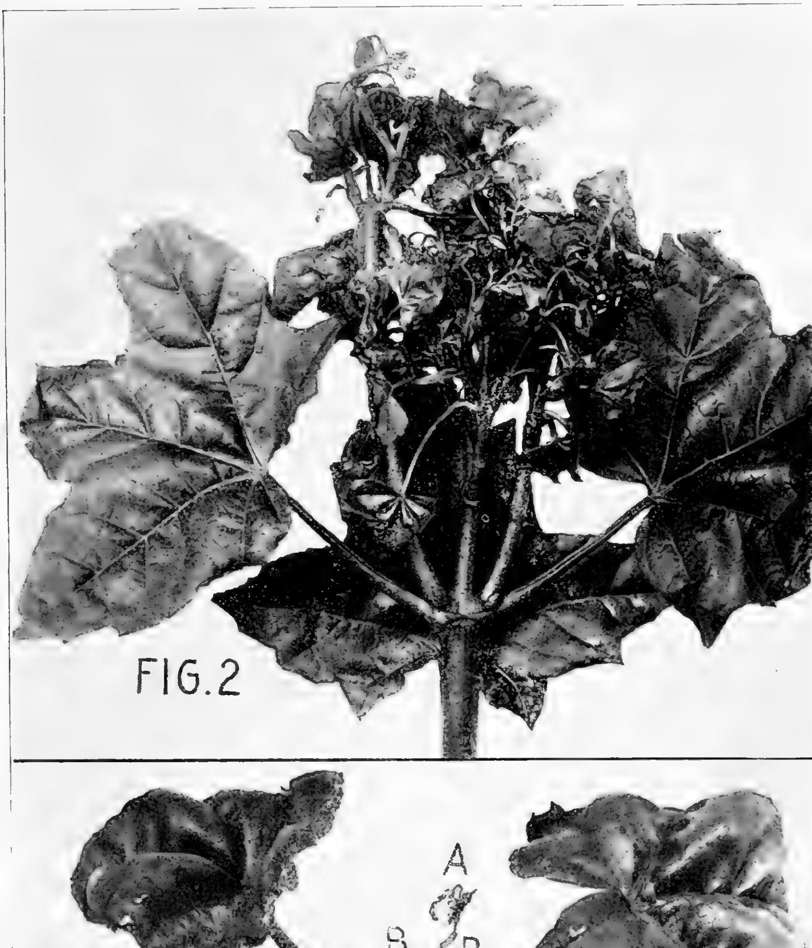
By some, the cause has been attributed to the use of Bordeaux mixture, but this theory is shown to be erroneous by the fact that the "belted" apples and pears are frequently found in unsprayed orchards. However, it appears probable that, in certain seasons, spraying with Bordeaux mixture tends to aggravate the trouble. Any slight irritation of the skin of apples and pears may result in the formation of russet cork cells. Spraying mixtures sometimes furnish the necessary irritation. Beach, [1] Green, [2] Jones, [3] Lodeman [4] and others have observed that russetted fruit may result from spraying; but in such cases the russet blotches are scattered irregularly over the surface instead of being arranged in the form of a well defined belt, as in the present case. I fully agree with G.

1 New York Exp. Sta. Bull. No. 84, pp. 24-33.

2 Ohio Exp. Sta. Bull. No. 48, p. 12; Proc. Western Hort. Soc., 1894, p. 65.

3 Garden and Forest, Vol. VII, 1894, p. 497.

4 Garden and Forest, Vol. VII, 1894, p. 456; Cornell Exp. Sta. Bull. No. 86, pp. 53 and 62. Mr. Lodeman uses the word "rust" to designate this rough, yellow-brown appearance, I consider the term objectionable in this connection as it is liable to lead to confusion. "Rust" has long been the common and appropriate name of a fungus disease of pomaceous fruits caused by *Roestelia* spp.



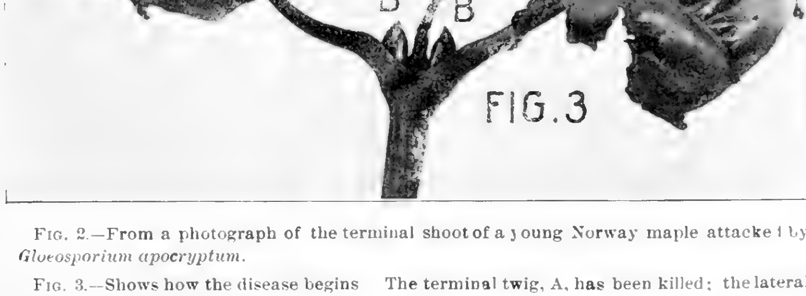


Fig. 2.—From a photograph of the terminal shoot of a young Norway maple attacked by *Gloeosporium apocryptum*.

Fig. 3.—Shows how the disease begins. The terminal twig, A, has been killed; the lateral buds, BB, will develop at once.

FIG. 4. "Belted" apples

Harold Powell, who says [5]: "This belt is due to any injury to the epidermis of the fruit in its young stage, and is caused by the freezing of the dew collected on these spaces." No other explanation so completely harmonizes with all of the facts. The belting of apples and pears on Long Island this season was probably caused by the frost which occurred on the night of May 16.

IX. A NEW LEAF-SPOT DISEASE OF APPLES.

When I first came to Long Island the Station Horticulturist, Prof. Beach, requested me to watch for a leaf-spot disease of apples which he had observed at Westbury, Long Island, in the summer of 1894. Early in May, 1895, I found it in abundance in Mr. Hicks' orchard at Westbury and later at various other places on Long Island. In Mr. Hicks' orchard it was so abundant that by July 1 some trees were almost completely defoliated. This indicates that it may become troublesome.

The disease appears in the form of circular brown dead spots about one-eighth inch in diameter. In the summer of 1894, Prof. Beach failed to find on the spots anything which would give him a clue to the identity of the fungus, but in 1895 I found it in fruit as early as June 29. The month of July, being rainy, was favorable to its development and it fruited abundantly. On each spot there appear several black specks which, upon examination under the compound microscope, prove to be spherical sacs (perithecia) filled with colorless, one-celled elliptical spores. These are the characters of the genus *Phyllosticta*. Saccardo has described *Phyllosticta pirina* which occurs on pear and apple foliage. This species, although occurring frequently, has seldom been reported as doing damage. Alwood [1] has reported a *Phyllosticta*, which he doubtfully refers to *P. pirina*, Sacc., as doing serious damage to apples in Virginia, in the season of 1891. As our *Phyllosticta* did not agree with the characters of *P. pirina*, I sent specimens of it to Prof. C. H. Peck, who replied that it is a new species and that he has given it the name *Phyllosticta limitata*. The spores are longer and larger than those of *P. pirina*.

---

5 Garden and Forest, Vol. VIII, 1895, p. 417.

1 Virginia Exp. Sta. Bull. No. 17, June, 1892, p. 62.

Prof. Peck has kindly given me permission to publish his technical description of the fungus. It is as follows:

Phyllosticta limitata, n. sp. Spots small, obricular, commonly one to three lines broad, sometimes confluent, brown or reddish-brown, occasionally becoming gray or having a grayish center, often sterile, definitely limited and surrounded by a narrow, slightly elevated brown or blackish-brown margin, perithecia epiphyllous, few, minute, punctiform, black; spores elliptical, .0003 in. long, .00016 broad.

Living leaves of apple tree, *Pyrus malus*. Westbury, Long Island. June. *F. C. Stewart.*

The three applications of Bordeaux mixture recommended [2] for apple scab will probably keep the leaf-spot in check.

2. N. Y. Exp. Sta. No. 86, February, 1895, p. 70.

REPORT

OF

ENTOMOLOGISTS.

VICTOR H. LOWE, B. S., and F. A. SIRRINE, M. S.

REPORT OF ENTOMOLOGISTS.

PART I.

By Victor H. Lowe, B. S.

The following is a list of the subjects discussed in this report:

I. The Oak Scale at Geneva, N. Y.

II. The White-marked Tussock Moth in Western New York.

III. The Cotton-wood Leaf Beetle at Liverpool, N. Y.

IV. The Corn Worm.

V. The Striped Cucumber Beetle.

VI. The New York Plum Lecanium.

VII. A Preliminary Report of Experiments with Remedies for the Potato Flea Beetle.

In addition to the work indicated by the above outline, considerable time has been given to answering correspondents. A station collection of insects of economic importance is under preparation and has taken a portion of the Entomologist's time during the summer.

During the past year the Entomologist has been called upon to address farmers' meetings at Southampton, Mattituck, Southold, Riverhead, Huntington, Mineola, Jamaica, Farmingdale, Unionville, Washingtonville, Brewsters, Mt. Kisco, and Northville.

I. The Oak Scale at Geneva, N. Y.

This insect has been very abundant on oak trees at Geneva during the past season. The writer's attention was first called to it by Mr. C. K. Scoon who had observed the scales in great numbers on a row of white oak trees on one of the streets of the village. The trees were examined May 28. The first two trees on the north end of the row were nearly leafless and apparently dying. They were badly infested with the scale from the highest branches to near the base of the trunks. The next two trees were apparently succumbing to the scale. Most of the lower limbs had not produced leaves and some of the smaller branches were dead. All of the remaining trees in the row, three or four in number, were infested with the scale but to a less extent, the last one the least of all. The lower limbs in each case gave evidence of having been infested first. The young scales were not observed moving about at this time.

The accompanying illustration, Fig. 1, which shows the scales natural size, is from a photograph of twigs taken July 3 from an oak tree at Geneva, which was infested on nearly all the branches and part of the trunk as badly as the twigs in the illustration. The tree was destitute of leaves.

A few infested twigs were sent to Mr. L. O. Howard, Entomologist of the United States Department of Agriculture, who replied that the scale is a common European species, *Asterodiaspis quercicola*. In the same letter Mr. Howard says: "This insect is now to be found in a number of localities in the Eastern States, and when it occurs abundantly on the trees is a serious enemy."

When requested at another time for a remedy for this insect, Mr. Marlatt, First Assistant Entomologist, replied in Mr. Howard's absence that the scale may be reached by spraying the trees with kerosene emulsion at the ordinary summer strength, one part of the emulsion to 7 to 9 parts of water, if applied in the spring or

FIG. 1.—Young willows showing injury from the beetles.

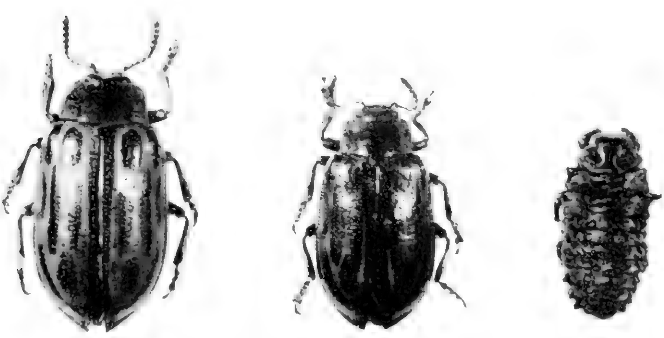


PLATE I.

FIG. 2.—Cotton-wood Leaf-beetles (Willow-beetles) and larva; enlarged about four times.

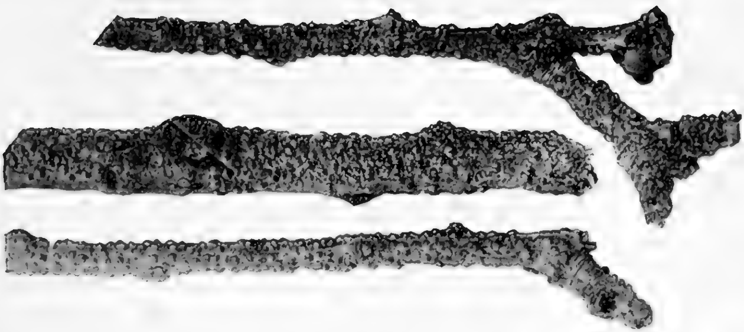


FIG. 1.— The Oak Scale, *Asterodiaspis quercicola*, Bouché, natural size.

FIG. 2.— Caterpillar of the white-marked Tussock-moth. (From a drawing by W. P. Wheeler.)

early summer, while the young scales are hatching. In order to make the work thorough, more than one application will be needed in most cases, as Mr. Marlatt says that the period during which the scales may continue to hatch extends over a considerable time.

In Insect Life, Vol. VII, p. 120, Mr. Marlatt states that he succeeded in killing newly hatched scales of this species with kerosene emulsion reduced to one part of the emulsion to thirteen parts of water.

II. The White-marked Turrock Moth, Orgyia Leuco-stigma, in Western New York.

Numerous complaints concerning the depredations of this insect in apple-orchards have recently come from fruit-growers in the western part of the State, especially from Yates and Ontario counties. One fruit-grower in this vicinity reports that 25 per cent. of his apple crop has been ruined this year by this insect. The injury is done by the caterpillars alone, which feed not only upon the foliage but upon the young apples as well. They gnaw into the sides of the apples, thus causing them to become withered and deformed.

This destructive caterpillar is very striking in appearance. It is quite slender and covered with hairs of various lengths and colors. The prevailing color is bright yellow. The head and two tubercle-like projections on the back are coral-red. The four tufts of hair on the back are white. The two long plumes in front and the one at the posterior extremity are black. A broad black stripe runs the full length of the back, and on each side is a broader dark brown or black one. Along the sides, arranged in two rows, are numerous yellow tubercles, from which radiate pale yellow hairs.

The adult insect is a moth. The female is wingless, light gray in color, and if examined soon after she emerges from her cocoon, will be found greatly distended with eggs. The males are provided with four dark brown wings, marked with a few dark wavy lines and a white spot on the inner angle of each anterior wing. Not being able to fly, the female clings to the outside of her cocoon, upon which she deposits her eggs, fastening them in place by a gelatinous frothy mass, which soon becomes hard and brittle. Usually one or two dead leaves will be found sticking to the mass. According to Mr. Saunders, a single female will deposit from 300 to 500 eggs in one of these masses.

It is in this state that the insect passes the winter, the eggs lying dormant until about the middle of May or first of June, when the young caterpillars are hatched. They quickly spread to various parts of the tree, feeding voraciously on the under sides of the leaves, and, as above noted, frequently upon the young apples as well. This brood completes its transformation about the first of August, and the second brood before the cold winter weather sets in.

When the caterpillars are established in an orchard, jarring the trees is recommended. Mr. C. K. Scoon, of Geneva, N. Y., who found them abundant in his plum-orchard last year, kept them in check by frequently jarring the trees by a succession of light taps. The caterpillars at first hang suspended by a silk thread, but the repeated jars cause them to fall to the ground; or, better yet, a curculio cart may be placed in position in which they could be easily captured and killed. In case the curculio carts are not to be had, any large sheet spread on the ground under the tree will answer the purpose.

During the winter, a very careful search should be made for the egg masses, which, as above noted, will be found attached to the empty cocoons which were formerly inhabited by the females. The eggs may be destroyed by crushing.

Spraying with arsenites is also recommended, although the grower referred to as losing a considerable portion of his apple crop says that he sprayed his orchard three times with Paris green, but apparently to no effect. This failure may have been due to a lack of lime in the mixture, as an excess of lime has a tendency to make the poison remain on the leaves. The spraying should be done very thoroughly, care being taken to drench the under surface of every leaf. The caterpillars are said to be more susceptible to the poison when young.

According to Dr. Lintner, this insect is widely distributed in the United States, being found both north and south as far west as the Rocky Mountains. It has a large variety of food-plants, but, according to Mr. Saunders, prefers the apple. It is known to frequently occur on the plumb, and has been found upon the pear. Professor Beach, of the New York Agricultural Experiment Station, tells me that he has found it upon the apricot. In some sections of the State it is very destructive to shade-trees, particularly the elm and maple.

Fig. 2 represents a caterpillar feeding upon the under surface of an apple-leaf. An injured fruit is represented on the left. The drawing for the illustration was made by Mr. Wm. P. Wheeler of the New York Agricultural Experiment Station [Garden and Forest, August 7, 1895].

III. The Cottonwood Leaf Beetle at Liverpool, N. Y.

During the latter part of May, 1894, Mr. Joseph P. Kennedy, a leading willow grower of Liverpool, N. Y., sent us a number of these beetles, stating in his accompaning letter that serious injury had been done to the willow industry in that vicinity the previous season, and as the beetles were again very numerous he feared even more serious destruction the coming summer.

July 5, the writer visited Liverpool, and in company with Mr. Kennedy went through some of the infested fields. Although the beetles were not as numerous as they had been a few weeks previous, their injurious work was apparent on every hand.

Appearance of the beetles.— The beetles vary in size from three to five-eighths of an inch in length and are a little more than half as broad as long. Although the markings vary, the head is usually black, the thorax has a broad margin on either side of brick red, partially interrupted about midway by an obscure black spot. The elytra (wing covers) are marked with black and gold, the black being in the form of three interrupted lines extending longitudinally along each elytron. The legs vary in markings, although in the average specimens examined they were brick red and black. Some of the beetles are very dark in color, the lighter markings being almost obscure. Plate 1, fig. 2, represents two of these beetles greatly enlarged.

Injuries to young willows.—The willow growing industry is a very important one in the vicinity of Liverpool. About three thousand tons are produced there annually and last year the prices ranged from $16 to $40 per ton. The willows are cut the third year and made into baskets.

Although the beetles were very numerous last year on old willow trees throughout the section around Syracuse, there was probably no more damage done by them than to the young willows on the willow farms about Liverpool. One willow grower in that vicinity who states that his farm usually yields $2,000 worth of willows annually, yielded this year less than $200 worth. This failure he says may be due in part to the dry weather of the previous season, but very largely to the work of the beetles. The writer saw this field and found it no worse infested than other fields in the vicinity. A few growers had given up the business and were plowing out their willows on account of the persistent attacks of the beetles.

How the damage is done and habits of the insects.—Mr. Kennedy tells me that the beetles are first noticed at Liverpool from the twentieth of May to the first of June. The willows are then beginning to get a good start for the summer's growth. The beetles feed to a certain extent upon the leaves, but they seem to prefer the young and tender growth at the tips of the willows. These are sometimes eaten clear off and at others only part way. The tender leaves are also eaten.

Plate 1, Fig. 1, is from a photograph of a bunch of three year old willows which have been injured by the beetles.

This injury to the new growth not only delays the plant but causes the young willow to branch. For the purposes for which these willows are grown, this is just what is not wanted. The willows should be smooth and straight, otherwise they may be of little or no value. Hence, at the very beginning of the season, thousands of the willows may be made practically useless in a very short time, for the beetles work rapidly.

The eggs for the first brood are laid at this time. They are placed on the under sides of the leaves in clusters of twenty-five or thirty and resemble in general appearance the common potato beetles' eggs, excepting that they are yellow in color. The time of incubation varies with the season, although the eggs are usually hatched in two weeks. The young larvæ are nearly black in color. They feed close together at first on the under sides of the leaves devouring the cuticle and soft parts leaving only the upper cuticle and framework. As they grow larger they separate eating ragged holes or consuming the entire leaf with the exception of the larger ribs. If irritated the larvæ emit a milky substance of strong unpleasant odor from little tubercles along each side of the body. They are usually mature in two weeks.

Plate 1, Fig. 2, on the extreme right represents one of these larvæ greatly enlarged.

Pupation takes place above ground, the larvæ merely attaching themselves head down to a convenient leaf or twig. The transformation soon takes place, the pupæ being retained in the old larval skins. Fig 3 is from a photograph, natural size, of a number of the empty pupa cases as they remain attached to the twig or leaf. This stage lasts about ten days.

During the time that this first brood is maturing, the willows are said to grow, under favorable circumstances, about one inch per day. As soon as the beetles come forth, however, they begin to feed on the new growth, thus causing the injury above mentioned.

There are said to be three annual broods of these beetles in this State. They may be found on the willows at Liverpool continuously until about the first of August and frequently somewhat later.

Some of the mature beetles hibernate, thus continuing the brood over winter. During this time they may usually be found under any convienent debris.

This insect is widely distributed in the United States. In the American Entomologist, Vol. III, p. 159, Dr. Riley states that the beetle is found in abundance "infesting the leaves of the cottonwood and other species of Populus and of willows throughout the west to Colorado and south to Louisiana." This beetle is scientifically known as *Lina scripta*, Fab.

REMEDIES.

London purple and Paris green are the remedies most commonly recommended for this insect. Either one may be used. London purple is somewhat cheaper and remains in suspension in water longer than Paris green. In either case lime should be added to prevent burning the foliage by the free arsenic which is dissolved by the water. The lime should be added in the form of milk of lime. One pound of poison to 150 gallons of water is considered strong enough for insects of this kind.

Mr. Kennedy tells me that although he and some of his neighbors sprayed thoroughly and persistently with Paris green they were unable to keep the insects in check. This was undoubtedly largely due to the fact that the mixture does not stick readily to the smooth surface of the willow leaf. This defect may be in part overcome by adding glucose or molasses to the mixture using about one quart to 150 gallons of water.

Arsenate of lead is another insecticide which may prove effectual against this insect. It has been extensively experimented with by

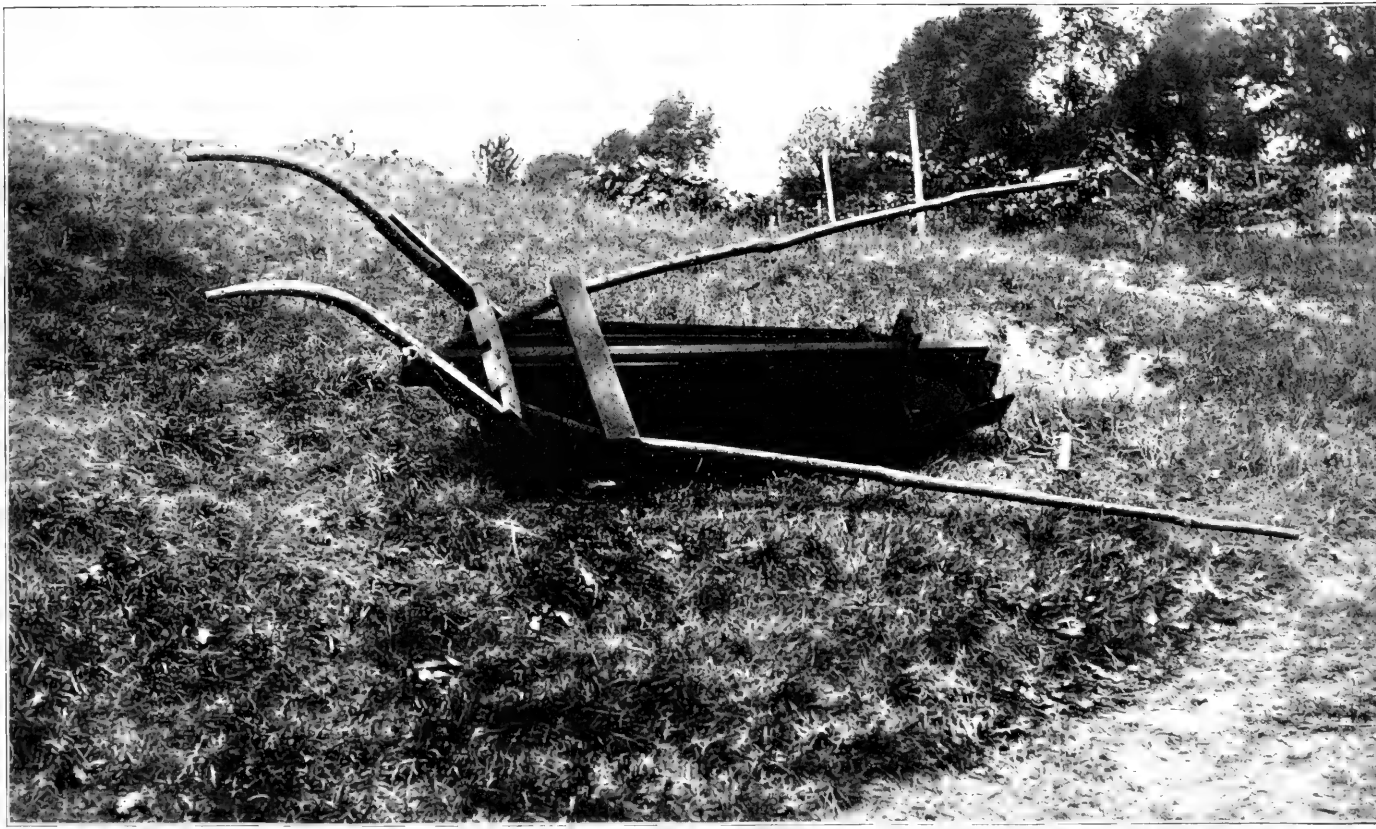


Plate II. Showing machine for catching the beetles.

Plate III.—Showing machine in position ready for use.

the Gipsy Moth Commission. It has also been recommended as a remedy for insects of similar habits to the cottonwood leaf beetle.

In Bulletin 103 of the New Jersey Agricultural Experiment Station, in connection with a discussion of the elm-leaf beetle, Prof. J. B. Smith says of this material: "It is formed by adding four ounces arsenate of soda and eleven ounces acetate lead to one hundred gallons of water. The chemicals dissolve readily and unite to form a white precipitate which is arsenate of lead, and which remains in suspension a long time, settling very slowly, and thus requiring less stirring than either Paris green or London purple. Two quarts of glucose or molasses to one hundred gallons of the mixture will add so greatly to its sticking qualities that even a heavy shower will not wash it off completely." If a less amount is desired, it may be formed in water by combining three parts of arsenate of soda with seven parts of acetate of lead, the chemical action which results producing arsenate of lead. The poison may then be mixed with water in the proportion required. This insecticide, when mixed with water in the proper proportions, is applied in the form of a spray in the same manner as Paris green.

In using any of the above insecticides for the cottonwood leaf beetle, the first application should be made when the beetles first appear in the spring. This should be followed by one or two other applications as the occasion demands.

Catching and killing the beetles and larvæ has proved a successful method of combating this insect at Liverpool, N. Y. The insects are caught by means of a machine, as shown in Plate II. The original, of which the photographs for these plates were taken, was made by Mr. Joseph Kennedy of Liverpool. The dimensions of the body are as follows: Length, 5 feet; width at the rear end, 2 feet; front end, 20 inches; depth, 6 inches. The body thus forms a shallow tank, which may be lined with tin or zinc, and in which kerosene oil should be kept while the machine is in use. A number of narrow strips are placed longitudinally over the top in the manner shown in Plate II, to keep the willows from touching the oil. Stout runners fastened to the underside support the machine.

Plate III shows the machine in position ready for use. As it will be observed it is made to run between the rows. The long arms which extend obliquely from either side, cause the willows to bend over and at the same time rub off the beetles and larvæ which drop into the tank.

A lighter machine is made after the same general plan for hand use. The chief difference in construction between this and the horse-power machine is the wheel which is placed in front, after the principle of a wheel-barrow.

These machines are put in use about the first of June and kept running while the beetles remain numerous. One grower told me that he killed about ten bushels of the beetles on 20 acres of willows with one of the hand power machines during the early part of the season, and another that he killed three bushels of beetles in one day from 18 acres of willows, the same kind of a machine being used. Judging from numerous heaps of dead beetles along the borders of the fields, these statements were not exaggerated.

The Beetles on Carolina Poplars at Syracuse.—June 20 Messrs. Smiths, Powell Co., wrote us that the "Willow beetles" and grubs were attacking a block of Carolina poplars and threatened to ruin them. Upon a previous occasion they had used Paris green, London purple, kerosene emulsion and lime in an effort to exterminate the insects, but all to no avail. The only insecticide which they found at all effective was hellebore.

The writer visited the above nursery July 5 and found that most of the grubs had pupated, although both larvæ and beetles were to be found in comparatively small numbers. A block of Norway poplars near by was also found infested.

In the block of Norway poplars, the insects were much more numerous on the tender leaves of a few suckers, which had been allowed to grow up between the rows, than upon the leaves of the young trees themselves.

The insects were promptly checked in their work by hand picking and also by crushing the pupae and grubs.

IV. The Corn Worm.

(*Heliothis armigera Hubn.*)

INTRODUCTION.

The corn-worm is a well known pest in both north and south. In the south it annually does much damage to growing cotton, boring into the bolls and causing them to decay. In the north its chief food plant is corn. In both north and south truck farmers especially suffer from the ravages of this insect, as it feeds readily upon a variety of fruits and vegetables, such as tomatoes, potatoes, beans, peas, cucumbers, pumpkins, melons, etc., and is especially fond of the tenderest varieties of sweet corn.

In the southeastern portion of this state the corn-worm appears to be increasing to an alarming extent and for this reason it is made the subject of this article. The great variety of its food plants, together with its peculiar habits, make the insect a difficult one to handle. Indeed the only remedy that has yet proven practical in the north is fall plowing. The reasons why this is so are herewith plainly stated, the habits and life history of the insect are given and some of the more important plants on which it is known to feed are named. Some of the remedial measures that have been suggested, but that are still of doubtful value, are also briefly reviewed.

Distribution.—The corn worm is known in a considerable portion of the United States and in many parts of the world. As would be expected from its wide geographical distribution, this insect has a large variety of food plants. In the United States its chief food plants are two of the great staples of the country, namely cotton and corn. In the south it is known as the Cotton Boll-worm.

Destructiveness.—The abundance of this insect varies with the season and locality. Dry seasons are considered more favorable to its growth and development. Some opinion of the serious nature of its attacks upon corn may be formed from the following which is quoted from Dr. C. V. Riley's Third Missouri Report, page 107: "In 1860—the year of the great Kansas drouth—the corn crop in that state was almost entirely ruined by the corn worm. According to the Prairie Farmer of January 31, 1861, one county there which raised 436,000 bushels of corn in 1859 only produced 5,000 bushels of poor wormy stuff in 1860, and this, we are told, was a fair sample of most of the counties of Kansas."

While the injury to the corn crop in New York State has probably not been as serious as this, with the possible exception of a few localities, yet the damage is annually sufficient to demand the attention of growers who wish to make an effort to bring the pest under control. Last fall the writer examined several fields of late sweet corn on Long Island and, in one case, a small field where most of the ears were examined, found nearly every ear infested, while other fields showed at least fifty per cent to be wormy. At one of the New York markets last fall, it was found that a large proportion of late sweet corn brought in on market wagons showed the effects of the work of this pest.

LIFE HISTORY AND HABITS AS A CORN AND TOMATO PEST.

Figure 4 represents the insect in all of its stages, *a* and *b* representing a much magnified egg, the former being a side view and the latter a top view. The eggs are ribbed and of a pale straw color. According to Dr. Riley, Third Missouri Report, page 106, each female moth is capable of depositing upwards of five hundred eggs.

On Long Island and vicinity, the winter is passed in the pupa state from four to six inches under ground. In these localities the moths issue in the spring before corn is up, hence, the eggs for the first brood are deposited on some other food plants, preferably peas, beans, and tomatoes. These vegetables frequently suffer severely from their attacks. In the former cases the leaves and pods are eaten, while in the latter the young fruits are attacked, and occasionally the stems, the larvæ feeding upon the solid parts until decay begins, then leaving for a fresh fruit. Figure 5 represents a full grown cornworm feeding upon a tomato. When feeding on pumpkins, squashes, or cucumbers, they occasionally burrow into the stems, but usually into the fruit.

The eggs hatch in a few days. The young larvæ vary greatly in color, from pale green to dark brown, and are striped longitudinally

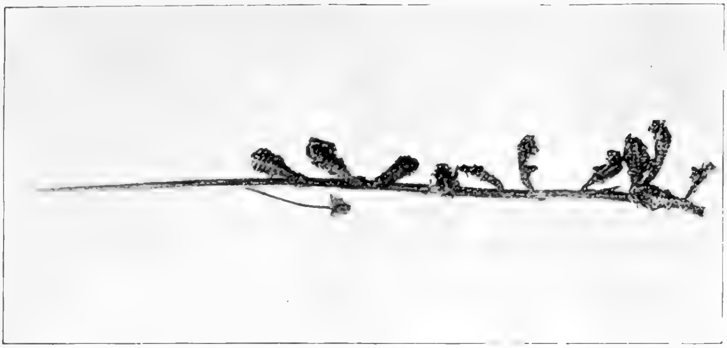


FIG. 3 —Empty pupa cases of Cotton-wood Leaf beetle, natural size.

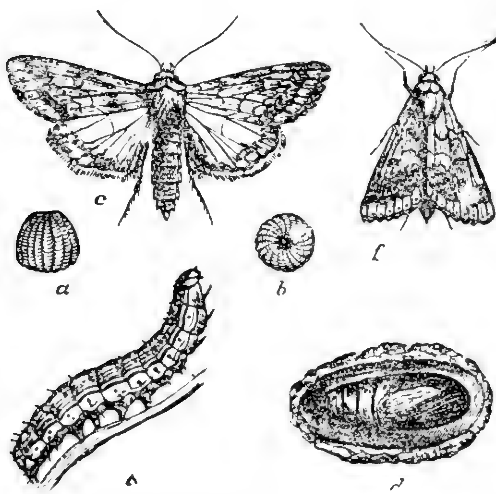


FIG. 4.—Heliothis armiger *a*. Egg, from side. *b* Same from top, both enlarged. *c* Larvæ—corn-worm. *d*. Pupa. *e*. Moth with wings expanded *f*. Same, wings folded. (After Riley.)

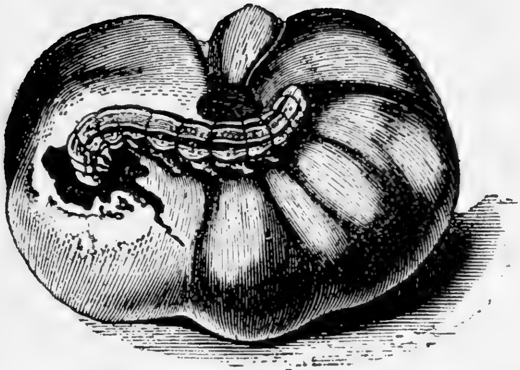


Fig. 5.—Corn-worm attacking tomato. (After Riley.)

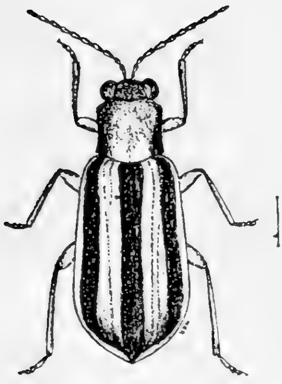


Fig. 6.—Striped Cucumber-beetle. (Original.)

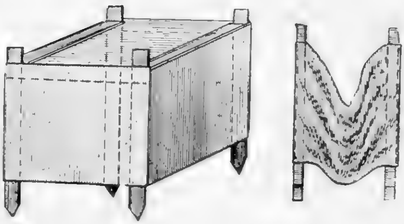


Fig. 8.—Sherman's plant protector.

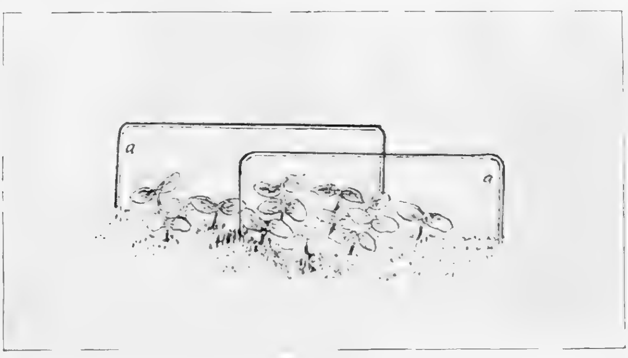


Fig. 7.—Showing supports for plant protector. (From a figure in the American Agriculturist.)

with darker stripes of the same color. This variation in color may easily lead to much confusion, in the mind of the novice, concerning the identity of the specimens. However, although there is considerable variation in color there are some markings which, it is said, can always be depended upon, namely, eight round shining black spots on each segment of the body, from which arise short brown hairs, and the longitudinal stripes above referred to. A full grown larva is about one and a half inches long.

The larvæ of this first brood do not go very deep into the ground to pupate, but spin loose silken cocoons very near or even upon the surface, sometimes being protected only by a loose chunk of dirt or a bit of rubbish. The pupa or resting state, at this time, lasts between one and two weeks.

On Long Island, the moths of the first brood appear about the time that early sweet corn is in roasting ears, depositing their eggs usually on the silk upon which the young larvæ feed for a short time, when they burrow down to the milky kernels. These they eat partially or entirely off in patches. The damage done, however, is not confined to the kernels actually eaten, but the fermentation and decay resulting from the exudation of sap, together with the droppings of the confined worms make a convenient hot-bed for the germination and growth of mould, and a breeding place for numerous species of small insects which are attracted to such places. Thus a whole ear may be made unfit for use although but few kernels have been eaten. The number of worms in a single ear may vary from one to six or eight. We may add here, that although the worms seem to prefer the corn when in the milk, they are not infrequently found, in the fall, feeding on hard corn.

As above intimated, the fall brood of caterpillars when ready to pupate, descend to the ground and burrow to a depth of from four to six inches. Here each caterpillar makes for itself an oblong earthen cell, inside of which a cocoon is spun consisting of coarse silk interwoven with bits of dirt. In these snug retreats they finally change to the pupa or dormant state and, thus protected, are prepared to pass the winter, issuing in the spring as moths. Fig. 4, *d*, represents the cocoon, natural size, cut open lengthwise.

Description of the moth.— The moth is described by Dr. C. V. Riley in his Third Missouri Report, page 107, as follows: "In this last and perfect stage the insect is quite variable in depth of shading but the more common color of the front wings is pale clay-yellow with a faint greenish tint, and they are marked and variegated with pale olive and rufous, a dark spot near the middle of each wing being very conspicuous. The hind wings are paler than the front wings, and invariably have along the outer margin a dark brown band interrupted about the middle by a large pale spot." Fig. 4, *e* and *f*, represents the moths natural size.

Appearance of infested ears.— The silk is usually partially or may be entirely eaten off to the tops of the husks, and if the larvæ have been at work some time the husks may be wilted and of a lighter color. Sometimes the husks are considerably eaten near the top. If the larvæ has left the ear its place of escape is usually conspicuous, being a round hole through the husk about half way up from the base of the ear.

REMEDIES.

When feeding on corn, the corn-worm is distinctively an "ear-worm," feeding during nearly all of its larval period upon the kernels, protected from exposure by the husks. Evidently but few parasites or predacious insects succeed in getting into these snug retreats and hence the pests are preyed upon but very little during this period of their lives. For the same reason it is very difficult to effectually apply insecticides. The only time that insecticides would prove available would be just after the larvæ hatch and while they are yet feeding upon the silk. The uncertainty, however, in the time when the eggs will hatch, and the short period in which the larvæ remain exposed, combined with the difficulty of successfully applying an insecticide to a field of corn in the ear, make this method impracticable as a rule.

FALL PLOWING.

This is undoubtedly the most practical method of combating the corn worm in the north, that has yet been tested. It is generally recommended by station workers. Concerning this method Prof. Smith of New Jersey, says:* "The species should be treated in the cornfield by late fall plowing. The general practice is to allow cornfields to remain undisturbed throughout the winter, and this, of course, allows the insect to rest safely until spring. Fall plowing

*Report New Jersey Agricultural Experiment Station 1892, p. 445.

breaks up a very large proportion of the cells, and throws many of the pupæ to the surface where birds find them readily enough or where they perish during the winter. Where they are not thrown to the surface they are brought into direct contact with the soil, which, by freezing and thawing, will crush or otherwise destroy them. Very early spring plowing, when frost follows, is sometimes quite effective, but plowing after all frost, while it will kill a certain proportion by crushing, and will expose another quantity to their enemies, will leave uninjured a very large proportion of the pupae." He also adds: "The essential factor in the destruction of the pupæ is to break up the cells, which brings the surrounding earth into direct contact with them. Therefore the first freeze will probably complete the work of destruction by crushing the insect. So long as the cell remains entire, extremes of cold will not injure it."

It is well to keep in mind that the more larvæ and moths destroyed in the spring the better. In small fields, the pests may be kept under control with comparative ease by cutting open the husks of infested ears and destroying the worms.

REMEDIES WHICH HAVE BEEN TESTED FOR THE CORN-WORM WHEN ATTACKING THE TOMATO.

In the United States Agricultural Report for 1888, p. 143, Prof. S. M. Tracy, of the Mississippi Agricultural College, gives the results of his experiments with various insecticides to be used against the corn-worm when attacking tomatoes. Of those tested the most successful were Paris green, London purple and kerosene emulsion. The Paris green and London purple were applied both dry and suspended in water. His accounts of the experiments with these remedies are as follows:

"*Paris green*, dry and in suspension, in forty and fifty gallons of water to a pound of poison, apparently killed half of the young worms, but a large number escaped. The mixture in sixty gallons of water accomplished but little.

"*London purple*, in suspension, produced somewhat more marked effects than did the Paris green, but was less effective when applied dry.

"*Kerosene emulsions.*—These were much more effective than any others of the applications made. When the emulsions were diluted with twenty-five, forty and fifty parts of water, nearly every worm and egg on the treated plant was destroyed; when sixty parts of water was used a few, perhaps one-fourth, escaped. When twenty-five parts of water were used without turpentine[2] a few of the very young leaves were injured, but the damage was so slight as to be scarcely appreciable. For several days after making the applications the weather was cloudy, so that applications which might otherwise have scalded the leaves were harmless."

SOME DOUBTFUL REMEDIAL MEASURES.

Trap lights.—The use of trap lights placed in the field or garden at night to attract and destroy injurious night-flying moths has been occasionally recommended. In 1891-'92 Mr. F. W. Mally, at that time connected with the United States Department of Agriculture, Division of Entomology, carried on an extensive series of experiments in the South with the trap lights for the corn-worm moth. Concerning the use of trap lights, he says:[3] "Numerous and decisive experiments with lamps for trapping boll-worm moths were made. Some of these were made under the most favorable circumstances. They all proved the absolute folly of this practice among planters. The moth is not attracted much at any stage of its existence, and whatever insects are captured are in the whole decidedly beneficial. This practice, then, is a positive injury, in that it systematically destroys beneficial insects without accomplishing any good as a recompense. The measure, so commonly practiced by planters, should, in view of the decided and constant harm attendant upon its use, be unhesitatingly condemned whenever opportunities are presented for doing so." In a subsequent publication[4] Mr. Mally reports even more extensive experiments and with practically the same results.

Attracting and destroying moths by poisoned sweets.— Mixtures of vinegar and molasses or beer and molasses are frequently used by entomolgists and amateurs to attracting night-flying moths for the purpose of capturing them. With this fact in mind, various experiments have been made with mixtures of molasses and some odorous substance to which poison has been added to determine whether this would be a practical method of destroying injurious

2 The turpentine was added at the rate of one pint to two gallons of oil to make the emulsion more stable.

3 Bul. 26, U. S. Dept. of Agr., Div. of Entomology, p. 53.

4 Bul. 29, U. S. Dept. Agrl., Div. Ent.

moths where they occur in abundance. The mixture is usually put in dishes and placed in different parts of the field in such a way as to be easily accessible to the moths. Extensive experiments of this kind were made in the south by Mr. Mally,[5] who reports that the usual methods of utilizing poisoned sweets against this pest are evidently useless and moreover expenditures of time and money which are practically an entire loss. This conclusion is based upon the behavior of the moths towards the sweets during the egg-laying period. That time over, many individuals may be caught, but then their capture has no real economic significance.

It may be here added that Mr. Mally experimented extensively in the south with poisoned sweets sprayed upon a trap crop, usually cow peas, which were planted early enough so as to bloom about the time the moths of the first brood were ready to deposit eggs. That this method of treatment would be practical on the small farm, and especially with the truck farmer, has not yet, so far as we are able to learn, been demonstrated. Of course the trap crop upon which the poison is sprayed would be of no value as a forage crop, and, unless decidedly favorable results were obtained, it is doubtful, we believe, whether the experiment would be a success in the truck farming communities of the State where the corn-worm is most numerous.

---

5 Bul. 29, U. S. Dept. of Agr., Div. Ent. p 4.

V. The Striped Cucumber Beetle.

(*Diabrotica Viltata*, Fabs.)

INTRODUCTION.

The striped cucumber beetle is one of the best known of the insect pests of the garden. In some sections of the State where cucumbers, squashes, melons, etc., are extensively grown, it is much dreaded. This is especially true on Long Island where these crops are very important ones. Here the destructive work of this little black and yellow beetle is annually apparent. In some sections of Long Island where cucumbers are extensively grown for pickles, the ravages of this little insect cause heavy losses every year, and the insect has come to be one of the important factors in pickle growing.

During the past season, letters from growers in different sections of the State have come to this Station complaining of the depredations of this insect and inquiring for the best methods of combating it. Although no experiments with preventive measures or remedies have recently been undertaken by this Station, it has been thought desirable to publish a brief report at this time giving a short account of the life history and habits of this insect together with descriptions of some of the preventive and remedial measures which have proven a success when properly used.

Distribution.

This insect is found in destructive numbers in many parts of the United States. Indeed it is said to be one of the most broadly distributed of our leaf-eating insect pests. In the central, southern and some of the western States, as well as here in the east, it is considered one of the most troublesome insect enemies of the garden.

Abundant on Long Island.— In some sections of Long Island, where cucumbers are extensively grown, this little beetle annually causes heavy loss. An illustration of its destructive work is given in the following extract taken from a letter to the writer from Mr. Wm. H. Williams, of Jericho, L. I. Mr. Williams says: "This beetle is quite discouraging to the growers of early pickles or cucumbers. Half-grown vines as they begin to produce fruit, die here and there, and in most pickle fields the vines also appear to be injured as a result of an attack upon the roots. This last evil threatens to ruin the industry. It has moved the western limit of successful pickle growing from the immediate vicinity of Jamaica to Westbury* in twenty-five years." While there are other destructive insects which feed upon the cucumber, including one or two species of cut-worms known to attack the roots, there is, probably, no one species which has been so persistent in its attacks in the locality referred to as the cucumber beetle. This insect may be considered then, a regular visitor, although like other insects, its increase is influenced by the weather. Dry seasons are considered more favorable for its growth and development. The two seasons previous to this were unusually dry on Long Island and the beetles were very abundant, but during the past season rain has been more plenty and the beetles less numerous.

DESCRIPTION AND LIFE HISTORY.

The cucumber beetle is too well known among farmers and gardeners to need a description here, excepting for the fact that there is another beetle of about the same size and general outline which is frequently found in company with it. Judging from our experience, this fact often leads to confusion in the minds of many growers as to the identity of the real cucumber beetle. The beetle referred to is commonly known as the twelve-spotted diabrotica, and scientifically as *Diabrotica 12-punctata*. It is not considered an enemy of any importance to cucurbitaneous plants, In its larval form, however, it is known as the Southern corn-root worm, and is a well known and often much-dreaded pest to corn growers.

Although the beetles resemble each other in general outline, they may be easily distinguished by their markings. As its name indicates, the twelve spotted Diabrotica is marked with twelve spots. These are conspicuous black spots on the wing covers. The striped cucumber beetle has three black stripes in place of the spots. Fig. 6 represents the striped cucumber beetle greatly enlarged. The head

* A distance of over 11½ miles.

is black, legs black and yellow, and the thorax and abdomen, with the exception of the stripes, yellow.

On Long Island the beetles appear early in the spring, but are usually first noticed in the fields about the middle of June, when they appear, as a rule, in great numbers. A variety of plants serve as food until the young cucumber or melon vines appear. These they eagerly seek, sometimes eating them off before they are fairly out of the ground.

The females are soon ready to deposit eggs, which they place upon the stalks or roots of the host plants above, or just below, the surface of the ground. The eggs soon hatch, not into beetles as some suppose, but into slender white grubs, which, when mature, measure about two-fifths of an inch in length and are not much larger around than an ordinary pin. These little grubs feed upon the roots, usually preferring the pithy interior. Sometimes one root will contain six or seven.

As would naturally be supposed, the vines suffer greatly from such injuries to the roots and not infrequently rapidly wilt and die.

The grubs are mature in about three weeks, when they burrow into the ground for a short distance, each one forming a small cell in which to pass from the grub to the pupa state. They remain in the ground about two weeks, finally coming forth as mature insects. The beetles prefer the leaves, which they feed upon during the cool of the day. They are usually found upon the under surface. Thus the vines suffer from the attacks of this insect not only while the beetles are mature, but during their larva or grub stage as well.

In this climate the beetles may be found upon the vines throughout the season. In the fall of 1894 they were abundant on Long Island during the latter part of September. This indicates that there are more than two broods here.

During the winter the beetles may be found hybernating in various out of the way places. The cold makes them inactive and they appear as if dead unless removed to a warm place or allowed to remain until the warm sunshine of spring brings them to life again. Some of the pupae also are supposed to live over winter. These belong to the late brood of the previous season, and remain in the ground in the little cells, as above referred to, until spring, when they come forth as beetles.

METHODS OF TREATMENT.

For convenience, this topic may be considered under two heads, namely, preventive and remedial measures.

Preventive Measures.

The safest way to prevent the attacks of the cucumber beetle upon the very young vines, when they are grown in the field, is to cover the hills with some form of protector. Concerning this method Dr. Riley, in his second Missouri Report, page 66, says: "Of all the multiferous remedies proposed against the attacks of this insect there are none so effectual or so cheap in the end as inclosing the young vine in boxes which are open at the bottom and covered with millinet on top. Such boxes are made at a trivial cost and if properly stored away each season after use will last many years."

There are other forms of plant protectors which do not have the objectionable feature of shading the young vines while in use. A very simple one of this kind is described and illustrated by Mr. L. D. Snook in the American Agriculturalist for June 29, page 895, as follows: "For a garden where less than two dozen hills are planted, the safest and cheapest way to protect the vines is by a covering of mosquito netting or cheese cloth cut into pieces 18 or 20 inches square. These, to add to their durability, should be first dipped in oil and wrung as dry as possible. Now take a piece of No. 12 or 14 wire, galvanized if possible, cut into 20-inch lengths, bend five inches of each end at right angles, and set them two inches into the ground at the corner of each hill, as seen at *a a* in the engraving, Fig. 7. The netting is now spread over this frame, and the edges are covered with a little soil to keep it in place. This thin covering, while admitting plenty of light and rain as it falls, also keeps out the little striped beetle. Cucumbers can thus be protected until they send out laterals, and even if the vines press against the sides and top it does not injure them. Put on the protectors just as the plants are breaking through the ground, removing in about three weeks. Kept in a dry place when not in use, they will do service eight or ten years."

Dr. C. M. Weed in his book on "Insects and Insecticides," edition of 1891, describes three forms of these protectors. He also states that the cloth may be simply placed over the plants without any support, merely covering the edges with loose dirt to hold them in place. The cloth covers should be loosened occasionally so that the plants will not be crowded. In the same book Dr. Weed describes another protector which has been successfully used. Referring to the method of covering the plants with cloth or netting he says: "A modification of this method which has been successfully used consists of two end boards one-half inch thick, about fifteen inches long by six or eight inches wide. On the middle of each of these is nailed a piece of pointed lath at right angles to the long way of the board. The lower end of each lath projects below the edge of the board, and is stuck in the ground a few inches. Before the lath are put on, the end pieces are connected with each other by a piece of plant cloth about 16 x 17 inches, the ends being tacked to the top and sides of the boards. * * * When it is desired to cultivate the hills, it is only necessary to pull up one end, stir the earth and put the ends back in position."

Another form of protector is easily made by bending two hoops into a half circle and sticking the ends into the ground so that the hoops will cross each other at right angles over the center of the hill. The covering may then be placed in position and the edges fastened down with loose dirt.

Mr. William H. Williams, of Jericho, Long Island, recently suggested to the writer a style of protector as described below. Ordinary wire netting, such as is used for screen doors, etc., is cut into convenient lengths and bent longitudinally through the middle in such a manner that the edges, when the protector is placed in position, will not interfere with the hill, but will come as close to it as seems desirable. A cross section of the protector when placed in position will then represent an inverted V. The protectors may be made long enough to cover several hills, and when a number of them are placed in position, each should lap over the other slightly until the end of the row is reached. The openings at either end may then be covered in any convenient manner. Protectors of this kind will last indefinitely if properly cared for. They are of especial value where the cucumbers are grown in rows.

On page 424 of Bulletin 75 of this Station another form of plant protector is mentioned in connection with a brief discussion of the striped cucumber beetle which is therein given. This protector is manufactured by I. E. Sherman, of Sidney, New York, and is known as the Folding Plant Protector. It has been used at this

Station with satisfactory results. Two sizes of this protector are on the market. No. 2 is 12 inches square and 9 inches high. No. 3 is 14 inches square and 12 inches high. Any size desired will be made to order. The prices are as follows: No. 2, $6 per 100; No. 3, $8 per 100.

These protectors are made of cloth supported on light wooden frames. Fig. 8 represents one of these protectors.

The above descriptions are given here to enable the reader to form a definite idea of some of the different forms of plant protectors which have been successfully used. Any of them will admit of various modifications to suit the convenience of the individual.

Plant protectors have not come into general use in large fields although their failure when used on a larger scale is yet to be satisfactorily demonstrated. Some consider them too clumsy while others consider them too expensive, not fully realizing, no doubt, that it is also expensive to plant the seed over two or three times, which is not an exceptional occurrence here on Long Island as a result of the work of the cucumber beetle, and then to have a late crop in the bargain. The protectors will keep the beetles away from the young plants during the time when they are most easily destroyed. They may be left on until the vines have made a good start. Instead of using the protectors or leaving the very young plants to take their chances with the insects, some farmers prefer to start the young vines under glass.

Planting the cucumbers and manuring the hills. — Mr. Williams, writes me that he usually succeeds in getting a good start of late cucumbers by planting the seed during the last of June or early in July, preferably where the ground is wet, having previously put manure in the hills and covered it while wet. In this way Mr. Williams succeeds in dodging the beetles, so to speak, for while the young plants are coming up the early brood of beetles are going through their transformations under ground and hence but comparatively few of them are present to attack the young vines. By the time the beetles come forth the vines are large enough to resist their attacks with comparative success, for, as Mr. Williams says, "the tenderer the leaves the more swiftly and surely these insects destroy the plants."

Remedial Measures.

Under this head we will briefly mention some of the remedies which may be applied if the beetles become established in a field, or which may be used in connection with the protectors.

Dry wood ashes and air-slaked lime are successfully used in various sections of Long Island as remedies against the cucumber beetle. Concerning these remedies Mr. Wm. A. Fleet, of Citchogue, L. I., writes me as follows: "The remedy most used here (for the cucumber beetle) is dry wood ashes applied when the vines are wet, or air-slaked lime is also good. Either of these remedies will keep off the beetles if applied frequently and *the beetles are not allowed to get there first.* If the beetles should become established, however, a very little turpentine mixed in the ashes will usually drive them off. Care must be taken not to use too much turpentine. A table spoonful to a peck of ashes is plenty." The ashes or lime should be thoroughly applied. Every leaf should be covered and frequent applications made if the beetles are numerous.

Paris green and plaster have been used with much success. This is an old remedy. The Paris green and plaster should be mixed in the proportion of about one part of the poison to twenty parts of plaster. Apply when the vines are wet. In order to show how effectual this remedy has been the following is taken from Prof. J. B. Smith's report for 1890, page 482.* The experiments were made under his direction by Mr. F. J. Kroboth, who reported as follows: "Scattered among 118 hills (three or four vines each) of musk melon, I have left ten hills to take their chances with the bugs; the remaining 108 I have treated according to your directions. The untreated hills are now totally destroyed by the striped bug and what appears to be its larva, a small worm entering the stem near the root and working down * * * Driven from the melons they are to be found among my late cabbages, beans, tomatoes and egg plants apparently doing little or no harm. The treated hills are all doing well, having melons nearly ripe." Paris green may also be mixed with water, one pound of the poison to 150 gallons of water, and the mixture applied in a fine spray. Newly slacked lime, at least as much by weight as there is Paris green, should be added to prevent burning the foilage.

Pyrethrum when properly applied has been found a good remedy

* Report of the Entomologist, New Jersey Agricultural Experiment Station, Newark, N. J.

for the cucumber beetle. Prof. C. P. Gillett records, in Bulletin 5 of the Iowa Agricultural College, page 176, a series of experiments with pyrethrum as a remedy for this insect. He found that pyrethrum when dusted over the plants in the middle of the day did very little good, but when applied early in the morning, in this case at 5 o'clock, it was a complete success. "At this time in the morning," he says, "the beetles are cold and sluggish and their bodies are damp with the dew of the night so that they do not fly away and every particle of the powder that falls on them sticks." Pyrethrum is a powerful irritant and kills by contract.

Tobacco dust is a common remedy among farmers and other growers for various insect pests. For the cucumber beetle it should be applied liberally upon the hills early in the season, preferably just as the young plants are about to come up. Later in the season if the beetles are numerous the vines should be thoroughly dusted with it while they are wet with dew or rain. If the beetles are numerous apply frequently. The tobacco not only aids in keeping the beetles away, but has valuable qualities as a fertilizer.

Combinations of preventive and remedial measures may consist in using the protectors early in the season, and Paris green or wood ashes or lime or other efficient remedies later, if the beetles are present in sufficient numbers to do serious damage to the vines.

SUMMARY.

From the above we may briefly summarize as follows:

The striped cucumber beetle attacks cucumber, squash, melon and other cucurbitaceous plants during two stages of its life history namely, the larva or grub stage and the mature or beetle stage.

The beetles attack the young plants just as they are coming to the surface of the ground and eat the leaves of the vines later in the season.

The grubs attack the roots burrowing into them and causing the vines to wilt.

The beetles may be found upon the vines throughout the season.

As a preventive measure the proper use of plant protectors is considered practical.

Among the most successful remedies for this insect may be mentioned dry wood ashes, air slaked lime, dry wood ashes and turpentine, Paris green mixed with plaster or water, pyrethrum, and tobacco.

VI. The New York Plum Lecanium.

(*Lecanium, sp.*)

INTRODUCTION.

The unusual outburst of Lecanium scale insects, which recently occurred in Western New York, caused considerable alarm among fruit growers in this locality. The insects were first noticed in unusual numbers early in the season of 1894. At this time they were found in abundance upon plum trees especially, although other fruit trees did not escape attack. Their work was most apparent, however, in several large plum orchards in the vicinity of Geneva, Rochester and Lockport. At least two of these orchards suffered very seriously from their attacks.

Specimens of the new pest were sent to the Station from time to time accompanied by letters of inquiry concerning a reliable remedy. Prof. S. A. Beach, horticulturalist of the Station, thus having his attention frequently called to it published a brief notice of the unusual increase in Garden and Forest for July 18, 1894.

Early in the following November, the writer was directed to undertake a series of experiments with a view to determining a practical method of combating the scale when occurring on plum trees in injurious numbers; the plan and results of the experiments, together with such remarks concerning the life history and habits of the insect as seemed desirable, to be finally presented in shape for publication. The following pages contain the report. It may be here added, however, that the work has been carried on during four visits to Geneva during the year, which has made an accurate study of all points in the life history of the insect more difficult than might otherwise have been the case.

Recent Publications Concerning the New York Plum Lecanium.

As above mentioned, Prof. S. A. Beach published a notice of the alarming increase in the numbers of this scale in Garden and Forest for July 18, 1894, giving a brief account of the life history and habits of the insect, together with remarks as to its appearance, and, at Mr. L. O. Howard's suggestion, recommending dilute kerosene emulsion as a remedy.

In the Rural New Yorker for November 10, 1894, Mr. M. V. Slingerland, of the Cornell Agricultural Experiment Station, published a more elaborate account of the insect, recommending kerosene emulsion as a remedy, to be used not weaker than one part of the emulsion to four parts of water, and not stronger than one part of the emulsion to three parts of water. In December, 1894, Mr. Slingerland published Bulletin 83 of the Cornell Agricultural Experiment Station, entitled "A Plum Scale in Western New York."

Mr. L. O. Howard, Entomologist of the United States Department of Agriculture, speaks of this insect in the Year Book of the United States Department of Agriculture for 1894, page 272, stating, among other things, that this scale resembles the Peach Lecanium in general appearance.

In the annual report of this Station for 1894, the writer has a brief preliminary report of experiments with kerosene emulsion as a remedy for this new pest.

The next and last publication concerning this insect in western New York that has come under our observation, is by Mr. M. V. Slingerland, in the Rural New Yorker for April 13, 1895, and is entitled "Latest News on the Plum Scale."

APPEARANCE OF THE SCALE IN WINTER.

Generally speaking, two sizes of the scales may be found in this latitude during the winter, namely, the large oval ones, which are the remains of the mature females of the previous season, and the small hibernating scales which are destined to carry the brood over to the coming spring. The old dead scales are very conspicuous and hence easily recognized. They are dark brown in color and vary in length from one-eighth to three-sixteenths of an inch and are decidedly oval in outline. They are not very securely fastened to the bark but rub off easily, and in time would be blown off by the wind. Fig. 9 is from a photograph of some of these scales enlarged to about four times their natural size. When one of these scales is forcibly removed it leaves a white mark upon the bark together with a white powdery substance which is made up of thousands of minute pieces of egg shells, the remains of the eggs laid by the scale the previous spring. Fig. 10 is from a photograph of an infested twig from which the scales had been removed. These white marks gradually fade and finally disappear altogether.

Fig. 11 represents the other form of scale referred to. The scales are so small and there is so little contrast between their color and that of the bark to which they are attached that they do not show very plainly in the figure. These scales, however, are alive. They are hibernating after having fed upon the juices of the leaves or tender twigs during the previous summer. Most of these scales are young females. A description is omitted here as they will be considered more in detail later on.

Classification and Name.

The family Coccidale includes all of our scale insects as well as certain other insects of similar habits and characteristics. The insect under consideration belongs, therefore, to this family. It is further classified into the genus Lecanium, a prominent and widely distributed genus of this family, and one which includes a number of species of economic importance, not the least of which is the well-known black scale of California. The females are not provided with separate scales or coverings as is the case with other scale insects, but are soft and naked until egg laying begins when the integument gradually hardens to a brittle shell; hence these scales are frequently called soft scales, although the scientific name Lecanium seems to be coming into general use.

As to the identity of this species there still seems to be some uncertainity. Two different specific names were given to the same scale sent by the writer to different entomologists, namely, *cerasifex* and *juglandis* Bouché. In the Year Book of the United States Department of Agriculture for 1894, page 272, Mr. L. O. Howard speaks of it under the specific name *prunastri* Fonc., Mr. Newstead of Chester, England, having decided that it is identical with the European species of that name, and gives it the popular name of New York Plum Lecanium.

Distribution in the United States.

The uncertainty as to the specific name of the insect under consideration makes it difficult to determine its distribution. It is not improbable, however, that it is widely distributed throughout the

FIG. 9.—Plum scales enlarged about four times.

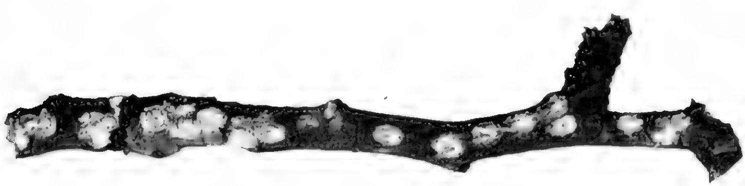


FIG. 10.—Showing scars, natural size, left by old scales.

FIG. 11.—Young scales, natural size, as they appear in winter.

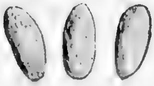


Fig. 12.— Eggs of Plum-scale. (Original.)

Fig. 13.— Larva of Plum-scale, under surface. (Original.)

Fig. 14. Male Plum-scale (Original.)

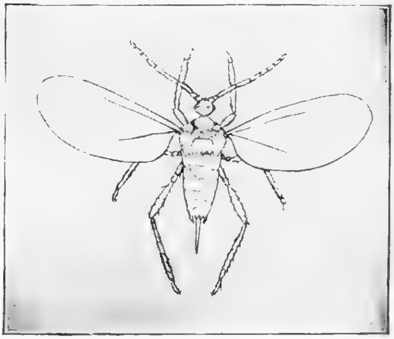


Fig. 15.— Mature Plum-scale, male. (Original.)

Fig. 16.—Showing Plum-scale which has been attacked by parasites, showing holes from which parasites emerged; enlarged about four times.

Figures 12, 13, 14 and 15—greatly enlarged

United States. In Bulletin 83, Cornell Agricultural Experiment Station, page 685, Mr. M. V. Slingerland states that the scale may be identical with a species observed in Vermont in 1886 and also with a Lecanium scale found on plum at Queenstown, Canada, by Mr. James Fletcher.

In Bulletin 32 of the United States Department of Agriculture, Division of Entomology, pages 41–44, Miss M. E. Murtfeldt, of Kirkwood, Mo., records her observations upon the life history and habits of a Lecanium scale, found upon both peach and plum trees, which resembles the New York species in many respects.

In the annual report of the New Jersey Agricultural Experiment Station for 1894, page 502, Prof. J. B. Smith mentions a Lecanium scale, under the name *L. cerasifex*, which he considers identical with the New York species, and states that he has found it in small numbers "at several points" in New Jersey.

The writer has had his attention called to a Lecanium scale which was quite abundant on plum trees in Lapeer county, Michigan, during the season of 1894. In one plum orchard in particular the scales were very abundant, and it is reported that several trees were badly injured by them. This scale has the appearance of being the same species as the New York Lecanium, although we have not yet examined it in its different stages with sufficient care to be positive.

The scale has also been observed on plum trees by the writer at Hector, Lodi, Geneva, Rochester, Syracuse, and Castleton Corners, Staten Island. In all of these places, with the exception of Syracuse and Castleton Corners, the scales were present in sufficient numbers to cause serious injury to trees and fruit.

As before mentioned, specimens of the scale have also been sent to the Station from various other localities in the western part of the State.

The above indicates that the scale has a wide range in this State, and that it may be well known in widely distant localities in the United States. Thus far, however, it seems to be doing the greatest damage in western New York.

History in New York.

From reports received from fruit growers it appears that the scale is not a new comer in western New York. One fruit grower states that he has occasionally seen the scale in his plum orchard for twenty years past.

Mr. Slingerland states* that he saw the scale at Lockport in 1893, but not in any such numbers as last year.

It was not until the spring of 1894 that the scale began its rapid increase. At that time it was noticed in alarming numbers in certain large plum orchards in western New York. Further investigations, however, showed a wide distribution throughout the plum-growing section of the State. The scales multiplied at a rapid rate during the spring, and by the following fall the young scales could be found literally by the millions on infested trees.

The winter of 1894–95 was a severe one, but although a large number of infested plum trees were examined during the latter part of December, we failed to find any change in the appearance of the scales. Later examinations at Hector and Geneva during the latter part of March, showed a large percentage of the scales dead, except on certain trees and in certain orchards which were protected, in a measure at least, from the severe winds common to these localities.

At present the scale may be found in many orchards in the State. In some, if not all of them, where proper precaution is not taken, in sufficient numbers to cause very serious damage in case the conditions should again be such as to bring about another rapid increase.

Long Island.—Although we have not observed the scale upon Long Island, it is said to be known here. It is certainly very near here, for, as previously mentioned, it is known to occur at present in New Jersey and on Staten Island. In the latter case, a few old plum trees and some quince trees near by were found slightly infested. It will be well, therefore, for Long Island fruit growers to bear this in mind, and to be prepared to stamp the pest out in case it should increase to an alarming extent here.

The Winter of 1894–5.—The following account of our experience in two or three plum orchards situated on the shores of Seneca lake, may be of some interest in showing the effect of the wind and cold upon the scales.

The first orchard to which our attention was called is situated on the east shore of Seneca lake, about thirty miles south of Geneva. The trees stand on a steep slope such as is common to that section,

* Bul. 83, p. 686, Cornell Agricultural Experiment Station.

and contains about 5,000 trees. On either side of the orchard is a gully, bordered on the sides nearest the orchard by a moderate growth of timber. The prevailing winds during the winter in this section are from the south, following the lake.

When the writer visited this orchard, in November, 1894, it was very badly infested with the scale. Indeed, it was one of the worst infested orchards in that vicinity. Nearly every tree was black, from the highest branches to the ground, from the effects of the fungus which grows in the honey dew secreted by the scales. The young scales were abundant on every tree. This was especially true in the southwest corner of the orchard, which is protected to a considerable extent on both south and west, by a dense growth of young trees. Mr. Wright, superintendent of the orchard, tells me that the scale was first noticed in this section of the orchard, and that it began to spread along the borders of the woods, and finally, in 1894, westward through the orchard. As has already been intimated, this orchard was visited from time to time during the winter and following spring. The orchard was again carefully examined during the latter part of June. The change which had taken place was remarkable. The scales were practically all dead throughout the orchard, excepting on a few trees along the woods on the south and in the southwestern corner above referred to. Here a number of trees still harbored live scales. There seemed to be no other reason for their remaining alive on these particular trees, excepting for the fact that they were sheltered from the severe south and westward winds which prevail in that section.

Another orchard not far from this one and on the same side of the lake, was not found infested to any extent excepting in two places, one which was partially protected by woods in a manner similar to the above, and the other where the ground sloped away from the lake. In both these places there were a few infested trees, while the remainder of the orchard including many trees of the same varieties and under exactly the same cultivation, were practically free from the scale.

Three orchards at Geneva also illustrates the apparent effect of the cold wind upon the scales. In one of them a number of trees are planted between rows of large apple trees, while the remainder of the orchard contains plum trees alone. Nearly all of the trees in that orchard which were infested with the scale were between the rows of apple trees, although none of the apple trees were attacked. The scales on these trees were also apparently unaffected by the weather during the winter.

Another orchard similarly situated was badly infested last year, but now the scales are confined to only a few trees, most of them in the interior of the orchard and all of them on a slope away from the lake.

The third orchard referred to is situated some distance back from the lake and in a hollow, so that it is more protected from the wind than any of the orchards above mentioned. This orchard was also not only very badly infested last year, but the scales have rather increased than decreased this year, the winter having apparently had no effect upon them.

During the past summer, Lecanium scales have also been observed in great numbers in some of the gulleys which are common along the shores of Seneca lake and other lakes in that vicinity. In one large gulley in the vicinity of Hector, a number of small maple and iron-wood trees were found almost covered with these scales. Similar trees, however, growing in exposed places along the banks of this and other gulleys in the vicinity, which, during the summer of 1894 were badly infested with the scales, were observed the past season to be almost free from them. This seems to indicate that exposure to the wind had something to do with reducing the numbers of these scales.

Other instances of a similar nature might be mentioned. From the above, however, it does not seem unreasonable to infer that the orchards least protected from the full force of the prevailing winter winds, other things being equal, are most likely to be comparatively free from the plum scale.

FOOD PLANTS.

In Garden and Forest[1] Prof. Beach names apple, pear, maple and Cissus as among the food plants of this insect. In Bulletin 83[2] Mr. Slingerland mentions cherry and peach as well, in addition to other food plants. In addition to some of the above, we have observed this or a closely allied, if not identical, species upon the following: Quince, apricot, cultivated blackberry, cultivated grape, honey locust,

1 Garden and Forest, July 18, 1894, p. 284.

2 Bul. 83, p. 687, Cornell Agricultural Experiment Station.

black ash, iron wood (*Ostryia*), and golden rod. In the case of the golden rod the infested plants were growing in a badly infested grove of black ash trees. The writer has found the scale infesting the following varieties of plum: Lombards, Bradshaws, Quackenboss, Prune, Shippers' Pride, Myrabolam, Yellow Egg, Washington, Empire, Hudson River Egg, and Union Purple. In every infested orchard examined, which includes six large ones and one comparatively small one, the scales were always more abundant on some one or two or all of the first three varieties named, than upon any of the others.

Although the scale is at present chiefly a plum pest, it has lately infested quince orchards sufficiently to cause alarm, and has been found in apple trees in sufficient numbers to do serious injury.

Will the scale attack nursery stock?—During the winter of 1894–95 we had occasion to examine plum stock ranging in age from one to three years in nurseries at Geneva, Rochester and Syracuse, but failed to find the scale, excepting in one case where a few scales were found on a number of three-year old plum trees which were heeled in in the nursery waiting to be sold. In one nursery there were a number of badly infested plum trees along a wagon path between blocks of young plum stock, but no scales could be found upon the stock.

In addition to examining the stock we have made numerous inquiries among nurserymen, but have failed to find an instance, with the above exception, where the scale has been found upon nursery stock.

How do the Scales Spread?—This question is one which is often asked and receives many different answers. There may be several ways. It is possible that birds aid by carrying the young female scales on their feet from one tree to another, or from one orchard to another. Larger insects, such as certain of our lady bird beetles, have been found with young scales crawling about on them, thus giving opportunity for transportation from one tree to another by this means. They may also easily get on the clothes of workmen who are in the orchard when the scales are active during the summer or fall, or they may be carried from one place to another on the boxes, baskets, wagons, etc., used in the orchard at various times. Another means of travel is undoubtedly upon the leaves which are blown from the trees during the summer and scattered about through the orchard. During the winter the young scales may frequently be found upon the old dead leaves scattered through the orchard.

INJURY TO TREES AND FRUIT.

As will be shown hereafter, the scales suck the sap from the trees both from the bark and leaves. In this way the trees are undoubtedly injured to a greater or less degree according to the number of scales present. In one respect, however, the most serious injury is done to the fruit. The scales do not attack the fruit but they secrete a clear, sweet, sticky liquid known as honey dew. The branches, leaves and fruit of the trees soon become partially coated with this honey dew. Very soon a black fungus begins to grow on all parts of the tree and fruit where the honey dew has fallen, until a badly infested tree will look as if it had been smoked from the top to the ground. The fruit thus becomes greatly disfigured, and as the fungus will neither rub nor wash off, may readily render the fruit unmarketable.

Sickly trees are undoubtedly most readily attacked by the scales. This is probably common in other cases of insect attacks upon trees or other plants. The question why this is so is not easily answered. Prof. Comstock, in the United States Agricultural Report for 1880, page 285, suggests that the sap of sickly trees may be more nourishing to the scales than that of healthy trees, for, as he also states, the scales do not usually have an opportunity to select their food plant and the scales certainly grow vigorously and quickly cover the weak and sickly tree.

LIFE-HISTORY, HABITS AND DESCRIPTION.

Transformations.—With the exception of one order, individual insects are said to undergo one of two forms of metamorphosis in reaching maturity, namely, complete and incomplete. In the former case the different stages are distinct and easily recognized one from the other. An illustration of this, as commonly given, may be found in the life-history of any butterfly. The butterfly's egg produces a caterpillar, the caterpillar changes to a chrysalis, and the chrysalis produces a butterfly. All of these stages are distinct and well defined; no one of them resembles another. This is called complete metamorphosis. In the latter case, however, the different stages are not so easily distinguished; as for instance, a young squash bug or locust resembles the parent in general appearance and continues to do so more and more until finally mature.

This is called incomplete metamorphosis and is found to occur in true bugs and locusts.

In the scale insects, which belong to a family of true bugs, we find both forms of metamorphosis. The male undergoes the complete and the female the incomplete transformation. Hence in the plum scale we must look for a decided difference in appearance in the male and female scales, although the difference is not readily apparent in the larval forms.

The Egg.— Fig. 12 represents some of the eggs greatly enlarged. The eggs average about 0.3 *m. m.* in length and are oblong oval in shape and rounded at the ends. The shell is smooth. At first they are white in color but Mr. Slingerland has observed that they "become pinkish in color about a week before hatching."

The eggs are laid under the mother shell. Indeed it may be said that the mother literally turns into a mass of eggs, as but little more than the integument finally remains, which, as previously noted, forms the brittle oval shell. Egg laying begins about the middle of May. Mr. Slingerland notes * that in 1894 egg laying began by the 18th of May. June 28 (1895), the writer found at Hector an occasional female scale just beginning to lay eggs, indicating that the time for egg laying may vary over a month in individual cases. The period of incubation varies considerably in western New York. June 24 (1895), Mr. Beach wrote that the Lecanium eggs were hatching. June 28 the young scales were quite abundant in infested plum orchards at Geneva. Eggs from scales on fresh plum twigs sent to Jamaica and kept in the laboratory, hatched June 21.

The number of eggs laid by a single female is astonishing, varying it is said, from less than one thousand to several thousand. The writer counted two thousand one hundred and thirty eggs under a single female of average size.

The Larva.— The newly-hatched larvæ remain under the mother shells for a time varying from a few hours to two or three days.† Fig. 13 represents one of these larvæ viewed from the under surface. At this time they vary in size from .02 to .03 of an inch in length, and are a little more than half as broad as long. If examined carefully, a side view will show that they are very thin

* Bulletin 83, Cornell Agricultural Experiment Station, p. 690.

† Young scales reared in the laboratory did not come forth from the mother shells until three days after hatching.

and slightly oval above. The slender curved setæ, by means of which the food is obtained, are shown in the figure.

As would be supposed, a swarm of little scales are produced from a single mother. After leaving the mother shell, they travel about apparently aimlessly for a time but within a few days settle down, most of them upon the under surface of the leaves along the mid ribs and larger veins, although many may be found upon the upper surface as well. Still others, however, may be found scattered about promiscuously on both surfaces of the leaves, and it is not unusual to find some that have remained behind on the new and tender twigs. When attacking the leaves of quince trees they seem to prefer the upper surfaces. Out of a large number of infested quince leaves examined, only an occasional scale could be found on the under surfaces, while the upper surfaces were moderately infested. The heavy pubescence on the under surface of the quince leave may account for this change in the insect's habits.

The little insects now insert their tiny setæ into the leaves or twigs, causing the sap to flow from which they obtain sustenance. It should be remembered that these scales are very small at this time. They are also very light in color, being almost semi-transparent, and as they stick very close to the leaves are very easily overlooked. Hence, in examining the leaves for them, it is well to use a small magnifying glass. When examining plum leaves the under sides should be examined first, as most of the scales will be found there, but with quince leaves the scales should be looked for on the upper surfaces.

Comparatively little change takes place in the appearance of the scales from now on during the summer. They grow slowly,* however, and change to a darker color. They also secrete honey dew during this time, and when abundant undoubtedly weaken the trees.

During the latter part of August or early in September † the young scales return from the leaves and seek shelter upon the twigs and branches, usually upon the under side, and also upon the trunks. On badly infested trees they may frequently be found over-lapping one another, and in sheltered places, as in crevices in the bark, it is not unusual to find them two or three deep.

The scales are now of a dark reddish brown color. They become quite firmly attached to the bark and unless one is familiar

* Mr. Slingerland notes, Bul. 82, Cornell Agr. Exp. Station, p. 691, that during the summer (1894) the young scales increased to twice their former size.

† September 8 (1895), scales were found migrating at Geneva.

Plate IV. Plum twigs infested with hibernating scales; natural size. A few of the old dead scales still remain attached.

PLATE V.—Branch of Bradshaw plum infested with Plum-scale.

with insects, to some degree at least, and especially with scale insects, he might easily fail to recognize at first sight these peculiar flat creatures as being insects at all, for, from an upper view, they appear to be without legs or antennæ or even a head. They look more like little brown pods which have been stuck on the bark. If one of them is removed, however, and examined with a hand lens, the legs and antennæ will be found drawn under the body and extending backwards.

Hibernation. — The young scales remain thus attached during the winter. They now measure from .03 to .04 of an inch in length. Plate IV is from a photograph of two twigs cut from one of the larger limbs of a plum tree infested with the hibernating scales. As has been previously mentioned, these scales, unlike most other scale insects, are not protected by a scaly covering either during the winter or at any other time of their life-history. As has already been pointed out by Mr. Slingerland,* this is undoubtedly the weakest part in the life-history of this insect, for, although they are more susceptible when just hatched to the effects of insecticides, they are more easily reached at this time with a spray than when the foliage is on the trees.

Appearance in the spring; the Female. — During the latter part of March or early in April, the young scales begin to move about apparently seeking a suitable place to again insert their tiny setæ to suck the sap. They are soon settled, however, and begin to grow with astonishing rapidity.† From the small hibernating scales of the winter previous, the females grow in about two months to large, oval, fleshy scales, measuring nearly an eighth of an inch in length. Plate V is from a photograph of an infested branch of the Bradshaw plum. These scales are full grown. The lines on the right represent the length and width of an individual scale. During this period of rapid growth, secretion of honey dew again takes place causing the leaves and limbs and whatever the honey dew falls upon to become sticky and finally blackened, causing a badly infested tree to present a very unsightly appearance. These large scales are soft and stick quite firmly to the bark and, when removed, leave a white mark in a manner somewhat similar to the old shells when removed during the winter.

* Bul. 83, Cornell Agr'l Exp. Sta., p. 692.

†March 28 (1895), the writer found numerous scales on plum trees at Hector that were beginning to grow.

As soon as mature, which as above noted, is during May or early in June in western New York, egg laying begins. With the production of the eggs the mother dies, her shriveled body and shell-like integument being all that remains. Thus the life cycle is completed, it having extended over a period of between ten and eleven months.

The Male.—As previously stated the male scales do not grow in the spring in the same manner as the females. Very soon there is a decided change in their appearance. Their cast skin becomes a beautiful white waxy covering, barred and figured in a manner to give it the appearance of fine lace. Under this delicate shelter the insect undergoes its transformation from the larva to the mature form. These changes may take place in May or June. May 24–28 both pupæ and males were found at Hector.

The pupæ are light yellowish red in color with slight markings of light brown. We were not successful in rearing the males in the laboratory, but from observations in the orchard this stage appears to last from a week to ten days.

Although these male scales are smaller than the females, they may be easily recognized. They are oblong in shape, measuring about three sixteenths of an inch long by one-sixteenth wide, are much flattened and whitish in color. Two long white filaments may often be seen projecting beyond the scale from the tip of the abdomen of the insect, and not unfrequently the delicate wings, overlapping each other along the dorsal margin, may be seen projecting from beneath the scale. The male scales may be scattered about promiscuously among the females, or in groups of a hundred or more, usually upon the smaller branches. Fig. 14 represents one of these male scales greatly enlarged. The white line at the right indicates the true length of the insect.

The males come forth in May and undoubtedly in June, for, from May 18–26 occasional empty shells could be found, while mature males which had not yet emerged were abundant. June 28 to July 3, an occasional male scale could be found although most of them had disappeared.

Fig. 15 represents one of the mature males. They are very delicate and very beautiful. They take no food while in this mature state, the mouth parts having disappeared in the development of the insect. Although most other winged hemipterous insects are supplied with four wings, they, in common with other male Coccidæ, have but two, a pair of halteres terminated by hooks being in the place of a second pair of wings. The male is light yellowish or rose red in color. The life of this little creature is very short after it comes forth as a mature insect, probably only a few days, as it dies soon after performing its only function. We have thus seen that the males and females when mature are two very distinct creatures in appearance, resembling each other much less than some insects of entirely different species. This, however, is characteristic of the Coccidæ.

Summary.—From the above we may summarize briefly, as to the life-history and habits of this scale as it occurs in western New York, as follows:

Most of the young scales appear during the latter part of June and early in July.

During the summer they are to be found upon the leaves, and a few of them upon the tender twigs. They undoubtedly injure the trees during this time by sucking the sap. They also secrete honey dew, but grow but comparatively little.

They abandon the leaves in the fall and attach themselves to the under sides of the twigs and limbs, or even upon the trunks of the trees. They do not feed or grow but remain dormant during the winter.

They are most exposed during the winter of any time during the year and hence most easily reached by insecticides.

In the spring the females grow very rapidly and secrete honey dew. The males can now be readily distinguished from the females. They undergo complete metamorphosis and come forth supplied with wings, while the females remain wingless and unable to move.

The males die soon after reaching maturity, and the females die with the production of the eggs, the integument becoming hard and brittle, forming a covering for the eggs and also for the young during a short period.

There is but one brood during the year.

NATURAL ENEMIES.

Under this head are mentioned some of the predaceous and parasitic insects which have come under our observation as preying upon the plum scale.

Predaceous insect enemies.— The eggs of at least three species of predaceous hemipterous insects were found among the scale insects on infested plum trees during the winter of 1894-5. All of these species are probably predaceous upon the plum scales and hence aid in reducing their numbers. One of these species at least belongs to the genus *Sinea.* We endeavored to rear some of these insects in the laboratory, but through an accident failed to bring them to maturity or to prove that they would attack the plum scale. They belong, however, to the *Reduviidæ*, a family of insects the members of which, Professor Comstock states, "are pre-eminently predaceous upon their fellows." These insects have long legs and can move about quite rapidly. They are also provided with long sharp beaks with which they suck the blood of their victims.

The Twice-stabbed Lady-bird Beetle, *Chilocorus bevulneris*, is another predaceous insect which attacks the plum scale. This insect, as its name implies, belongs to the well-known family of lady-bird beetles. They were very abundant on infested plum trees last summer and the summer previous. They may also be found hibernating on the trees.

Their spiny larval skins may also be found on the trunks and branches of the trees. They were very abundant last winter in infested plum orchards at Hector and Geneva, and were frequently observed in groups of from less than a hundred to two or three hundred.

Plate VI, Fig. 1, is from a photograph of some of these spiny skins from which the beetles have emerged. At Plate VI, Fig. 2 *a*, one of the spiny skins from which the beetle has emerged is represented natural size, and at *b* one of the beetles. Both are greatly enlarged, the hair lines at the right showing the true lengths. The beetles are nearly as broad as long, decidedly oval, and about the size of a fully matured female plum scale. They are shining black in color and each wing cover is marked with a red spot.

The larvæ of these beetles also feed upon the scales. They are peculiar spiny creatures and may be found in the spring and summer.

Hyperaspis signata is another species of lady-bird beetles, or *Coccinellidæ* as they are scientifically known, which we have found upon infested plum trees, although in much smaller numbers than the previous species. They are also much smaller than this species but are black and similarly marked.

FIG. 1 — Pupa cases, natural size, of the Twice-stabbed Lady-bird Beetle

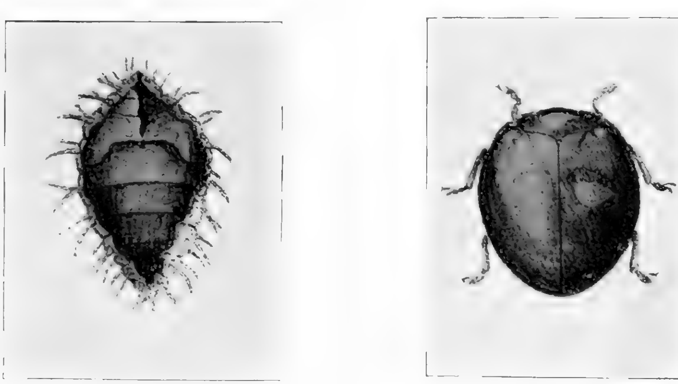


PLATE VI.

FIG. 2.—The Twice-stabbed Lady-bird Beetle, pupa case and adult, enlarged. (Original.)

Several other species of lady-bird beetles were found last year upon infested plum trees at Hector and Genevà, among the most common of which were the following: *Coccinella novemnotata*, *Adalia tripunctata* and *Hippodamia* 13—*punctata.*

Parasitic insect enemies.— During the winter certain of the young scale insects will be found to have become much more oval through the middle and to have turned to a dark, almost black color, excepting a narrow margin of light yellow. Remove one of these peculiar looking scales and examine it carefully and you will find within, a minute parasitic insect of the order *Hymenoptera.* If allowed to develop, this little insect would come forth a minute four-winged parasite. In May and June these little parasites may frequently be found moving restlessly upon the branches and leaves of infested trees. Some of the old scales will be found with one or more small round holes in them as illustrated in Fig. 16, which represents one of these scales enlarged. These have also been parasitized, the mature parasites having escaped.

A number of parasitized scales, taken at different periods of the year, were brought to the laboratory and placed in breeding jars. From these the following species were reared: *Blastothrix longipennis*, How., *Comys bicolor*, How., *Coccophagus lecanii*, Fitch, *Euderus lividus*, Ashm, and *Aphycus albiceps*, *n. sp.*, Ashm.

Doubtless there are other predaceous and parasitic insects which prey upon the plum scale. They should be left undisturbed when possible, for they are the friends of the fruit grower. Quite a large percentage of the scales were parasitized last year.

A fungus, *Cordyceps clavulatum*, is often found in shady or moist places growing upon scale insects of the genus *Lecanium.* It was very common last year on Lecanium scale insects on maple and iron wood in the gulleys along Seneca lake, in the vicinity of Hector. This fungus is discussed by Mr. R. H. Pettit in Bulletin 97, Cornell Agricultural Experiment Station, pp. 341–345. The diseased scales are easily recognized. They soon turn to a lighter shade, and finally delicate fruiting bodies are given off which soon terminate in a conical head. The fungus is described in the bulletin above referred to. Attention is here called to it, as we desire to be notified if any of our readers find the fungus on plum scales in their orchards.

EXPERIMENTS WITH REMEDIES.

A large number of washes have been recommended as remedies for scale insects. Before the experiments were undertaken, however, we wrote to Mr. L. O. Howard for his opinion regarding a wash which would be effective against the plum scale. Mr. Howard replied strongly in favor of kerosene emulsion. In a letter to the Director of the station dated December 14, 1894, he says: "The only absolutely effective wash so far found, viz., strong solution of whale oil or fish oil soap, is too expensive for application in a large orchard. The only substance which could rival the kerosene emulsion as used against your plum Lecanium would be one of the resin washes, but the weather in central New York in the winter time is too rainy to allow us to expect good results from this wash." It will be remembered that this scale, in common with other scale insects, obtains its food by sucking the sap from beneath the bark, hence an insecticide which would prove effectual when applied on the trees must be one which kills by contact. Kerosene emulsion is one of this class. The experiments were conducted in the orchards of T. Smith & Sons and Maxwell Brothers of Geneva, whose courtesy we wish to acknowledge, and to also express our thanks to Mr. C. K. Scoon of Geneva and Mr. James Wright of Hector for their kind assistance.

Plan of the Experiments.— The experiments were planned with a view to determining the relative merit of different strengths of kerosene emulsion when applied during the winter, when the young scales are hibernating on the trees, when applied in the spring, when he young scales are growing rapidly, and when applied upon the newly hatched scales. The emulsion was made according to the formula usually given. In Bulletin 86 of this station, page 113, directions for making kerosene emulsion are given, as follows: "This is made by dissolving one-half pound of either common soap or whale oil soap in one gallon of soft water. Heat the mixture and when boiling hot remove it from near the fire and add it to two gallons of kerosene. The whole is now thoroughly mixed by pumping continuously through a small force pump for from five to ten minutes. Mix until the ingredients form a creamy mass that becomes thick when cool and from which the oil does not separate." In all of these experiments the emulsion was sprayed upon the trees, great care being taken to thoroughly drench the trees from the tops to the ground.

Winter Treatment.— The following gives the number of trees, sprayed in November and December. As a matter of interest the cost per tree for the emulsion is given together with the condition of the weather at the time of application, as the force of the wind is an important factor in the application of liquid insecticides under these circumstances. In figuring the cost of the emulsion kerosene oil is valued at .066 per gallon, the price paid for it by the barrel at Hector in November, 1894, and soap at .04 per pound.* The cost of labor is not included. In all of the experiments a force pump and two nozzles were used, requiring three men.

The following experiments were made in one of Maxwell Brothers' orchards at Geneva. All of the trees sprayed were eleven-year-old plum trees:

Experiment No. 1.— November 16, 1894, 67 trees were sprayed with 4½ gallons of kerosene emulsion diluted to one part of the emulsion to four parts of water. The wind was very light and hence but comparatively little of the emulsion was blown away. The cost per tree, for the emulsion only, was less than one cent, in actual figures $\frac{6}{10}$ of one cent. Nearly all of these trees were very badly infested with the scale. Three of the worst infested trees were left as checks.

Experiment No. 2.— November 17, 55 trees were sprayed with 44½ gallons of kerosene emulsion diluted to one part of the emulsion to six parts of water. A strong wind was blowing and hence much of the emulsion was wasted. The emulsion cost $\frac{7}{10}$ cents per tree. Three badly infested trees were left as checks.

Experiment No. 3.— In this experiment the emulsion was made with milk and kerosene oil after the following formula, given in Farmers' Bulletin No. 19 of the U. S. Dept. of Agriculture, p. 12:

Kerosene	2 gallons.
Milk (sour)	1 gallon.

In making the milk emulsion heating is unnecessary, but it should be thoroughly mixed as with the kerosene and soap emulsion. This emulsion was diluted the same as in experiment two, and applied upon 45 trees. The cost of the emulsion was not figured.

The following experiments were conducted in the plum orchard of T. Smith & Sons, at Hector, N. Y. In this orchard the trees

* Scrap soap which will answer for this purpose may often be obtained from the soap factories at a much lower price.

varied considerably in size and in age. Nearly every one of the trees sprayed was badly infested with the scale.

Experiment No. 4.— November 22, 69 trees were sprayed with 125 gallons of emulsion diluted to one part of the emulsion to four parts of water. The weather was mild with but little wind. Two hours were required for the application; cost per tree, nearly $1\frac{1}{2}$ cents.

Experiment No. 5.— November 22, 69 trees were sprayed with 125 gallons of emulsion diluted to one part of the emulsion to nine parts of water. The weather was the same as in experiment 4 and the time required for the application the same. The cost was 1 cent per tree.

Experiment No. 6.— November 23, 85 trees were sprayed with 150 gallons of emulsion diluted to one part of the emulsion to 12 parts of water. The weather was cold and very windy. A little more than two hours was required for the application of the emulsion, and the cost per tree for the emulsion only amounted to a little over $\frac{6}{10}$ of one cent.

Experiment No. 7.— November 23, 71 trees were sprayed with 150 gallons of emulsion diluted to one part of the emulsion to four parts of water. The weather was the same as in experiment seven, and the time of application the same. Owing to the wind much of the emulsion was wasted. The emulsion cost .02 cents per tree.

In these experiments the emulsion was used at various strengths, varying from one part of the emulsion to four parts of water to one part of the emulsion to twelve parts of water. These experiments were duplicated with the 1 to 4 and 1 to 6 emulsions. Only one application of the emulsion was made in each case.

Results of Winter Treatment.—As previously mentioned, most of the scale insects in the orchard at Hector were killed apparently by the cold weather during the winter of 1894–5, hence we were unable to follow the effects of the treatment to the end of the season. Soon after the emulsion was applied, however, there was a decided change in the appearance of the scales on some of the sprayed trees, the young scales soon turned to a light yellowish brown color, shrivelled up and dropped off very easily. This condition was most apparent on trees sprayed with the emulsion diluted with four or six parts of water. After examining the trees early in December, we estimated that about 90 per cent of the scales were killed by the emulsion diluted with from four to six parts of water. Some of the scales on trees sprayed with the weaker emulsions showed the same effects to a slight degree.

At Geneva a better opportunity to observe the effects of the treatment was given. But very few of the scales on trees in the section of the orchard where the spraying was done were killed by the cold weather. The results of the treatment in this orchard may be briefly summed up as follows: The trees were observed several times during the spring and summer. The last observation was made September 10. At this time the check trees (trees not sprayed) were blackened and unsightly. The young scales were abundant on the leaves. Trees sprayed with the emulsion diluted with four parts of water, and those sprayed with the emulsion diluted with six parts of water were to all appearance practically free from the scale. In only two or three cases were any traces of the scale found on the sprayed trees, and these were very slight, while the check trees remained fully as badly infested as the season previous.

Spring Treatment. — A number of infested plum trees in the orchard at Hector were sprayed in May, about the time that the scales began their rapid growth. The emulsion was at first used very weak, but it was soon evident that it had little or no effect. The time required for application and the cost of the emulsion were not figured in these experiments or the others which follow.

Experiment No. 1.—May 23, 24 trees were sprayed with kerosene emulsion diluted with fifteen parts of water.

Experiment No. 2.—May 23, 35 trees were sprayed with kerosene emulsion diluted with nine parts of water.

Results.—Most of the scales in this orchard were dead at this time, evidently from the effects of the severe winter weather and the cold winds from the lake, and hence, although these trees were comparatively well sheltered, but comparatively few living scales were found upon them. As was expected, however, the weaker emulsion had no apparent effect, and very slight if any effects could be detected on trees sprayed with the stronger emulsion, excepting occasionally where the scales had made but very little growth.

Summer Treatment. — As previously stated the young scales emerge during the latter part of June or early in July. For a short time they move about upon the limbs and twigs. Naturally these young scales are more susceptible to the action of the kerosene emulsion at this time than during the winter. But the eggs continue to hatch for nearly a month, making several applications of the emulsion necessary in order to insure thoroughness in the work. The foliage also interferes with the thorough drenching of the limbs and twigs. However, a number of infested plum trees in an orchard at Geneva were sprayed early in July, as follows:

Experiment No. 1.— July 3 (1895), 16 trees were sprayed with kerosene emulsion, diluted with six parts of water.

Experiment No. 2.— Resin wash. In the same orchard 16 trees were sprayed July 3 with rosin wash, made after the following formula:

Resin	20	pounds.
Caustic soda (78 per cent.)	5	pounds.
Fish oil	2½	pounds.
Water to make	100	gallons.

Directions for making this wash are given by Mr. Marlatt, Farmers' Bulletin, No. 19, U. S. Dept., Agr. p. 13, as follows: "Place these substances with the oil in a kettle with water to cover them to a depth of three or four inches. Boil for one or two hours, making occasional additions of water, or until the compound resembles very strong black coffee. Dilute to one-third the final bulk with hot water, or with cold water added slowly over the fire, making a stock mixture to be diluted to the full amount as used. When sprayed the mixture should be perfectly fluid, without sediment, and should any appear in the stock mixture reheating should be resorted to."

Results.— September 10, all of the trees sprayed in the above two experiments were carefully examined. About 80 per cent. of the scales had been killed on trees sprayed with either kerosene emulsion or resin wash. The failure to kill all of them was undoubtedly due to the fact that most of the scales were on the under sides of the leaves and hence it was very difficult to reach them with the spray.

CONCLUSIONS AND RECOMMENDATIONS CONCERNING REMEDIES.

Kerosene emulsion is the cheapest and most practical insecticide for the New York Plum Lecanium.

All things considered, the best time to spray is during the winter.

Spray thoroughly, drenching the trees from the tops to the ground. Make a special effort to thoroughly wet the under sides of every branch.

While in the above experiments one application of the emulsion was sufficient to indicate the effects of the spray, fruit growers have found that at least two applications, and in some cases three, are necessary to insure thoroughness.

For winter treatment do not use the emulsion weaker than one part of the emulsion to four or six parts of water.

If there are still some live scales left on the trees in the spring, do not spray until the young scales begin to come forth, about July 1st, then spray at once with kerosene emulsion diluted with not more than nine parts of water.

Do not try to use a power sprayer. A hand force pump attached to a tank or barrel, so arranged as to be easily carted through the orchard, will be found more satisfactory. Use a nozzel that will apply the mixture in a very fine spray, such as that produced by the Vermorel or McGowen.

VII. Preliminary Reports of Experiments with the Potato Flea Beetle.

Although more than one species of flea beetle is known to attack the potato, the one that is best known on Long Island among potato growers, and has come to be called *the* potato flea beetle, is the common little black species, *Crepidodera cucumeris.*

This little insect has come to be a serious pest to potato growers in the locality above mentioned. During dry seasons they are usually very abundant, not infrequently coming in such numbers as to seriously cripple the potato vines before the tubers reach maturity. Although feeding upon a great variety of plants, this insect is pre-eminently a potato and tomato pest on Long Island.

Last year the beetles were abundant in the vicinity of Jamaica until the middle of June. From that time on they became less numerous for several weeks, although the year before they had been very abundant throughout the season.

The beetles injure the plants by eating small holes in the leaves, which finally causes the leaves to wither and die. They feed from both the upper and under surfaces, hence in applying insecticides for them care should be taken to cover both surfaces.

Early in the season a field of potatoes at Bay Side, Long Island, was engaged for the purpose of conducting a series of experiments with remedies for the flea beetle. It was the original intention to continue these experiments throughout the season. The work was only just begun, however, when the beetles became so scarce that the effects of the treatment were not apparent.

The field was divided into eight plots and treated as follows. There was not time to make more than one application of the insecticides before wet weather commenced and the beetles became comparatively scarce:

Plot I, containing five rows,* was sprayed with Paris green

---

* Each row was about ten rods long.

PLATE VII.—Potato leaves showing holes made by flea beetles. (See page 596.)

mixed with water, at the rate of one pound of the poison to 150 gallons of water.*

Plot II, containing four and one-half rows, was sprayed with Paris green and water, in the same proportion as in Plot I, but to which whale oil soap had been added at the rate of one pound of the soap to four gallons of the mixture.

Plot III, consisting of two and one-half rows, was sprayed with extract of pyrethrum at a strength of two and one-half ounces of the extract to four gallons of water.

Plot IV, consisting of five rows, was sprayed with whale oil soap and water, the soap being used at a strength of one pound of the soap to four gallons of water.

Plot V, consisting of five rows, was sprayed with whale oil soap and water, at the proportion used in Plot IV, but to which had been added extract of pyrethrum at the rate of two and one-half ounces of the extract to four gallons of the solution.

Plot VI, consisting of five rows, was sprayed with one per cent. solution of Lysol.

Plot VII, consisting of two rows, was sprayed with tobacco decoction, the tobacco being used at the rate of one pound of the tobacco to four gallons of water.

Plot VIII. This plot included about three acres, and was sprayed with Bordeaux mixture, to which whale oil soap had been added at the rate of one pound of soap to four gallons of the mixture.

All of the plots, excepting Plot VIII, were sprayed between June 10 and 19. Plot VIII was sprayed a few days later.

A knapsack sprayer was used in all cases, excepting Plot VIII, which was sprayed with a power sprayer.

Owing to the scarcity of the beetles the experiments were discontinued before final results could be obtained.

* In each case where Paris green was used the usual amount of lime was added to prevent burning.

PART II.

BY F. A. SIRRINE, M. S.

OUTLINE.

I. Notes of the Season.

The season of 1895, as compared with 1894, has been marked by a decided increase in the amount of damage done by certain groups of insects; also, by a decrease in amount of damage caused by other groups, and by the uniformity in the amount of damage done by still others.

There was a marked decrease in the amount of damage done by the "Cabbage-Root Maggot," the "Cabbage Louse," and the "Corn or Boll Worm." The amount of damage done by the "Colorado Potato Beetle," and the "European Cabbage Worm," will average well with the amount done last year. Although the number of cabbage-worm butterflies was not conspicuous in the early part of the season they increased rapidly throughout the summer and caused the usual amount of damage to late cabbage.

Cut-worms.—One of the first pests of the season to cause an incalculable amount of damage was the cut-worm. Complaints of damage done by them were universal in the southeast section of the State.

From the reports given at the meeting of Economic Entomologists at Springfield, Mass., during the first of September, it is evident that they occurred in destructive numbers in all the Northern States as well as in the State of New York. They also occurred in destructive numbers as far south as Kentucky.

From the cultural methods followed in the gardening districts near New York city it was a mystery how the cut-worms had found feeding grounds during the previous fall, especially favorable feeding grounds to have survived in such destructive numbers. Several localities were visited to determine as far as possible these conditions. In the onion growing sections of Orange county it was found that the fields are usually divided into long narrow plats by ditches which answer either for drainage or for irrigation purposes. The ditches, not sodded, are allowed to support weeds and various kinds of wild grasses. It was evident from the manner in which the cut-worms had invaded the plats that the moths had deposited their eggs the previous fall along the ditches and that the worms had found food here during the fall and early spring. As soon as the onions were fairly up the cut-worms left the ditches and migrated to the adjoining plats. In some instances only an irregular patch of onions through the center of a plat would be left. The remainder of the plat being as clean as though gone over with the hoe the previous day. Some of the onion growers saved part of their crop by cutting ditches ahead of the advancing horde of cut-worms and keeping the ditches filled with water.

Probably the species that did the most damage to onions was *Carneades messoria*. It was also quite destructive to potatoes.

The "Glassy Cut-worm" (*Hadena devastatrix*) did considerable damage in asparagus fields. No other food plant was necessary for the survival of this species in asparagus fields.

In most localities on Long Island I usually found *Muhlenbergia*, or "Drop Seed," and *Agropyrum* or "Couch Grass." From the fact that both these grasses form under-ground stems, they are called "Root" or "Joint Grasses," by many of the farmers. These grasses were found in fields which were said to have been in constant cultivation for the past twenty years. In addition to these grasses many of the cultivated fields are overgrown during fall and spring with "Chickweed" (*Stellaria media*). Parsley often furnishes plenty of food for the young worms during the fall and "Shepherds' Purse" or "Pepper Grass," keeps them from starving in the spring. A good many cut-worms have been noticed the past fall feeding on "Chickweed" in squash fields.

These observations help to confirm the value of the old remedy of *absolutely clean cultivation at all seasons of the year*.

Mr. Daniel Vail of Locust Valley, N. Y., tested bisulphide of carbon on cut-worms, using the McGowen Injector. No perceptible headway was made against them by this treatment.

THE PEAR MIDGE.— This pest is apparently well distributed over Long Island. It was found at Flushing, Jamaica, Queens and Locust Valley, N. Y. The infested trees noticed at Locust Valley were principally Lawrence. In the other localities the variety of the pear was not known. Part of the infested trees noticed at Flushing and Queens lost all their fruit during the month of June.

Arrangements were made for some observations on the "Pear Midge" in the pear orchards of Mr. J. R. Cornell and Mr. S. B. Huested at Newburgh and at Blauvelt, N. Y.

Both these gentlemen had used remedies the previous year. Mr. Cornell used kainit at the rate of 1,500 to 2,000 lbs. per acre, Mr. Huested used muriate of potash at the rate of 1,500 lbs. per acre. The orchards were visited April 19th. Traps covering about four square feet of surface, made of cheese cloth were placed under treated and untreated trees, and so arranged that the midges could not escape when issuing from the ground. On April 27th Mr. J. R. Cornell of Newburgh, found such countless numbers of "midges" under all the traps that it was impossible to distinguish any difference between treated and untreated trees.

Very few midges were to be found under any of the traps set in Mr. Heusted's orchard.

May 9th, at the time the pears were beginning to flower, the orchard at Newburgh was visited. None of the adult "midges" could be found at this time, nor did I succeed in finding eggs within the opening, or in the unopened flowers. One peculiar fact noted was that about one-third of the blossoms on Lawrence trees in an old orchard were blighted; the fruit and in many cases the fruit stems were much swollen; the latter usually dwarfed. These blighted flowers were always on the top branches which were the most vigorous. Plenty of the "Midge Maggots" were already at work in these small fruits. On less vigorous branches only the central flower of each cluster was found infested.

In a letter received September 15th, from Mr. S. B. Huested, he says: "The tree of Tyson which was most affected last year had two and one-half barrels of pears on this year. The two Lawrence trees you looked at have only one pear each." The Tyson tree which Mr. Huested refers to was treated with muriate of potash at the rate of about 1,500 pounds per acre. The Lawrence trees referred to were not treated. They were small trees which had been left in a corner of the nursery and not cared for.

Mr. Cornell, of Newburgh, writes that the young Lawrence trees, which were treated with kainit are in excellent condition, with a fair yield of fine fruit. He is confident that the heavy dressing which he gave helped the trees, if it did not reduce the number of the "midges."

Mr. Huested's orchard is located in what is known as the "Red Shale" belt, and, from results obtained by Dr. Smith, of New Jersey Experiment Station, he might be able to prevent the increase of the "midge" in destructive numbers by the application of kainit.

Mr. Cornell's orchard is on a clay soil which has flat broken stone on the surface. If he succeeds in the use of kainit it will be by applying it every year; then he will only reduce the number of the "midges" so that the thinning of the fruit, which they will do, will be a benefit to trees stimulated as the latter will necessarily be by the constant use of the kainit.

Apparently the "midges" were as plentiful in the vicinity of Newburgh this season, as on previous years, but the peculiar fact noted above, as to the way in which they had attacked the blossoms on the most vigorous branches, and the first flower on less vigorous branches, indicate that either the trees were backward in flowering or that the "midges" issued earlier and had mostly disappeared by the time trees pushed forth the flower buds. Whichever may have been the case the result was less injury as a whole for this season, and a fair crop.

PLANT LICE. — The scarcity of the "Cabbage louse" (*Aphis brassicæ*) on Long Island the past season has been very marked. It was noticed in small numbers in two localities, viz., Hicksville and Cutchogue. On the other hand, the "Green fly" (*Rhopalosiphum dianthi*) has occurred in destructive numbers on turnips, in a few cases on cabbage, and especially on kale. During the last half of October and the first half of November this Aphid was attacked by a fungus growth, *Empusa aphidis*, which destroyed at least 80 per cent. of them. Their destruction by this disease did not prove of much benefit to the growers of kale. The leaves were already more or less wilted, besides the dead plant lice were so firmly attached to the surface of the leaf by the fungus threads that it was impossible to jar or wash them off. The appearance of these dead lice injured the sale of the kale more than the live ones did, as part of the latter could be gotten rid of by jarring and washing. One farmer said if he succeeded in selling a little kale to customers he could not sell to them a second time.

The "Apple louse" (*Aphis mali*) has occurred in injurious numbers on apple, quince, hawthorn and spireas. Messrs. Keene & Foulk, of Flushing, treated part of their apple stock with whale oil soap, one pound dissolved in four gallons of water. This was applied by simply dipping the ends of the branches into a bucket full of the liquid. The effect of the treatment was most marked at the close of the growing season. The average growth of the untreated stock was one foot with nearly all the leaves curled.

The treated stock made an average growth of from two to three feet, with only a few curled leaves at the base of the new growth.

The latter part of June a "Green Plant louse" (*Siphonophora* Sp.?) was noticed in large numbers on "Pigweed" (*Chenopodium album*). On July 8th the same louse was noticed on potatoes and tomatoes. By July 15th they had increased in such numbers that complaints of their injury commenced to come in. The latter part of July they were found feeding on cucumber and squash vines, and on "Shepherd's Purse" or "Pepper Grass." I mistrust that this Aphid will prove to be identical with the "Rose Aphis" (*Siphonophora rosæ*). Emulsions made of crude petroleum, also of the light and heavy oils of crude petroleum, diluted with sixteen parts water to one part of the emulsion, were tested on this Aphid on tomato plants. About 75 per cent. of the Aphids were killed and all the plants were injured.

Besides the "Green fly" (*Rhopalosiphum dianthi*) two other species of plant lice are quite common and do considerable damage in neglected green houses. (The "Green fly" usually infests the carnations.) The "Dark-brown Chrysanthum fly" (*Siphonophora Artimesia?* BUCKTON) occurs on "Wormwood" or "Mugwort" (*Artimesia vulgaris*) in the fields and migrates from this to the chrysanthemums before the latter are taken into the greenhouse. In the field they usually feed on the under side of the leaves, thus are not noticed. About the time the chrysanthemums begin to open their flower buds the flies move to the flower stalk, at which time they are very conspicuous as well as injurious.

Another species, *Siphonophora circumflexa*, attacks calla lilies, Cyclamens, "Dusty Miller" (*Senecio cineraria*) and Spiraxis. It caused the most noticeble injury to the flower of the calla; an injury for which there is less excuse than for the injury done by any other plant louse known to infest greenhouses. The calla is an easy plant to wash before the flowers open; all parts of the plant can be reached by any method by which the washes are applied. Hence it is carelessness to allow this pest to increase until the flowers are open. As soon as the flowers open the plant lice crowd into them and in a short time make them filthy. A soot-like mould soon begins to grow on the flowers where these pests work.

SEED-STALK WEEVIL. A seed-stalk weevil of kale, cabbage and turnip did considerable damage to the above named plants in the seed-growing section of the island, especially at Cutchogue. This probably is identical with the species mentioned by Mr. Slingerland in a bulletin on "Cabbage-Root Maggot." Specimens were reared from all three of the above mentioned plants and sent to Dr. William G. Dietz, who kindly determined them for me. He says they are identical with the species which he has described as *Ceutorhynchus sericsetosus* in his forth-coming revision of North American *Ceutorhynchini*. I could find no trace of them at the west end of the island although they were searched for in "Shepherd's Purse" and mustard. An effort was made during the month of August to determine their habits throughout the fall and winter. Only a few specimens were found on the ground in the old kale fields and these died in confinement, although furnished with live cabbage plants.

During the latter part of August the "Tomato Worm" (*Phlegethontius celeus*) entirely stripped the tomato vines in many places in Queens county. They were so severely attacked by parasites (*Apanteles congregatus*) that it is safe to say that not over ten per cent. of this brood reached maturity. A search of over two hours in a field for healthy worms proved a failure. A few which did not show signs of being parasitized were taken to the laboratory, but they succumbed to parasites in a few days.

Some complaints of injury to currants by the "Imported Currant Saw fly" were received. They were quite abundant the latter part of May and where neglected, which was often the case, the currants were stripped of every particle of foliage.

II. Notes on Remedies for the Pernicious and Other Scale Insects.

(*a*) Pernicious Scale.

A brief review of the history of the introduction, distribution and spread of the "Pernicious Scale" has been given in Bulletin No. 87 of this Station.

Although it has not been entirely exterminated from nurseries on Long Island it is fairly well under control. At the close of the season of 1896 we hope to be able to report that it has been exterminated not only in all the Long Island nurseries, but also that it is in a fair way to be exterminated in private yards and orchards to which it has been distributed by these nurseries. At that time a complete review of the history, distribution and habits of the pest in this section may be valuable. For the present a summary of the remedies and measures used with notes made on the same may be of some practical use for future work.

No newly infested nurseries have been located the past year, but the pest has been traced to nearly all parts of the Island. In all cases where it has been found, the infested trees were obtained either from the infested Long Island, or the New Jersey nurseries.

Winter Washes.— On December 21, 1894, the following washes were applied to three and four year old pear trees in the nursery of Keene & Foulk, Flushing, N. Y.:

	Trees.
(*a*) Kerosene emulsion diluted with two parts water	60
(*b*) Kerosene emulsion diluted with three parts water	38
(*c*) Winter resin wash	35
(*d*) Lime-sulphur-salt wash	21
(*e*) Crude potash, saturated solution	28
(*f*) Fish oil soap, two pounds dissolved in one gallon of water	8

At the time the above washes were applied the twigs contained frost. All the washes had to be applied warm, even hot in the case of the lime-sulphur-salt and soap washes. The former crystalized as it came in contact with the twigs and the formation of hair-like crystals in the spraying nozzle interfered with its application. The soap solution hardened when it struck the twigs and did not spread well.

A light rain fell December 25th. This was followed by a heavy wet snow and rain December 27th. In a hurried examination of the trees made December 29th traces of all the washes were found on them. On January 15, 1895, sample twigs from trees sprayed with each of the above named washes were examined, a few live scale insects were found under margins of buds and at tips of twigs from trees which had been sprayed with the lime-sulphur-salt wash. Plenty of live specimens were found on twigs from trees treated with fish oil soap. No live specimens were found on twigs from trees treated with the two strengths of kerosene emulsion, with the winter resin wash, or with the crude potash wash. Part of the failure of the lime-sulphur-salt wash must be attributed to the difficulty of application. The same is true of the soap wash. The latter was probably removed by the rain before it softened enough to act upon the scale of the insect.

Between the 15th of February and the 15th of March, Messrs. Keene & Foulk sprayed about 30,000 three and four year old apple and pear trees with kerosene emulsion, diluted with three parts water. Two applications were made at intervals of about two weeks. They also sprayed twice about 15,000 one year old apple trees, and resprayed with kerosene emulsion (1 to 3) all of the pear trees sprayed December 21.

From the 1st to the 15th of April, several days were spent in careful inspection of stock in Parsons & Sons' nursery of Flushing, who up to that date had not treated any of their stock. During this inspection it was found that 90 per cent., if not more, of the "Pernicious Scales" not protected by buds or the rough bark were dead. On such plants as flowering quince (*Pyrus japonica*), where the branches rested on the ground, or where dirt had been plowed to the trees the previous fall, plenty of live specimens were found. Possibly 50 per cent. of the dead specimens should be deducted for old scales under which the adult insects had died after depositing the last brood of the season.

The above conditions show that no approximate estimate of the per cent. of pernicious-scale insects killed by the washes tested in the nursery of Keene & Foulk could be made.

During the spring shipping season all the infested stock in Keene & Foulk's nursery was destroyed, and all suspected stock sold, whether washed during the winter or not, was put through the "gas box" (See Gas Treatment.) A good share of the pear trees washed during December was destroyed. On all the latter that were saved, as well as on other stock treated twice with kerosene emulsion, a good many live specimens were found in July. In most cases they appeared to have issued from adults which were fairly well protected around the union of the branches with the trunk of the tree. In other cases the adults were protected by dirt at the base of the tree; this was especially the case with the one year old stock. Undoubtedly some of the scale insects would have escaped the action of the washes as well as the climatic effects at these points.

All the one year old stock was injured to such an extent by the kerosene emulsion that it had to be cut back. In some cases the branches of older stock were injured.

Summer Washes.—Of summer washes only kerosene and crude petroleum emulsions were tested. For the "Pernicious Scale" these washes were tested on one of the most difficult plants to treat that could be found in a nursery, viz., *Pyrus japonica.* Two rows, each about ten rods long, of one year old plants, were treated. Many of the branches were prostrate on the ground and partially covered by dirt in cultivation. This stock was in Parsons & Sons' nursery of Flushing, N. Y., and had received no previous treatment. The washes were applied during the time that the first brood of females was migrating from beneath the mother scale, viz., from June 21st to July 22d. The dates of application of crude petroleum emulsion and the strengths used at each application were as follows: June 21st, 1 to 12; July 1st, 1 to 10; July 15th, 1 to 11. Kerosene emulsion was applied on the following dates: July 2d, 12th and 22d. Only one strength was used — 1 part emulsion to 10 parts water.

As the principal object in using these washes was to determine which would destroy the largest number of the young during the period that they were migrating, the date of application was varied. A secondary object was to test the crude petroleum emulsion on the parent scales. There was a chance that the heavy oils of crude petroleum, which form a gummy emulsion, would either smother the parent scale or prevent the escape of the young from them.

For this reason the petroleum emulsion was applied as soon as the migration commenced.

The final results were as follows: The plants treated with the crude petroleum emulsion had very few leaves left on them. Probably 80 per cent. of all the young scales which issued during the period of treatment were killed. The plants treated with kerosene emulsion retained nearly all their leaves. They were also well supplied with live young "Pernicious Scales." Possibly 50 per cent. were killed. Approximately all the exposed young were killed by both emulsions at each application. The young which issued between the intervals of application of the washes and became partially protected with the forming scale were rarely affected by the kerosene emulsion, while with the petroleum emulsion many of the partially protected young were killed. Although on the morning of July 2d, hardly a living young scale could be found crawling on the plants sprayed with crude petroleum emulsion the previous day, the afternoon of the day following nearly as many could be seen as before treatment.

The exact date at which the first brood of females ceased to issue from beneath the parent scales can not be given. Winged males for the second brood were found August 16th.

Linseed-oil and Whale-oil Soap.— Between the first and fifteenth of August, Mr. Foulk trimmed about one hundred each of one and two year old apple and peach trees and had the dirt removed from their crowns. Half of each of these he washed, from the branches to the exposed roots, with whale-oil soap, using two pounds of soap to a gallon of water. The remaining 50 of each he painted with raw linseed oil.

These trees were thoroughly inspected August 21. With the exception of a few young which had migrated from the untreated branches unto the body where the whale-oil soap had been removed by rain, not a living specimen could be found. At that time no injury to any of the trees was noticeable.

As the linseed oil could be applied thoroughly more readily than the whale-oil soap* solution, Mr. Foulk proceeded to trim, remove

* Whale-oil soap solution lathers to such an extent that it is difficult for workmen to tell how thoroughly they are applying it. Linseed oil not only spreads nicely but it remains on the trees longer, besides every spot missed with the brush shows distinctly. It also shows distinctly where the tree is infested as the discoloration of the bark caused by the live scale is brought out.

dirt from crown, and paint all his infested one year old peach trees, between 3,000 and 4,000, with linseed oil.

This stock was all budded and apparently the "Pernicious Scales" had been on the buds used. This necessitated the removal of the dirt from the crown. The plan was to wash the body and crown of the trees while the dirt could be easily removed and while other work did not interfere, then wash the tops after the leaves had fallen.

About ten days after the peach trees were treated with the linseed oil the leaves commenced to turn yellow. By November 1st a good many of the trees were dead and all were injured to such an extent that they were worthless, and all were destroyed.

One peculiar fact noted was that the peach trees treated first as a trial were not injured to such an extent as those treated ten days later. Whether this difference was due to a difference in the oil, or whether there was a difference in temperature which may have caused a large portion of the oil applied to the first lot of trees to run from them is not known.

No injury resulted to any of the apple trees treated, possibly if the oil had been applied to the twigs it would have injured them as readily as the kerosene emulsion did during the winter.

During the first half of November Mr. Foulk cut back between 10,000 and 12,000 two year old apple and plum trees and removed dirt from collars. These he had washed with whale-oil soap solution, two pounds to one gallon of water. When inspected November 15th, it was found that the cold weather together with the frothiness of the solution had interfered with the thorough application of the wash. As a result some of the "Pernicious Scales" had escaped. All of these trees were re-washed, care being taken to keep the wash hot for the workmen.

Gas Treatment.—Before the spring shipping season opened Mr. Foulk of the firm of Keene & Foulk made two fumigating boxes for the purpose of treating with hydrocyanic acid gas all suspected stock sold. These boxes were 13 x 3 x 3 feet made of flooring and without a cover. White lead was used for filling the mortises and putty for the larger joints. The outside of the boxes was entirely covered with oiled muslin and the latter given two coats of paint. Each box cost about ($10) ten dollars.

The same amount of chemicals was used to each box of trees as recommended for treating scale insects on citrus trees in California, viz., 1 ounce of fused cyanide of potassium, 1 fluid ounce of commercial sulphuric acid and 3 fluid ounces of water for 150 cubic feet of space. As each box only contains 117 cubic feet, the amount of gas used in each box was a trifle more than recommended.

About 75 apple trees that had been treated with the gas were heeled in and retained for the purpose of noting effect of gas on trees and scale insects. They were examined on four separate occasions between the first of May and September.

When inspected in June a single live scale insect was found which proved to be a male. No injury to the trees was noticeable. In one case where gas treated stock was sent out a pear tree was found in August, to be infested. This tree with a number oi other pears was sold to the purchaser with a plum (*Prunus simonii*). The latter was badly infested with the "Pernicious Scale" and had been overlooked the previous fall when the stock was inspected. Of course the plum tree was brought in contract with the pears when delivered, but at that season the "Pernicious Scale" is supposed to be dormant. There is also a chance that the owner transferred the insects later in the season by handling the trees.

During the first half of October all of Keene & Foulk's stock was re-inspected. All infested stock required for fall and spring trade was stripped of its leaves, taken up, put through the gas boxes and heeled in. Double the amount of gas used during the spring was used for each box. It was found that where double the amount of potassium cyanide was used part of it was not acted upon by the sulphuric acid, hence the following proportions were used: Potassium cyanide 2 ounces, sulphuric acid 3 ounces and water 8 ounces. About two weeks after the stock was treated a live young "Pernicious Scale" was found crawling on some currant bushes that had been treated with the other stock. On investigation it was found that the workmen had placed these currants on top of a box full of trees and when the box was inverted no cleats were placed on the ground for the trees and currants to rest upon. As a result the weight of the trees forced the currants into the loose soil. Hence there is a chance that the failure in this case was due to the fact that the gas did not reach all the insects on the currants. What the effect of the gas will be used double ordinary strength on the trees, can not be determined until next year.

The gas treatment was tested during March, 1894, by the United States Division of Entomology at Charlotteville, Va., on trees in orchard. A tent was used in this test, and the same amount of gas used as recommended for citrus trees. This treatment was not a perfect success.

It is reported that Lovett & Co., of Little Silver, N. J., have used boxes for fumigating with hydrocyanic acid gas all the stock infested which they have sent out the past eighteen months. It was my privilege to watch throughout the summer a lot of apple trees which were purchased from Lovett & Co., April, 1895, by Mr. C. W. Ward, of Queens, N. Y. This stock was supposed to have been treated with gas, as it was evidently infested with the "Pernicious Scale." At the time the first brood of the "Pernicious Scale" commenced to appear the above stock was carefully inspected and not a tree was found that did not have young specimens crawling over them.

Although some results indicate that the gas treatment is not a complete success, in most cases the failures can be traced to something which has interfered with its thorough application. Any remedy will prove a failure when tested on the "Pernicious Scale," unless care is taken to make the treatment thorough. Even whale-oil soap will prove a failure in nursery unless dirt is removed from base of the tree and the wash thoroughly applied to all parts.

From the amount of stock which I have had the privilege of inspecting, after treatment with gas and with whale oil soap, I think it is safe to assert that, all things considered, the gas treatment is the cheapest remedy for nurserymen who handle and ship fruit trees in large quantities, and will be as effective as any remedy under ordinary conditions of application.

How to Use the Fumigating Boxes.—Figure 2, Plate I, shows a box filled with trees, inverted and banked with dirt ready to have the gas generators inserted. One generator will answer but two are better. An ordinary glass fruit jar makes a good generator. The fused potassium cyanide should be weighed and put into packages containing the proper amount required for each generator, so that all the workmen will have to do will be to empty the package into the generator after having placed it under the box. He should be provided with two measures, one for the acid and one for water. The acid and water should be put into the generator before the latter is placed under the box. As soon as the potassium cyanide is dropped into the generator the hole under the box should be closed with a short piece of board and banked with dirt. It is best to run the generators during cloudy days, or during early morning and late in the afternoon. The gas should be allowed to act for one hour.

Dipping Stock.—As Parsons & Sons Nursery Co., follow the plan practiced by some nurserymen of digging their stock only as needed to fill orders, some plan, which would be as cheap and more convenient for small lots of trees than the gas treatment, had to be devised. Dipping the trees in a solution of whale-oil soap appeared feasible and harmless to the trees. For this purpose the tank shown at Plate II, was made. This nursery haul their stock to one packing house to pack, hence it was an easy matter to dip the stock before packing and the principal cost by this method of treatment was the tank and soap. The tank was made of galvanized iron and cost $9.00. It is approximately 8 x 2 x 1 feet, and will hold a trifle over 94 gallons. It was found more convenient to only use from 60 to 70 gallons of the mixture at a time. Whale oil soap costs 6½ cents per pound in half barrel (200 lb.) quantities in New York city.

C. L. Marlett * in his report on "Experiments with winter washes against the San Jose scale" says: "Whale-oil soap washes, even at three pounds to the gallon are thin enough when cool to be sprayed without difficulty and no trouble whatever was experienced with one and one-half and two pounds to the gallon."

There must be a difference in the whale-oil soap manufactured by different firms. It was found that two pounds of the soap, obtained in New York city, added to a gallon of water had to be kept at a temperature of about eighty degrees to work well, and, if allowed to cool below sixty degrees it formed a very thick soft soap. It had to be scooped out of the tank into a kettle each morning and remelted, after which it was kept warm by placing an ordinary oil stove under the tank.

Parsons & Sons Nursery Company have only used this tank since November 10th, and none of the treated stock has been inspected. From the tests made of whale oil soap by the United States Division of Entomology near Riverside, Maryland; also, from those made during the fall in the nursery of Keene & Foulk at Flushing, it is

* Insect Life, Vol. VII, p. 368.

quite evident that a whale-oil soap solution made by dissolving two pounds of the soap in a gallon of water, will kill all the "Pernicious Scale" insects, if thoroughly applied, and not injure the trees. Hence, failure by the process of dipping must be the result of careless work.

(b) OTHER SCALE INSECTS.

As soon as there was the least evidence of the eggs of the Oyster-shell Bark-louse hatching, a number of poplar trees in nursery of Keene & Foulk were washed with the following substances: Linseed oil, whale-oil soap, 2 pounds to 1 gallon of water; and kerosene emulsion 1 part to 4 parts of water. These washes were applied each to an equal number of the trees May 28th.

Examination of the trees July 8th showed the following results: Very few live specimens on trees treated with linseed oil; about twice as many alive on trees washed with whale-oil soap; while on trees treated with kerosene emulsion they were so numerous no estimate could be made. Portions of the bark on these trees were rough; this would account for the escape of a few of the pests where only one application was made. No injury resulted to any of these trees.

A number of poplar trees which had not been previously treated and on which the young were issuing from beneath the old scales, were sprayed June 6th with crude petroleum emulsion diluted with 20 parts water. A number of other trees were sprayed the same day with crude carbolic acid (95 per cent.), 1 part to 100 parts water.

June 7th, dead specimens were found on all the trees sprayed June 6th, but the young were still issuing from beneath the old scales in countless numbers; hence no estimate of the number killed of those treated could be made. After this last test Keene & Foulk had all their poplar trees washed with the strong whale-oil soap solution. Only the bark lice not reached with the wash escaped.

The value of a series of applications of crude petroleum and kerosene emulsions was tested on *Euonymus latifolius* and *Euonymus europæus* against the "Enonymus Scale" (*Chionaspis euonymi*) in nursery of Parsons & Sons, of Flushing. Both emulsions were diluted with ten parts water and applied on the following dates: Crude petroleum emulsion, 1 to 10, 20 plants, June 21st, July 1st and 22d. Kerosene emulsion, 1 to 10, 15 plants, July 1st, 12th and 22d.

It was found after the second application had been made that a few male, but no female scales were alive on the plants treated with the crude petroleum emulsion; while on those treated with kerosene emulsion enough live male scales remained to give the impression that not over 50 per cent. had been killed. The females were not so plentiful. A third application of both washes was made to make the test as complete as possible.

Whether the male specimens issued from beneath the parent scale after the second application, or are not as easily affected as the female scales, is a question. The foliage was slightly injured by the crude petroleum emulsion, but the plants retained the injured leaves throughout the summer. When examined the latter part of August no living specimens could be found on plants sprayed with the crude petroleum emulsion. A good many of both males and females had escaped the action of the kerosene emulsion.

The above results show that the "Enonymus Scale" can be controlled, and, if the work is thoroughly done can be exterminated by three successive applications of crude petroleum emulsion. The first application should be made about June 20th and the last July 20th. If the spraying should be left until July 20th and only one application made, many of the young would be so well protected by their scale they would not be destroyed. They could probably be controlled by the use of kerosene emulsion, but four applications of this between the 20th of June and July 20th would be required, as it would not do to allow the young to become protected in the least by a scale.

The Oyster-shell Bark-louse can be controlled by the same washes, but the treatment should be commenced about 15 days earlier. The latter can be easily treated to advantage on some kinds of trees just before the eggs hatch with either linseed oil or whale-oil soap.

(c) SUMMARY.

With the exception of whale-oil soap none of the "winter washes" have proven successful in the tests made by the United States Division of Entomology. It was also proven by these tests that none of the washes were as effective when applied in winter as when applied during the fall. Fairly good results have been obtained at the Florida Experiment Station from the use of "resin wash." In this section of the country winter is not only a disagreeable time to apply the washes but rains are liable to remove them before they have time to act on the dormant scale insects. Hence the only conclusion that can be drawn is, that better results will be obtained by applying "winter washes" during the fall; that "winter washes" applied in the winter are liable to be a waste of time. Also, that the simplest remedy, viz., whale-oil soap, makes the best wash for general use.

In order that any wash may prove a success when applied to nursery stock for the "Pernicious Scale" it is absolutely necessary to remove the dirt from around the crown and apply the wash thoroughly from buds down to the roots. This is especially true for all stock which is budded, grafted or grown from cuttings. Hence for nursery stock the wash must be applied during the fall or early spring. It is recommended that the wash be applied during fall in preference to spring, as the "Pernicious Scale" is active during the fall and more susceptible than during the spring.

It should be remembered that whale-oil soap solution is more difficult to apply than some other washes unless applied during warm weather. By spraying the tops of the tree with a summer wash at intervals of five days during July, possibly whale-oil soap solution could be used to an advantage on the trunk of the trees during the summer.

All things considered, the gas treatment is the simplest and cheapest remedy that many nurserymen can use. As far as tested on nursery stock here on Long Island it has given as good results as any of the other remedies.

For nurserymen who dig their stock only as the orders are filled, probably the dipping of the stock in a solution of whale-oil soap will prove the simplest and cheapest remedy.

The "Oyster-shell Bark-louse" and the "Euonymus Scale" can be controlled by summer washes. If the latter are applied often enough and thoroughly at the right season, viz., from the 1st of June to the 1st of July for the "Oyster-shell Bark-louse," and from the 20th of June to the 20th of July for the "Euonymus Scale," these pests can be exterminated.

Linseed oil is not a safe remedy to use at any season on peach trees, and should be carefully tested on all plants with thin bark before being recommended for general use against scale insects. As far as tested it is the most effective remedy for scale insects during their dormant condition. Mr. Foulk thinks it can be safely applied to apple and pear trees, excepting the young twigs, at any season or stage of growth, and if applied to the old scales during the winter no young will ever issue.

The experience of Keene & Foulk demonstrate that kerosene emulsion, diluted with three parts water, applied even in winter is very unsafe and by no means certain in its results. In the tests made by the United States Division of Entomology only pure kerosene emulsion killed all of the "Pernicious Scales." It also killed the trees.

Poor results from the use of kerosene emulsion often occur, which can be traced to some slight detail in its manufacture, such as too much lime in the soap or in the water used, or to improper emulsifying. Hence the above results are given simply as they occurred and not to condemn kerosene emulsion for all purposes.

Crude petroleum emulsion is more expensive than kerosene emulsion. It will be a more dangerous remedy to use than kerosene emulsion.

(*d*) MISCELLANEOUS NOTES.

From the foregoing report the natural conclusion must be that Messrs. Keene & Foulk of Flushing have made strenuous efforts to rid their stock of the "Pernicious" or "San José Scale." The destroying of their worst infested stock, together with the unfortunate test of linseed oil and kerosene emulsion, has reduced their stock nearly one-half. They are practically free from the pest. It only remains to watch their stock another season in order to be sure that stock grown from cuttings, put out last spring, and the young budded stock has not accidently become infested. They are taking the extra precaution to dip in whale-oil soap solution, all cuttings of ornamental shrubbery which they expect to put out.

Up to November 10th Parsons & Sons Nursery Co., of Flushing, had simply destroyed their worst infested stock. This stock was marked for them. Since November 10th they have been dipping in a solution of whale-oil soap the stock used to fill orders. How thoroughly this work has been done can not be determined until next July, at which time the trees can be examined in private yards and orchards to which it has been distributed.

Boulon of the Sea Cliff Nursery, Sea Cliff, N. Y., has simply destroyed his worst infested stock. This was marked for him.

As the stock destroyed by the two last named nurseries was practically worthless, the principal loss at present to these nurseries has been the expense of removing the stock.

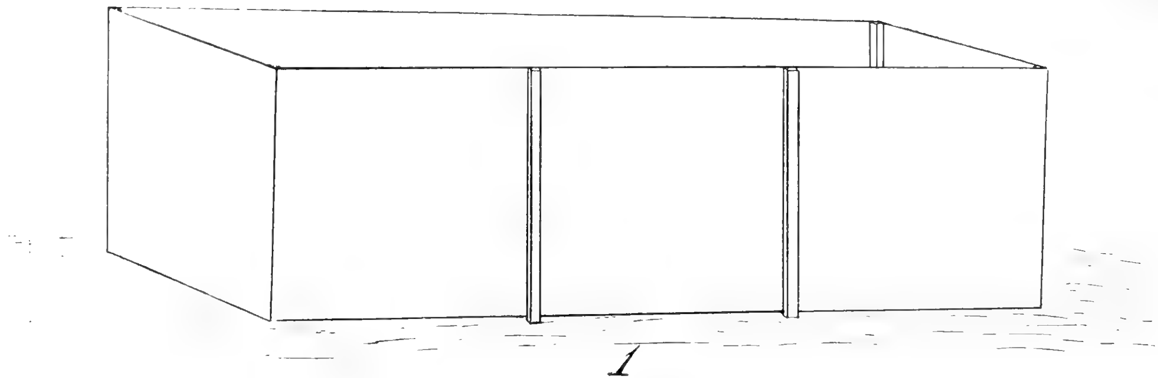
PLATE I.

Box for treating trees with hydrocyanic acid gas. Fig. 1. Box ready to be filled with trees. Fig 2. Box filled, inverted and banked with earth ready to have generator inserted.

PLATE II.

Tank for dipping trees in whale oil soap solution.

(Drawn and photographed by F. A. Sirrine.)



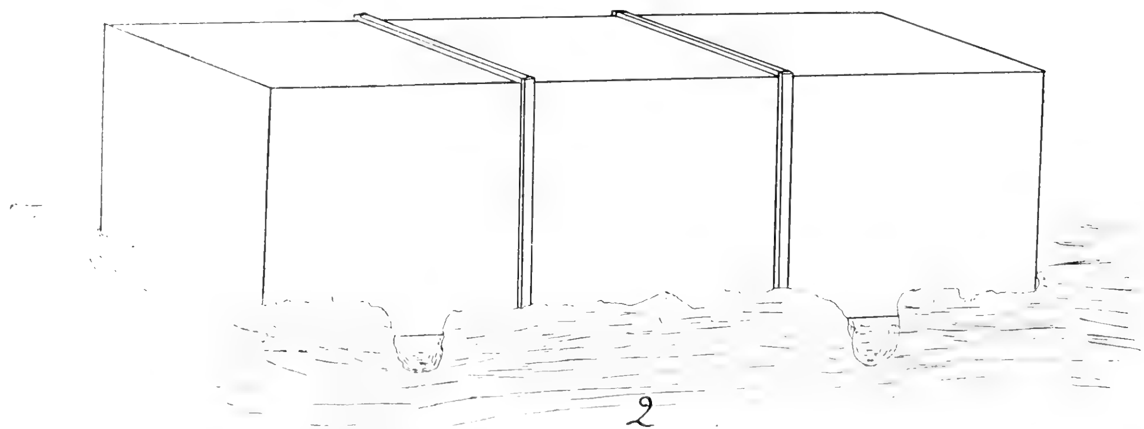


PLATE I.— Bed for treating trees with hydrocyanic acid gas.

FIG. 1. Bed ready to be filled. FIG. 2. Bed filled, inverted and banked with earth ready to have generator inserted.

Plate II. Tank for dipping trees in whale-oil soap solution.

III. The Bramble-Flea Louse.

(*Trioza tripunctata*, Fitch.)

ORDER HEMIPTERA: FAMILY PSYLLIDÆ.

HISTORICAL.— The first notice of the injury caused to blackberry canes by this insect was given by Drs. Walsh and Riley,* in 1869, from material received from Charles Parry, of Cinnaminson, N. J., who reported that it was injuring the cultivated blackberry.

In a paper read before the New Jersey State Horticultural Society, in 1880, A. S. Fuller† stated that this insect was rapidly increasing and doing more damage each year.

Mrs. Mary Treat described, in 1887, in "Injurious Insects of the Farm and Garden," the work of the "Bramble-Flea louse;" but her description is apparently a repetition of that given by A. S. Fuller, and undoubtedly refers to the injury at that date, viz., 1880. Whether it has caused any serious injury since the above date, I can not say; at least I find no record by any of the Station entomologists or horticulturists of injury done by it. It is a peculiar fact that all recorded complaints of injury by it are from New Jersey.

Dr. Riley states that it occurs on pine from Canada to Florida. The blackberry, as will be shown further on, is its principal food plant. Hence it is liable to increase in destructive numbers during almost any series of years which are favorable for it, and every precaution should be taken to prevent its increase.

Soon after commencing work in the Second Judicial Department, I noticed a peculiar curled and deformed condition of the wild blackberry leaves and canes. As, at the time I was not familiar with the species of Psyllidæ of the Atlantic coast, whose method of

---

* American Entomologist, vol. I, p. 225. † American Entomologist, vol. III, p. 62.

work resembled so closely the work on plants of many of the plant lice, I mistook the injury for the work of plant lice. On investigating the trouble, although a few plant lice were found, the cause was found to be the work of an immature form of a species of Psyllidæ.

This insect closely resembles the pear psylla, and will probably do as much damage as the latter in case its native wild food plant ever becomes scarce, or a series of favorable years should occur for such an increase that the wild blackberry would not furnish enough food for it. Even though there is an abundance of wild plants, it will cause some damage each year.

LIFE-HISTORY. — At the time (August 6, 1894) this injury to blackberries was first noticed no adult insects could be found. No pupal forms were found until September 12th. The first winged forms were reared from these September 29th. Specimens of these were submitted to Mr. Charles W. Mally, of Ames, Iowa, who determined them to be *Trioza tripunctata.* After October 15th, only the winged adults could be found within the curled leaves. During the month of October, I had occasion to visit the nurseries of R. P. Jeffery & Son, of Bellmore, N. Y., and of P. H. Foster, of Babylon, N. Y. These gentlemen had cultivated blackberries. Not a new cane could be found in their nurseries which was not distorted and dwarfed by the work of this pest. As yellow pine as well as wild blackberries grew in abundance in the vicinity of these nurseries an effort was made to find evidence of the work of this insect on the pines. There was plenty of evidence of their work on the wild blackberries, but no signs of work or of the insects could be found on the pines. Later in the fall a few adults were still to be found hidden away in the curled dry leaves which adhered to the canes. In an examination of the curled leaves of blackberries on March 11, 1895, I did not succeed in finding any of the adult insects. During the early spring an occasional specimen was found on pine trees.

About the first of June the adults were observed working on the new canes of blackberry, causing the leaves as well as the ends of the canes to curl. On June 28th, a few minute larvæ were found within the curled leaves. At the same time the eggs were found on the canes and leaf petioles near the curled leaves. The females were apparently busy puncturing the canes, as shown in Fig. 4, Plate III, and depositing their eggs. Whether the females feed when they puncture the cane or simply puncture it to irritate and cause it to curl, I can not say.

Because of the lack of breeding facilities the observations were confined to the field. Hence the exact period for the deposition of the eggs, the time required for the latter to hatch, the number of moults and lengths of larval and pupal stages were not determined.

CONCLUSION. — From the observations made the life-history is approximately as follows: The adult females deposit their eggs during the month of June and possibly July, on blackberry. The larvæ do not reach the pupal stage until September, change to adults within a month and hibernate as adults wherever they can find a dry protected place.

From the statements of Dr. Riley, I understand that only the adult forms have been captured on pine trees, where they possibly feed and pair during the spring. Have not observed them on the Dewberry, "Running-vine Blackberry."

DESCRIPTION — The eggs are light yellow in color and will not be found without the aid of a lens. They are deposited on the leaf petioles and on the canes near the curled leaves. These portions of the plants are quite hairy, and the eggs are held by the hairs and not inserted into the epidermis.

As a general rule, only the larval form will be noticed. In the larval stage they are nearly pure white, varying to greenish white, and to the unaided eye resemble some of the "leaf mites" or spiders more than they do plant lice. If they occur in numbers they appear to be covered with a white powdery secretion, which in reality is the excreta. When the larvæ are nearly full grown, or have changed to the purpal stage they are of a pale yellow or yellowish white color.

During the pupal stage they are nearly as broad as long and appear to be nearly circular in outline.

To the unaided eye the most distinctive character of the adult or full-grown insect is the yellowish-brown color of the whole body excepting the eyes, which are dark brown, and the three yellowish-brown bands on the wings, shown in Fig. 4, *b*, Plate III, as black bands.

The injury which the insect causes is more conspicuous than the insect itself; the twisted and distorted ends of the canes bear a cluster of curled leaves, which in summer are of a deeper green than the uninjured leaves and remain attached all winter. New canes, when attacked by a colony of the larvæ, only make an average growth of from 12 to 18 inches in height. In many cases the adults injure a cane but do not establish a colony. In the latter case the cane continues to grow, but has a twisted crook near the base. They often attack the branches of the old canes, in which case their injury is not so marked as it is usually distributed over a larger number of branches.

REMEDIES.— The only remedy that has been recommended is the gathering of the curled leaves, or cutting off the ends of the canes, and burning them. It is also recommended that this should be done early in the morning, or late in the evening, and that the leaves or the severed canes be placed within sacks as gathered. This undoubtedly is the most practical remedy that can be used, providing this cutting of the infected canes is done at the right season of the year. The latter, which is the most essential point, is not given in any of the recommendations, probably from the fact that all the habits of the insect were not known. From the few scattered facts obtained the past year it is evident, that, if the cutting out of the infested canes is done as soon as the leaves show signs of curling, say in June, only about one-half of the adults will be destroyed. They are quite active at this season and are able to fly; furthermore they are not confined to the curled leaves.

If pruned too early a second pruning will be necessary and consequently more of the young canes spoiled. If the pruning is left until the month of August, at which time the adult insects are all through depositing eggs, probably dead, and the larvæ are confined to the curled leaves and ends of the canes, one pruning will be sufficient.

If the pruning is done in August no such precautionary measures as has been recommended with regard to placing in sack and burning will be needed, for the larvæ are unable to travel far. By simply cutting out the infested canes and piling them on an open, or plowed piece of ground the larvæ will all perish by the simple drying of the leaves.

This means of getting rid of the pest does not save the canes and in order to make it thorough all wild blackberries in neglected places should be cut at the same time.

Possibly frequent applications of a weak kerosene emulsion, at the time the curling of the leaves is first noticed, will greatly reduce the amount of injury done to the cultivated berries, for at this time part of the adults as well as many of the eggs are exposed.

PLATE III.

Figs. 1 and 2. Modified camera lucida outline drawings of the pupal and larval forms of the Bramble-Flea louse, which are found under the curled leaves in August. About sixteen times natural size. Drawn from transparent balsam mounts.

Fig. 3. "Waxhairs" from body of larva, greatly magnified. (*a*) The point at which the "waxhairs" break when shed by the pupa. These hairs are arranged in double rows on head and abdomen.

Fig. 4. Photograph of curled branch and leaves of the blackberry, showing three adult specimens of the Bramble-Flea louse at (*b*); about two and one-half times natural size.

(All figures drawn or photographed by F. A. Sirrine.)

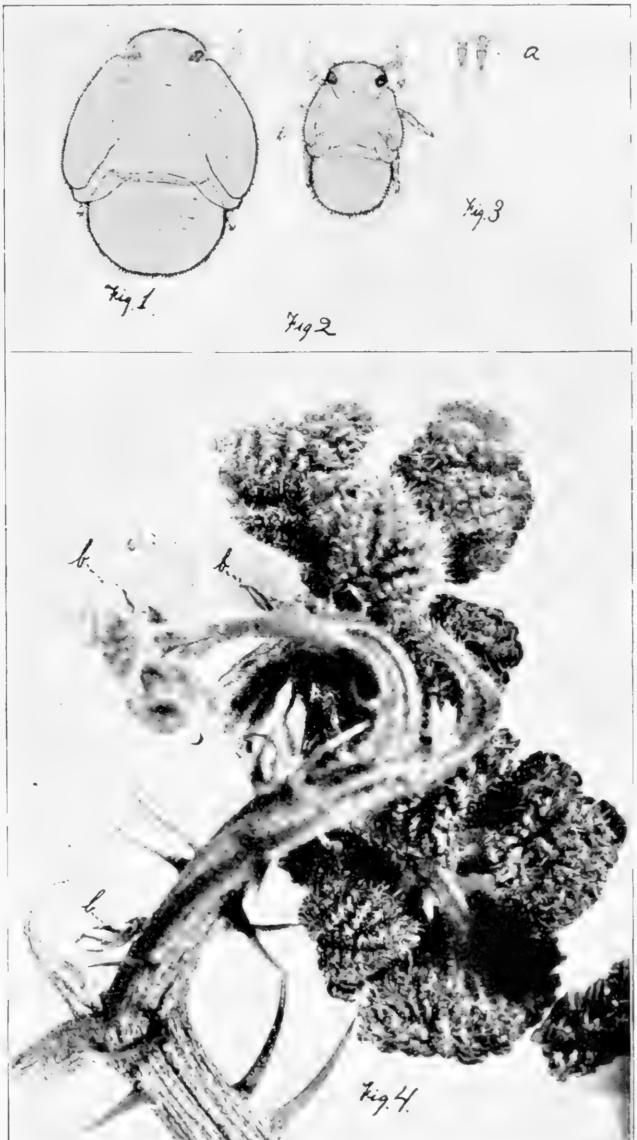


Plate III.

IV. The Spinach-Leaf Maggot, or Miner.

(*Pegomyia vicina*, Lintn.)*

ORDER DIPTERA; FAMILY ANTHOMYIIDÆ.

A small, white maggot which mines the leaves of spinach, beets and "Lamb's quarter," or "Pigweed," causing them to have a blistered appearance. The eggs, which are deposited by an olivaceous, ash-colored fly, are white and are usually to be found on the lower surface of the leaves.

HISTORICAL. — This insect has been called "The Beet leaf Pegomyia" by Professor Howard. As it causes the most marked injury to spinach in this section of the State I take the liberty to call it "The Spinach-leaf Maggot or Miner." It has some near relatives (*Chartophila betarum*, Lint and *Phorbia floccosa*, Meade) which also mine the leaves of beets.

The first record that I am able to find of *Pegomyia vicina's* being known as injurious to beets, as well as the first description of the

---

* Two other species of flies have been reared by Dr. Lintner from maggots found mining the leaves of beet; one of which (Chartophila betarum) was a new species. The other, Phorbia floccosa, Prof Slingerland thinks is identical with the "Cabbage-root Maggot" (Phorbia brassicæ). Whether either of the above species mine the leaves of spinach or Chenopodium I cannot say. Twenty-five specimens were bred from spinach, fifteen from Chenopodium and five from beet leaves, none of which agree with specimens of Phorbia brassicæ bred from roots of cabbage and turnip. Specimens reared from both spinach and Chenopodium were sent to L. O. Howard, of the Division of Entomology, who pronounced them all *Pegomyia vicina*.

There is considerable variation in the size of the flies bred from all three plants, but those bred from *Chenopodium* are all smaller than those reared from the beet and spinach leaves. They vary in color from an olivaceous ash to a very dark ash color. In addition to the characters given by Dr. Lintner, the following are noted: All the males (20 specimens) bred have the anterior femora, excepting the apical third, dark ash to black. Although the variation in the venation of male and female shown in Fig. 5 and 5' is partially due to the angle at which the wings were photographed, there is as much variation in the venation of different specimens of both males and females as figured by Dr. Lintner for the two genera *Chartophila* and *Pegomyia*, but in no case are all the legs black. In all the male specimens the abdomen is darker colored than in the females. (As material reared in breeding jars is liable to be consigned to the "Cyanide bottle" before the integuments are hardened, some variation in color must be allowed for the difference in the density of the integument of different species.)

fly and its maggot was given by Dr. Lintner * in 1882. He noticed it first at Middleburgh, N. Y., mining the leaves of beet. From material collected he reared the two species mentioned above and *Pegomyia vicina*. Of the latter he says: "This species was therefore obtained in larger numbers from the mined beet leaves than either of the other two." During the same year he noticed the work of maggots in beet leaves at Bennington, Vt., and had injury to beet leaves by maggots reported to him from Morrisville, N. Y. In his Second Report † Dr. Lintner quotes from a letter received June 9, 1884, from South Britain, Conn., in which the writer states that an observing farmer of that place had noticed injury to beet leaves by maggots for the past six or eight years, and, that he (the writer) had seen similar larvæ in the leaves of spinach.

During the summer of 1886, injury to beet leaves by maggots was reported from Middletown, Orange county, N. Y.‡

Flies reared in 1890 from maggots feeding in leaves of lambs-quarters (*Chenopodium Album*) at Ames, Iowa, by Prof. Gillette § are possibly identical with the spinach-leaf maggot.

In 1891, sugar-beet leaves were reported as injured, by maggots, at Castorville and Watsonville, California, and some of the infested leaves sent to the Assistant Secretary of Agriculture at Washington, D. C. Mr. Koebele, a government field agent, was sent to investigate the trouble. He obtained a large number of the maggots and reared the flies. These all proved to be Pegomyia vicina; at least Prof. Howard ‖ does not mention that any other species was reared.

Lawrence Bruner ¶ in his report as special agent for 1892, refers to a dipterous larva mining the leaves of *Chenopodium album* and suggests a possibility of its being the same as one of the species of Anthomyia which Dr. Lintner found mining the leaves of the beet. He says, "whether or not this is one of the species of Anthomyia which Lintner found mining the leaves of beet in New York I can not say, but from what I have observed * * * there is danger of all the enemies of the Chenopodaceous plants attacking the beet."

---

* First Annual Report State Entomologist of New York, pp. 181 and 209–211.
† Second Annual Report State Entomologist of New York, p. 46.
‡ Third Annual Report, State Entomologist of New York. p. 85.
§ Insect Life, Vol. II. p. 281: ‖ Insect Life, Vol. VII. pp. 379–381.
¶ Bull. No. 30, Div. of Ent. p. 40.

Prof. Slingerland writes me that in 1893 he bred a Spinach-leaf Miner at Cornell University, which Dr. Williston determined as *Scatophaga sp.*

Although "leaf miners" have been observed on beet, spinach, and in fact on *Chenopodium*, for the past ten years, it is evident from the above gleaned facts that they were not considered of very great economic importance previous to 1882. In fact, their injury to beets was of such a nature as not to attract attention unless the leaves were used for "greens." It is also quite evident that the flies which caused the damage were not widely known.

In the month of August, 1894, I collected near Queens, N. Y., beet leaves infested with a maggot that was new to me. During September, Mr. Backus, of Newton, N. Y., told us that some insect was injuring his spinach. Mr. Lowe visited Mr. Backus' farm, and found an unknown maggot mining the leaves. On September 25th the same trouble was noticed in spinach leaves on the farms of Mr. O'Donnell and Mr. Augustine, near Jamaica, N. Y. In many cases every leaf on all the plants covering small areas would be mined.

Throughout the past summer it has been impossible to find a plant of Lamb's-quarters that did not have some of these maggots in the leaves. During the fall they have attacked the spinach so severely that it was impossible for many of the farmers to sell their spinach after carting it to market. The injury to beets has not been so marked.

LIFE HISTORY.— All the flies reared by Dr. Lintner were obtained during July and August. Mr. Koebele's material was all bred during the month of June. In September, 1892, material was sent from California to Dr. Riley from which the adults issued September 8th. The following year in October more material was forwarded from California to the Division of Entomology at Washington, but no adults were obtained from this.

Spinach and beet plants whose leaves were infested with maggots were transplanted to breeding cages October 25, 1894. All had pupated November 5th. Flies commenced to issue in the cages as early as March 27, 1895, but the majority of them did not issue until about April 16, 1895. This proved that part at least of the flies pass the winter in the puparium. Probably they do not issue as early in the field, at least in this locality. The breeding jars had to be kept in an ordinary living room. Furthermore no larvæ were found in spinach leaves until after the 15th of May, 1895.

Howard * gives from three to four days as the time required for the eggs to hatch, seven to eight days as the larval or maggot stage and twenty days for the puparium or resting stage; thus making the length of the Life-cycle about one month. Specimens of *Pegomyia vicina* bred from the leaves of beet by Prof. Comstock emerged after twenty-days pupation. Dr. Lintner says: "The period of their (the beet leaf miner) pupation was not ascertained." It will probably be found not to vary much from two weeks. Bruner gives ten days as the time required for one specimen which he bred from *Chenopodium* to change from the maggot to the adult. Specimens taken here in leaves of *Chenopodium album* June 7th commenced to issue June 30, 1895.

We can safely assume that the period for a generation of the flies, throughout the summer, as given by Prof. Howard for material which was bred in California is approximately correct for the same species of fly in other sections of the country. Here on Long Island the larvæ or maggots have been found for the two seasons of 1894 and 1895 working on spinach as late as November 20th. They were observed feeding on Chenopodium throughout the entire season of 1895. As previously stated they were noticed mining spinach leaves as early as the middle of May. Thus in this locality they have an abundance of food plants and the season is long enough for them to produce seven broods. Hence we can safely assume that there are six if not seven broods in this section of the State; the last brood passing the winter in the puparium or resting stage. As we have no insectary, or even a green house, where food plants can be grown and the broods separated it was impossible to determine definitely the number of broods.

HABITS.— The adult flies are not very conspicuous. They can be seen by close observation flying near the surface of the ground, hovering around "Pigweed" or crawling over the leaves. The eggs are usually deposited on the lower surface of the leaf and are arranged in twos and threes, sometimes in fours and fives. (See Fig. 1, Plate IV.)

---

* Insect Life Vol. VII, p. 378.

As soon as the young maggot hatches from the egg it buries itself within the leaf tissue. When they first begin to feed they make quite a distinct thread-like "mine" but they soon feed, as Dr. Lintner says: "In a curve of an entire semi-circle." The anterior portion of the body is extensile and allows them to feed in this manner. As soon as they begin to feed in the last-named manner the mine appears as a blistered blotch. The blistered appearance being caused by their devouring the green tissue or parenchyma of the leaf. From three to four larvæ are often found in one blistered portion of the leaf. When feeding on *Chenopodium* one leaf does not furnish enough food for one maggot, so they have to migrate to other leaves. This same habit holds when they feed on spinach, at least while the spinach is small or in case they attack the seed leaves. In spinach which is gathered for market they seem to have more of a tendency to migrate and find the greenest leaves. This habit prevents the sharpest-eyed house-wife finding them all, when preparing the spinach for "greens," for it is impossible to detect their presence within the leaf tissue until after they have eaten a portion of the parenchyma.

Occasionally the maggot changes to the pupa within the leaf especially if the latter lies on the ground and is decaying. The majority of them enter the loose soil a short distance or crawl under the fallen leaves to pupate.

FOOD PLANTS. — As far as known the beet, spinach and *Chenopodium* are the only plants on which this maggot works. Where all three of these plants are raised in such abundance as they are liable to be in gardening districts the flies are sure to find plenty of food plants to deposit their eggs upon. Where chenopodium is not disturbed by cultivation it matures about October 1st; hence the principal food plant during the fall is spinach.

There is a possibility of their feeding on the leaves of some of the "docks" or "sorrels."

DESCRIPTION. — The eggs are white, about .03 of an inch in length, delicately reticulated and nearly cylindrical in shape. The white reticulated portion of the egg is an outer covering and is easily removed in little scale-like particles. When the eggs are deposited this covering is apparently viscid and aids in attaching them to the surface of the leaf. Beneath this reticulated covering is a semi-transparent membrane.

The maggot or larva is about five-sixteenths of an inch long, when full grown, larger at the posterior than at the anterior end. When first taken from the leaf they have a white, glassy appearance. In the posterior half of the body the green contents of the intestine show quite distinctly, while the black, hook-like jaws, or what answers for jaws, can be seen as a curved line at the anterior end. (See Fig. 2, Plate IV.)

The puparium, or resting stage, is about .21 of an inch long, chestnut brown in color when first formed but soon changing to a dark brown and difficult to distinguish from the surrounding soil.

The flies are quite variable in size. They usually carry the body in a slightly curved position. The front of the head is silvery white with a reddish brown line extending vertically through the centre. The females are of an olivaceous ash color, and can be distinguished from the males by the following characters: The eyes are smaller and placed further apart than in the male. The legs, excepting the tarsi, are yellow or reddish yellow. The body is not as hairy as in the males, nor are the hairs as long, except at the end of the abdomen where there is a distinct tuft of long hairs. (See Fig. 5′, Plate IV.) The males are darker colored than the females, more hairy; the femora of the front pair of legs are nearly the same color as the body, the remaining legs are the same color as in the females. The eyes are large and nearly meet on the crest of the head.*

ENEMIES.— Thus far no parasites have been bred from the material collected. No indications of parasites have been found in the field; neither do I find any record of parasites having been reared.

In the field maggots were often found dead within the leaf. For some time it was a question as to what was the cause of this, until finally the finding of the bugs (*Coriscus ferus*, *Linn.*) shown at Fig. 6 and 6′ Plate IV, were found hunting under spinach leaves. These bugs were too wary to be caught in the act of killing maggots,

*For a technical description see 1st Rept. St. Ent. p. 209.

but the leaves which contained dead maggots showed on close examination a small puncture at the point where the dead maggot lay. Besides it is known that this bug feeds on other insects.

REMEDIES. — The only remedies that have been recommended are, first, the gathering and destroying of the infested leaves; second, crushing, by hand, the maggots within the leaf, and third, plowing the field after the beets have been gathered. Apparently these remedies were all recommended on the supposition that the beet was the only food plant of the maggot. Since it is known that the maggot feeds on beet, spinach and *Chenopodium*, and on the latter more than on either of the others, a fact that was quite evident here the past season, it is a self-evident fact that very little will be accomplished by simply destroying the maggots on beets or even on spinach. It is also quite evident, from the habits of the maggot, that no insecticide can be used to destroy them. Thinking there was a possibility of reaching the maggots through the blistered portion of the leaves with some wash of an oily nature, during the fall of 1894, I tried kerosene emulsion of severa different strengths on spinach. In one trial it was used as strong as one part of the stock emulsion to six of water. This injured the leaves, but in no case could I find any injured maggots. In a few instances they had left the injured leaves and found their way to fresh leaves. From the fact that the eggs are deposited on the lower surface of the leaf it will be impossible to get at all of these with washes; besides, the washes would have to be applied so often that it would become an expensive remedy.

The only feasible plan of keeping them in check is culture methods, which should be as follows: Throughout the summer all "Lamb's-quarters," or "Pigweeds," should be cut, hoed or cultivated out every ten days or two weeks. If it is impossible to keep these weeds cut from neglected corners, hedges, fences, roadsides, driveways and "turnrows," such places should be kept in grass or clover. In the case of turnrows, rye or oats can be used instead of grass or clover. Crimson clover will not answer on Long Island, as usually there is as good a stand of weeds as of clover. Destroying the weeds every ten days will cut off the food supply of many newly-hatched maggots.

On Long Island, land on which beets or spinach have been raised should be plowed at least six inches deep any time between the middle of November and the 15th or 30th of March, depending on the forwardness of the season. Spinach sown for spring cutting if sown late is not liable to harbor many of the maggots.

The plowing should be thoroughly done and the ground rolled, if possible, as the object of the plowing is to bury the puparia so deep that the delicate flies, when they issue, will be unable to get to the surface.

True, many of the gardeners and farmers on Long Island as well as elsewhere practice late fall and early spring plowing, and are still troubled with the "Spinach maggot."

Undoubtedly they destroy a goodly number of the pests but it is the same with cultural methods of treatment as with other remedies, it must be thoroughly done and at the right time. Furthermore, care must be taken not to allow some corner to grow two or three crops of weeds which furnish a good breeding ground for the flies, and plenty of food for the maggots.

Possibly some farmer who reads the above recommended measures will decide that it is useless for him to take all this trouble to keep his fields clean unless all his neighbors keep their fields clean. I have noticed a decided difference in the amount of damage done in fields of thrifty farmers and in the fields of those who simply exert themselves enough to get a crop to grow. This fact would indicate that the migration of the flies from one field to another is slow. Possibly cornfields or other crops act as barriers.

It is also quite evident that if roadsides and fence corners were kept in grass and clover that it would add 50 per cent. to the appearance of many farms, besides yielding some return in hay and a better crop of beets and spinach.

CONCLUSION.— The "Spinach maggot" is known to feed within the leaves of beets and lamb's quarters (*Chenopodium album*) as well as within spinach leaves.

As far as known these are the only food plants that this species feed upon in this country.

It can not be destroyed by any insecticide without injury to the plant.

The brood which passes the winter in the pupa state can be destroyed by plowing the ground deep enough to bury the puparia to such a depth that it will be impossible for the flies to work their way to the surface.* The latter method will do only a small amount of good unless measures are taken to prevent the growth of lamb's-quarters in uncultivated places and in cultivated fields after the crops are "laid by."

* Since the above was written actual tests have shown that this species of fly can work its way through eight inches of dirt. The only gain of deep burying was to retard for several weeks the time of their appearance in the spring. F. A. S.

PLATE IV.

Fig. 1. Eggs of *Pegomyia vicina* on leaf of *Chenopodium album*. Magnified about 16 times. The irregular dots on the surface of the leaf is a peculiar wax-like secretion which gives the Chenopodium leaf its mealy appearance.

Fig. 2. The maggot or larva. Magnified approximately three times, showing the hook-like jaws and the irregular dark area of the intestinal contents.

Fig. 3. Puparium magnified approximately three times.

Fig. 4. Leaf of spinach showing mined area at (*a*) slightly magnified.

Fig. 5. Male. 5′ female magnified about 4 times.

Fig. 6 and 6′. Top and side view of the bug (*Coriscus ferus*) which feeds on the maggots, magnified about 4 times.

All figures photographed from natural objects by F. A. Sirrine.

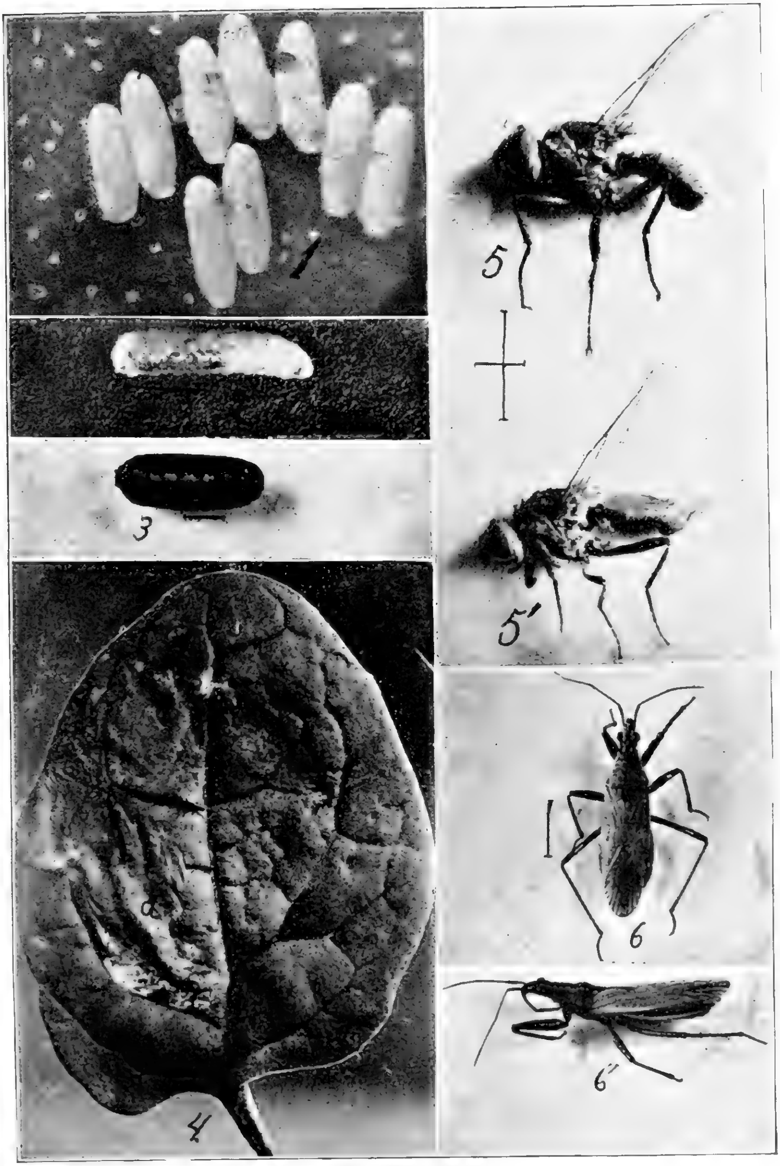


Plate IV.

INDEX.

B.

C.

D.

E.

F.

G.

M.

N.

O.

P.

Q.

R.

S.

T.

U.

V.

W.

Y.