THIRTY-SIXTH ANNUAL REPORT

OF THE

NEW JERSEY STATE

Agricultural Experiment Station

AND THE

TWENTY-EIGHTH ANNUAL REPORT

OF THE

New Jersey Agricultural College Experiment Station

FOR THE YEAR ENDING OCTOBER 31ST

1915

PATERSON, N. J.
News Printing Co., State Printers.
1916.

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New Jersey Agricultural Experiment Stations

NEW BRUNSWICK, N. J.

1. STATE STATION. ESTABLISHED 1880.

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2. AGRICULTURAL COLLEGE STATION. ESTABLISHED 1888.

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The Board of Trustees of Rutgers College in New Jersey

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FANNIE F. COOPER, B.S., Assistant in Home Economics.
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Letter of Transmittal.

To His Excellency, James F. Fielder, Governor of the State of New Jersey:

SIR—I have the honor to submit herewith the Thirty-sixth Annual Report of the New Jersey State Agricultural Experiment Station, as required by the law establishing the Station, which was approved March 10, 1880, and which is chapter 106 of the laws of that year.

JAMES NEILSON,
President.

NEW BRUNSWICK, N. J., November 30, 1915.

To His Excellency, James F. Fielder, Governor of the State of New Jersey:

SIR—In compliance with an act of Congress, approved March 2, 1887, and with an act of the Legislature of this State approved March 5, 1888, I beg leave to submit, on behalf of the Trustees of Rutgers College in New Jersey, maintaining Rutgers Scientific School, the New Jersey State College, for the benefit of Agriculture and Mechanic Arts, the Twenty-eighth Annual Report of the operations of that department of the College which has been organized in accordance with said act of Congress, and is known as "The State Agricultural College Experiment Station."

W. H. S. DEMAREST,
President.

NEW BRUNSWICK, N. J., November 30, 1915.

Treasurer's Report

Irving S. Upson,* and Irving E. Quackenboss, in account with the New Jersey State Agricultural Experiment Station, November 1st, 1914, to October 31st, 1915.

Appropriation for Salaries and Expenses.

Appropriation	$25,000.00
Collections for Sales of Milk, Cream, and Dairy Stock	4,997.93
Collections for Sales of Swine	2,865.11
Collections for Sales of Peaches	2,013.60
Refund by Railroad—1 Water bottle broken in transit	1.00
Total	$34,877.64

PAYMENTS.

By Treasurer of the Experiment Station	
Salaries and Wages	$18,337.00
Bills submitted to State Comptroller for direct payment	
Advertising	5.00
Books and Magazines	2.00
Chemical Supplies	101.00
Coal	599.97
Electric Current	167.35
Express, Freight, and Cartage	408.59
Farm Machinery and Tools	377.35
Feed and Shavings	4,329.73
Fertilizers	8.66
Gas	48.34
Iceing and Loading Cars of Peaches	100.00
Insurance	560.67
Labor	1,211.82
Live Stock	750.00
Office Fnrniture	169.45
Office Supplies	863.18
Photographic Supplies and Blue Prints	98.11
Postage	1,192.21
Printing and Stationery	973.27
Registration of Animals	24.00
Repairs	1,468.04
Scientific Apparatus	623.77
Team Hire	240.00
Telephone and Telegraph	271.41
Traveling Expenses—Managers	241.86
Traveling Expenses—Officers	828.99
Traveling Expenses—Sampling Feeds	341.17
Trees, Seeds, and Vines	65.81
Veterinary Services	248.35
Water and Ice	26.19
Sundries	160.28
Total	$34,843.57

*Died February 25, 1915.

Appropriation for Printing Bulletins.

Appropriation	$ 6,000.00

PAYMENTS.

Bills submitted to State Comptroller for direct payment	
For Printing Bulletins	$ 5,148.27
Amount reserved by requisition until next fiscal year	
For Bulletins in press	849.50
Total	$ 5,997.77

Appropriation for the Purpose of Carrying into Effect "An Act to Provide for Locating and Abolishing Mosquito-Breeding Salt Marsh Areas within the State, for Assistance in Dealing with Certain Inland Breeding Places, and Appropriating Money to Carry Its Provisions into Effect."

Appropriation	$20,000.00

PAYMENTS.

By Treasurer of the Experiment Station	
Salaries and Wages	3,720.00
Bills submitted to State Comptroller for direct payment	
Advertising	108.50
Express, Freight, and Cartage	5.60
Mosquito Field Work—Ditching, etc.	2,919.00
Motorcycle	275.00
Office Supplies	25.57
Photographic Supplies and Blue Prints	134.16
Postage	27.20
Printing and Stationery	77.48
Scientific Apparatus	260.92
Telephone and Telegraph	44.87
Traveling Expenses—Officers	1,462.91
Labor	207.34
Sundries	35.85
Amount reserved by requisition until next fiscal year	
For Mosquito Field Work—Ditching, etc.	10,506.25
Total	$19,810.65

Appropriation for the Scientific Investigation of Oyster Propagation.

Appropriation	$ 900.00

PAYMENTS.

By Treasurer of the Experiment Station	
Salaries and Wages	500.00
Bills submitted to State Comptroller for direct payment	
Chemical Supplies	2.85
Express, Freight, and Cartage	3.61
Hardware Supplies	1.53
Insurance on Boats	25.50
Office Furniture	27.64
Postage	10.17
Rent of Ground	15.00
Repairs to Oyster Culture Laboratory Equipment	9.80
Scientific Apparatus	82.35
Storing and Hauling Boats	56.95

Traveling Expenses—Officers	135.45
Sundries	14.66
Amount reserved by requisition until next fiscal year	
For Scientific Apparatus	12.00
Total	$ 897.51

Appropriation for Buildings, Fences, and Equipment in the Department of Poultry Husbandry.

Appropriation	$ 5,000.00

PAYMENTS.

By Treasurer of the Experiment Station	
Salaries and Wages	980.00
Bills submitted to State Comptroller for direct payment	
Blue Prints and Plans	25.00
Buildings, Fences, and Equipment	3,345.02
Express, Freight, and Cartage	206.14
Labor	442.55
Total	$ 4,998.71

Appropriation for the Maintenance and Operation of the Department of Poultry Husbandry.

Appropriation	$ 6,500.00
Collections for Sales of Poultry and Eggs	2,279.29
Total	$ 8,779.29

PAYMENTS.

By Treasurer of the Experiment Station	
Salaries and Wages	$ 6,155.00
Bills submitted to State Comptroller for direct payment	
Books and Magazines	17.00
Chemical Supplies	7.05
Coal	284.71
Express, Freight, and Cartage	29.89
Labor	175.68
Office Furniture	116.80
Office Supplies	123.54
Oil	19.90
Photographic Supplies and Blue Prints	125.35
Postage	50.50
Poultry Feed and Litter	375.70
Poultry Stock	257.00
Poultry Supplies and Tools	471.87
Printing and Stationery	179.12
Repairs	88.34
Traveling Expenses—Officers	255.72
Seeds	19.68
Sundries	25.01
Total	$ 8,777.86

Appropriation for Carrying Out the Provisions of "An Act Concerning Seeds."

Appropriation	$ 2,000.00

PAYMENTS.

By Treasurer of the Experiment Station	
Salaries and Wages	1,725.00

Bills submitted to State Comptroller for direct payment	
Labor	14.40
Office Furniture	11.00
Office Supplies	20.65
Printing and Stationery	5.25
Repairs	23.00
Scientific Apparatus	10.29
Traveling Expenses—Officers	146.90
Seeds	5.27
Sundries	17.41
Amount reserved by requisition until next fiscal year	
For Office Furniture	20.00
Total	$ 1,999.17

Appropriation for Carrying Out the Provisions of "An Act to Regulate the Sale of Insecticides."

Appropriation	$ 1,000.00

PAYMENTS.

Bills submitted to State Comptroller for direct payment	
Chemical Supplies and Scientific Apparatus	916.74
Traveling Expenses—Sampling Insecticides	58.49
Printing and Stationery	4.50
Amount reserved by requisition until next fiscal year	
For Scientific Apparatus	18.74
Total	$ 998.47

Appropriation for the Purpose of Maintaining and Carrying on Experimental Work in Floriculture.

Appropriation	$ 3,000.00
Collections for Sales of Flowers	1,941.35
Total	$ 4,941.35

PAYMENTS.

By Treasurer of the Experiment Station	
Salaries and Wages	$ 2,660.00
Bills submitted to State Comptroller for direct payment	
Books and Magazines	3.00
Chemical Supplies	12.58
Coal	1,550.14
Fertilizers	19.25
Floriculture Supplies and Tools	139.20
Labor	42.50
Office Furniture	7.80
Photographic Supplies and Blue Prints	68.18
Printing and Stationery	49.75
Repairs	242.00
Scientific Apparatus	12.00
Trees, Seeds, and Vines	118.50
Amount reserved by requisition until next fiscal year	
For Scientific Apparatus	9.00
Total	$ 4,933.90

Appropriation for a Refrigeration Plant for Floricultural Investigations.

Appropriation	$ 1,200.00

PAYMENTS.

Bills submitted to State Comptroller for direct payment	
Furnishing and Installing Refrigeration Plant	1,077.04

Appropriation for Farm Demonstration in Agriculture.

Appropriation	$10,000.00

PAYMENTS.

By Treasurer of the Experiment Station	
Salaries and Wages	6,286.64
Bills submitted to State Comptroller for direct payment	
Books and Magazines	2.70
Express, Freight, and Cartage	113.88
Fertilizers	132.11
Hardware	23.65
Labor	27.95
Office Supplies	23.65
Photographic Supplies and Blue Prints	11.09
Postage	93.14
Printing and Stationery	16.50
Seed	121.22
Telephone	4.64
Toward Maintenance of Mercer County Farm Bureau	900.00
Toward Maintenance of Sussex County Farm Bureau	100.00
Toward Salary of Bergen County Superintendent of Farm Demonstration	416.67
Toward Salary of Monmouth County Superintendent of Farm Demonstration	416.67
Traveling Expenses—Officers	1,122.52
Wooden Stakes for Demonstration Purposes	60.00
Sundries	77.54
Total	$ 9,950.57

Appropriation for Expenses of Orchards at Vineland and High Bridge.

Appropriation	$ 1,031.69

PAYMENTS.

By Treasurer of the Experiment Station	
Salaries and Wages	550.00
Bills submitted to State Comptroller for direct payment	
Express, Freight, and Cartage	15.00
Fertilizers	99.43
Labor	28.00
Lumber	62.96
Orchard Supplies	89.29
Printing and Stationery	61.50
Spraying Material	119.73
Trees	2.20
Total	$ 1,028.11

Feed Inspection Fees Account.

Appropriation—Collection of Feed Inspection Fees	$17,464.40
PAYMENTS.	
By Treasurer of the Experiment Station	
Salaries and Wages	6,978.50
Bills submitted to State Comptroller for direct payment	
Books and Magazines	36.00
Chemical Supplies	77.48
Coal	27.40
Electric Current	276.23
Express, Freight and Cartage	40.86
Farm Machinery and Tools	445.66
Feed and Shavings	5,874.67
Fertilizers	302.24
Furniture	90.45
Gas	138.94
Insurance	156.00
Labor	270.63
Moving and Repairing Refrigeration Plant	293.00
Office Supplies	54.87
Photographic Supplies and Blue Prints	44.12
Printing and Stationery	290.06
Refund of Inspection Fees	24.00
Registration of Animals	11.75
Repairs	267.86
Scientific Apparatus	198.69
Telephone and Telegraph	434.79
Traveling Expenses—Officers	143.90
Traveling Expenses—Sampling Feeds	280.18
Trees, Seeds, and Vines	443.86
Water and Ice	13.10
Veterinary Services	108.75
Sundries	42.64
Total	$17,366.63

Appropriation for Repairs in New Jersey State Agricultural Experiment Station Building.

Appropriation	$ 500.00
PAYMENTS.	
Bills submitted to State Comptroller for direct payment	
For Repairs in Experiment Station Building	$ 498.81

Fertilizer Inspection Fees Account.

Appropriation—Collection of Fertilizer Inspection Fees	$24,332.31
Refund by Public Service Electric Co.—Over-payment of May bill,	6.84
Total	$24,339.15
PAYMENTS.	
By Treasurer of the Experiment Station	
Salaries and Wages	$13,750.00
Bills submitted to State Comptroller for direct payment	
Books and Magazines	43.35
Chemical Supplies	64.99

Coal	124.50
Electric Current	237.23
Express, Freight, and Cartage	94.07
Farm Machinery and Tools	428.20
Feed and Shavings	2,780.60
Fertilizers	987.87
Gas	86.94
Labor	705.40
Live Stock	100.00
Office Furniture	31.00
Office Supplies	430.33
Peach Crates	635.50
Photographic Supplies and Blue Prints	85.50
Postage	2.26
Printing and Stationery	755.75
Refund of Inspection Fees	1.80
Registration of Animals	55.00
Repairs	176.35
Scientific Apparatus	90.45
Telephone and Telegraph	407.33
Traveling Expenses—Officers	1,309.34
Traveling Expenses—Sampling Fertilizers	656.63
Trees, Seeds, and Vines	113.23
Veterinary Services	66.00
Sundries	109.40
Total	$24,329.02

Collections Account.

RECEIPTS.

From Poultry Department	
Collections for Sales of Poultry and Eggs	$2,279.29
From Floriculture Department	
Collections for Sales of Flowers	1,941.35
From Horticulture Department	
Collections for Sales of Peaches	2,013.60
From Dairy Department	
Collections for Sales of Milk and Dairy Stock	4,997.93
From Swine Department	
Collections for Sales of Swine	2,865.11
From Chemical Department	
Collection of Fertilizer Inspection Fees	24,332.31
From Chemical Department	
Collection of Feed Inspection Fees	17,464.40
From Raritan River Railroad Co.	
For 1 Water Bottle Broken in Transit	1.00
From Public Service Electric Co.	
For Over-payment in May Electric Power Account	6.84
From National Bank of New Jersey	
For Interest on Deposits	8.48
Total	$55,910.31

PAYMENTS.

To State Treasurer Collections for Sales of Poultry and Eggs	$ 2,279.29
To State Treasurer Collections for Sales of Flowers	1,941.35
To State Treasurer Collections for Sales of Peaches	2,013.60
To State Treasurer Collections for Sales of Milk and Dairy Stock	4,997.93
To State Treasurer Collections for Sales of Swine	2,865.11
To State Treasurer Collection of Fertilizer Inspection Fees	24,332.31
To State Treasurer Collection of Feed Inspection Fees	17,464.40
To State Treasurer For 1 Water Bottle Broken in Transit	1.00
To State Treasurer For Over-payment in May Electric Power Account	6.84
To State Treasurer For Interest on Deposits	8.48
Total	$55,910.31

The Auditing Committee of the Experiment Station has examined the accounts of the Treasurer of said Station, and has found them correct.

GEORGE E. DE CAMP,

GEORGE SMITH,

Auditing Committee.

Financial Statement

The Trustees of Rutgers College
for
The New Jersey State Agricultural College Experiment Station
in Account with
The United States Appropriation, 1914-1915.

RECEIPTS.

From the Treasurer of the United States—	
Hatch Act	$15,000 00
Adams Act	15,000 00
	$30,000 00

PAYMENTS.

	Hatch Act	*Adams Act*	*Total*
Salaries	$9,275 00	$11,145 83	$20,420 83
Labor	1,330 72	1,830 63	3,161 35
Publications	.... ..	....	....
Postage and Stationery	734 39	9 60	743 99
Freight and Express	80 84	7 10	87 94
Heat, Light, Water and Power	819 13	232 07	1,051 20
Chemicals and Laboratory Supplies	497 62	193 45	691 07
Seeds, Plants and Sundry Supplies	239 15	211 88	451 03
Fertilizers	181 70	59 85	241 55
Feeding Stuffs	30 00	330 00	360 00
Library	301 03	23 40	324 43
Tools, Machinery and Appliances	72 40	166 62	239 02
Furniture and Fixtures	236 63	....	236 63
Scientific Apparatus and Specimens	121 58	3 55	125 13
Live Stock	.... ..	....	....
Traveling Expenses	699 36	3 10	702 46
Contingent Expenses	124 30	33 75	158 05
Buildings and Land	256 15	749 17	1,005 32
Total	$15,000 00	$15,000 00	$30,000 00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the New Jersey State Agricultural College Experiment Station for the fiscal year ended June 30th, 1915; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was $...... on the Hatch Fund and $...... on the Adams Fund; that the receipts for the year from the Treasurer of the United States were $15,000.00 under the act of Congress of March 2d, 1887, and $15,000.00 under the act of Congress of March 16th, 1906, and the corresponding disbursements $15,000.00 and $15,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving balances of $...... and $......

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2d, 1887, and March 16th, 1906, and in accordance with the terms of said acts, respectively.

(Signed) W. H. S. DEMAREST,

J. G. LIPMAN,

Auditors.

REPORT OF THE DIRECTOR

Report of the Director

JACOB G. LIPMAN, PH.D., *Director.*

CONTENTS.

Report of the Director.

JACOB G. LIPMAN.

Throughout a period of thirty-five years the New Jersey Agricultural Experiment Station has kept in touch with the broader problems of agricultural uplift, as well as with those of a more local character. Within that time, far-reaching changes have come into argricultural practice. When the New Jersey Station was established in 1880 commercial fertilizers were hardly known, and the fertilizer resources of the country were still to be developed. Some of our most valuable deposits of phosphate rock had not yet been discovered; the packing house industry had not yet learned to utilize thoroughly its nitrogenous and phosphatic by-products; the great supply of sulphur and of sulphides for the manufacture of sulphuric acid had not been tapped; and the modern and efficient methods for making sulphuric acid were unknown. The nitrogen problem, by far the biggest in agricultural production, seemed to offer no ready solution. Meanwhile the free Government land was being taken up rapidly, and the drift of population was to the West while the older soils were being rapidly depleted of their fertility.

With cheap land and dear labor, every effort was made in the Middle and farther West to convert quickly the readily available plant food into staple crops, without regard to soil waste. Farm manures were not cared for, or deliberately dumped into the nearest stream to save the cost of handling. Straw and corn stalks were burned as the easiest means of disposal, and small grains and corn, as cash crops, were produced without regard to rotations and the restoration of soil humus. Agricultural machinery was invented to lighten the labor burden of the farm, and as it became more abundant and more effective new areas were put under cultivation to contribute their share of cheap grain and livestock.

Such were the conditions under which New Jersey and other Eastern States had to compete with the younger West. As a result, grain growing, general farming and stock raising ceased to be profitable. Land values passed through a period of shrinkage; the ambitious and agressive members of the young generation turned their thoughts to the city; and the farms of the East suffered a loss not alone of their income, but also of what they could ill afford to lose, the wide-awake and sturdy sons and daughters of the farmers. It was during this time of depression and discouragement that the Experiment Station together with other agricultural institutions and organizations was called upon to suggest a method for rehabilitating the agriculture of the State.

The first Director of the Station, Dr. George H. Cook, realized that the salvation of Eastern agriculture lay in specialization, in the abandoning of the old types of farming and in the growing of crops of high commercial value. Accordingly, an impetus was given to the production of vegetables, berries, tree fruits, ornamental plants, poultry and high grade milk. The unparalleled advantages as to transportation and markets, the rapidly growing cities, the increasing number of discriminating consumers of high grade farm produce all served to stimulate specialization and the inrroduction of new crops. But as specialization became more common new problems and difficulties forced themselves upon the attention of the farmer.

Injurious insects newly introduced, or at least not heretofore troublesome, assumed, in many instances, the proportions of a grave menace. Their survival and spread was favored by the greater abundance of their favorite food crops and in this manner the Colorado beetle, the plum curculio, the strawberry weevil, the flea beetle, the peach tree borer, the San Jose scale and a host of others began to spell ruin to a reawakening industry. To make matters worse fungous diseases became more trouhlesome from day to day. Various hlights, mildews and rots appeared as one of the major limiting factors in crop production. Potatoes, tomatoes, sweet potatoes, melons, asparagus, grapes, cranberries, apples, pears, peaches and even grasses and clovers were affected more or less seriously by parasitic fungi.

It will be seen readily that in the process of adjustment to new crops and conditions the farmers of New Jersey were confronted by puzzling questions which they promptly referred to their Experiment Station. They wanted to know how to buy and use commercial fertilizer, how to maintain and increase the fertility of their land under the more intensive methods of culture. They were clamoring for remedies against the destructive insects and fungi. They were eager for information on the composition of home-grown and purchased cattle foods; on rational methods of feeding, on new crops and varieties of old crops, and on miscellaneous matters of concern to our rural population. Hence, the Experiment Station was soon engaged in carrying on fertilizer experiments on different soils and with different crops; in discovering, introducing and applying insecticides and fungicides; in conducting digestion and feeding experiments; and in testing out new varieties of plants and new methods of cropping and of farm management. The farmers of the State learned to use commercial fertilizers in increasing amounts, learned something of their limitations and a great deal about their composition and value. They learned how to keep in check the potato beetle, the San Jose scale, brown rot, peach leaf curl and pear blight. They gained a clearer understanding of balanced rations, of silos and ensilage, of soiling crops and of desirable sources of nutrients in commercial feeding-stuffs. And, as they referred new questions that came to them to their Station, the latter was compelled to adjust its organization to the agricultural needs of the State so that it would be in a position to serve best the larger and more permanent interests of the entire industry, as well as the more local and temporary phases of agriculture. Moreover, the New Jersey Station is expected, as are the Stations in other States, to show the way of progress; to look into the future, and to anticipate, in a measure, the new problems that are likely to arise. That the New Jersey Station has done its share in laying the foundation of a more prosperous and more progressive agriculture in the United States is readily shown by its annual reports and its bulletins. Its investigations and teachings have not been confined in their application to New Jersey alone, and to this extent it has in a measure repaid the debt which the farmers of the State owe to investigators and teachers in other States and countries.

It is now the task of the New Jersey Experiment Station to help find methods for developing economically the still unimproved lands of the State, a domain of vast possibilities. If experience in other lands may at all serve as a guide, there is room in the State for 150,000 farmers and their families. It is also the task of the Station to contribute in every way to the continued evolution of extensive into intensive methods of cropping. In performing these tasks it must retain and strengthen every branch of its present activities including the inspection service, the investigation of fundamental problems in agricultural science, and the dissemination of information gathered from different sources. To attain this end the organization and equipment of the institution must be made adequate for the larger service which it is expected to render.

THE STATION ORGANIZATION.

In looking through the annual report of the Station one will find that there have been important changes in its organization since 1880. The institution was organized in that year with a staff of five persons. Its activities were confined to the analysis of samples of fertilizers sold in the State; to experiments with fertilizers; to the study of methods of analysis; and to the testing of some promising new crops. The annual income of the Station was then $5,000.

Ten years later the scope of the Station's activities was much wider, thanks to the enactment of the Federal Hatch Law in 1887. As organized in 1890, the Station included the departments of Chemistry, Biology, Botany and Entomology. Its staff comprised nine persons and its annual income was $25,000. The investigations and other activities of the Station embraced work incident to the collection and analysis of samples of commercial feeding stuffs; fertilizer experiments with tomatoes, potatoes, sweet potatoes, fruit trees and strawberries; feeding experiments with different classes of farm animals; investigation of oyster culture; the study of fungous diseases of a large number of cultivated crops, and the study of economic insects and their control.

At the end of still another decade the Staff of the Station had increased to 14 persons and its annual income to $31,000. Departments of Horticulture and Dairy Husbandry had been organized in addition to those which existed in 1890. The new problems which were being made the subject of investigation included the availability of nitrogenous plant-foods; the comparison of varieties of berries, tree-fruits and vegetables; the study of irrigation of bush fruits; soiling crop systems; and feeding rations for milch cows. The College Farm of about 100 acres was being utilized in a more effective way for the study of crop and live-stock problems, and an effort was being made to determine the influence of different methods of cropping on the maintenance of soil fertility.

In 1910, the Staff of the Station consisted of 30 persons and its annual income had increased to $61,000. It was in touch then with a rapidly growing constituency and was making a study of problems which were not included in its program ten years earlier. The study of the economically important problem of mosquito extermination had been begun, and results of great scientific and practical value has been obtained. Floricultural investigations had been provided for under a special appropriation of the Legislature, and experimental peach orchards had been established at Vineland and High Bridge. Moreover, the scope of the investigations in the Botany Department had been materially widened to include the study of plant breeding with special reference to inheritance and environment as factors in breeding. The Department of Soil Chemistry and Bacteriology, established in 1901 and enlarged in 1906, had acquired a very effective equipment and was making a study of various phases of the nitrogen problem including nitrogen availability, and the accumulation and transformation of nitrogen compounds in the soil.

In the present fiscal year the number of persons regularly employed by the Station was 80. Since 1910, the Departments of Agronomy, Seed Control, Poultry Husbandry, Plant Pathology and Agricultural Extension had been established, and the income of the institution had been increased to $160,000. New problems pertaining to agricultural production have been made the subject of investigation. These include soil protozoa; soil fungi; parasitic fungi; farm surveys; the feeding of dairy animals and swine; the control of hog cholera; varieties of fruit; the pruning and fertilization of fruit trees; the marketing of peaches; fertilization of cranberries; breeding, feeding and housing of poultry; fly and mosquito control; spraying of potatoes; etc. Much progress has been made in assuring more adequate protection against fraud or misunderstanding to purchasers of fertilizers; feeding stuffs, insecticides, lime and seeds. The educational activities of the Station have been extended by the establishment of farm bureaus, the engaging of additional extension specialists, the publication of a larger number of circulars and bulletins, and the providing of better facilities to residents in the State for securing personal advice from members of the Staff either through correspondence or personal conference.

As the range of the Station's activities was widened there was placed at its disposal and at the disposal of the Agricultural Department of the College a more adequate equipment. The land area of the College Farm comprised about 145 acres in 1910; while in 1915 the acreage had been increased to 305. During that time there were constructed the greenhouses for investigations in floriculture; the poultry buildings; horse barn; cow barn; tile silos, machinery storage building; blacksmith shop and the Agricultural Building. The value of the land, buildings and equipment placed at the disposal of the Station and Agricultural Department of the College within the past five years is probably not less than $240,000.

THE STATION STAFF.

Within the fiscal year 1914-15 there was an unusually large number of resignations, transfers and appointments. A record of these changes follows:

Resignations.

ALFRED S. COOK, Dairy Husbandman.
ALBERT S. HAGEN, Herdsman.
JOHN H. VOORHEES, Associate Agronomist.
MALCOLM LEWIS, Assistant Bacteriologist.
JOHN V. CROOT, Helper.
JOEL P. SHERMAN, Field Assistant.
MARY A. WHITAKER, Stenographer.
WILLIS H. PEARSON, Assistant Chemist.
WILLIAM SCHIEFFERSTEIN, Field Assistant.
ROBERT SCHMIDT, Assistant Seed Analyst.
CHARLES M. ARTHUR, Extension Specialist in Market Methods.
B. H. A. GROTH, Plant Physiologist.
ARTHUR N. HUTCHINSON, Assistant Chemist.
MARION T. PLEASANTS, Laboratory Assistant.

Transfers.

JOHN W. BARTLETT, from Dairy Department to Horticultural Department.
IRVING L. OWEN, from Associate Agronomist to County Superintendent of Farm Demonstration.
WARREN W. OLEY, Extension Specialist in Fruit Growing to County Superintendent of Farm Demonstration.

Appointments.

HENRY P. SCHNEEWEISS, Chief Clerk.
LOUIS M. RUSSELL, Helper—Dairy Department.
A. SYDNEY CARROLL, Helper—Dairy Department.
WILLIAM J. CARSON, Dairy Husbandman.
LLOYD S. RIFORD, Assistant Dairy Husbandman.
J. MARSHALL HUNTER, Assistant Animal Husbandman.
FRANK APP, Agronomist.
ROSCOE W. DEBAUN, Extension Specialist in Market Gardening.
CARL R. WOODWARD, Editor.
SAMUEL I. HODGESON, Assistant Chemist.
CHARLES S. VAN NUIS, Associate Agronomist.
CHARLES S. BECKWITH, Field Assistant.
LAWRENCE G. GILLAM, Field Assistant.
W. RAYMOND STONE, Orchard Foreman.
JOHN W. SHIVE, Plant Physiologist.
SELMAN A. WAKSMAN, Research Assistant.
ROLAND E. CURTIS, Research Assistant.
WILLIAM S. PORTE, Research Assistant.
[illegible], Research Assistant.

WEBSTER S. KROUT, Research Assistant.
WILLIAM H. MARTIN, Research Assistant.
FANNIE F. COOPER, Assistant in Boys' and Girls' Club Work.
GEORGE B. THRASHER, County Superintendent of Farm Demonstration
PAUL B. BENNETCH, County Superintendent of Farm Demonstration.
WARREN W. OLEY, County Superintendent of Farm Demonstration.
GEORGE T. REID, County Superintendent of Farm Demonstration.

Especial mention may be made of the appointment of several researct assistants who are to be employed on the half-time basis. These assistants are expected to devote themselves to the study of important researcl problems under the direct supervision of their department heads.

Mr. Irving Strong Upson, for many years Secretary and Treasurei of the New Jersey State Agricultural Experiment Station, passed away on February 25, 1915. To Mr. Upson the Station owes much of its present effectiveness in the conduct of its various enterprises. He was at all times faithful to the interests of the institution and his death is a serious loss to the Station.

The Physical Equipment.

Thanks to the generosity of Mr. James Neilson, President of the Board of Managers of the Station, as well as Trustee of Rutgers College, the land area of the College Farm was increased during the year to the extent of 32 acres. It is expected that this tract of land will be utilized for experimental work in forestry. The new State Department of Conservation and Development, of which Mr. Alfred Gaskill, State Forester, is Director, has offered to cooperate with the Station and the College in conducting experiments in forestry. Still another addition to the College Farm was made by the purchase of 5 acres of land situated between the Dairy Farm and the Blew Tract Mention may also be made of the gift to the College of several small parcels of land located near the City reservoir. The administration of the Station and the College Farm is under deep obligation to Mr James Neilson, to Mr. William H. Leupp and to other Trustees of the College for their generous support of the Agricultural Department

The new Agricultural Building was completed and occupied in the late fall of 1914. A generous appropriation of $20,000 made by the State was expended to advantage in securing the needed scientific apparatus, Laboratory furniture, office furniture and miscellaneous supplies Another appropriation of $5,000 was made available for the same purpose in the Supplemental Appropriations Act of 1915. As it now stands, the Agricultural Building has brought under one roof some of the scattered activities of both the Station and College, and has made possible the prosecution in a more effective way of the research, regulatory and extension work of the Station. Moreover, the Agricultural Building has made possible for the first time in the history of the College the offering of adequate Laboratory instruction in agronomy, horticulture and soils.

Aside from the completion of the Agricultural Building the physical equipment of the Station has been made more ample by the construction of several poultry buildings, the installation of refrigeration in the cellar of the floricultural greenhouse; the construction of a pumphouse, septic tank and filter bed at the Dairy Farm; the repair of several of the farm buildings and the building of roads and fences incidental to the development of the new poultry plant of the Station. Some of the old frame buildings at the Dairy Farm, which had been destroyed by fire during a thunder storm in August, were replaced by a reinforced concrete machinery building. Another glazed tile, circular silo was built in the early fall of 1915.

The collection of agricultural implements and machinery owned in part by the Station and in part by the College has been made much larger, partly by purchase and partly by gifts. The Director of the Station would at this time express his feeling of indebtedness to Dr. William S. Myers, a Trustee of the College, for his gifts of wagons and agricultural machinery.

Grading and road construction work has been continued in so far as the means of the Station and College would permit. It is hoped that the grading of the portion of the Agricultural Campus immediately adjoining the Agricultural Building will be completed in the spring.

The Station Activities.

The year 1914-15 was one of growth and expansion in the activities of the Station. The range of these activities was greater than usual, as was also the number of people who had recourse to the service offered by the Station. Brief resumés of the activities of the several departments of the Station, as submitted by the heads of these departments, are herewith given.

Chemistry.

The work of this Department was confined largely to the carrying out of the provisions of the inspection laws. In addition to this more or less analytical work was done for some of the other departments of the Station. Assistance was likewise rendered to our county demonstrators by the analysis for them of miscellaneous samples. Aside from these activities, the Department has continued the work with the cottonseed in order to secure information to be used by the Control Officials for making a definition for cottonseed meal that would be true to the material as sold.

The routine activities of the Department may be divided into two classes, namely, the executive and the chemical. The executive or administrative work embraced the following:

Fertilizer registrations received	1595
Feeding stuff registrations received	2546
Insecticide registrations received	172
Lime registrations received	83
Total number of reports issued	3122
Number of letters, dictated and circular	6660

The tonnage reports received were as follows:

FERTILIZERS NOV. 1, 1914.

Mixed fertilizers	59,223.26
Fertilizer materials	8,686.99

FERTILIZERS APRIL 1, 1915.

Mixed fertilizers	87,052.13
Fertilizer materials	7,276.45
TOTAL TONNAGE FOR FISCAL YEAR	162,238.83

The feeding-stuffs tonnage reports received were as follows:

January 1, 1915	114,508.73	Tons
July 1, 1915	103,581.91	"
Total	218,090.64	"

The chemical work consisted of the following:

Fertilizer and lime samples received	1614
Samples analyzed	1048
Total number of determinations, approximate	12000

FEEDING STUFFS.

Number of feeding-stuff samples received	1322
Number of samples analyzed	920
Total number of determinations, approximate	5520

INSECTICIDES

Number of samples received	90
Number of samples analyzed	68
Number of determinations, approximate	400

It will be noted, therefore, that there were approximately 17,920 determinations made during the year.

Horticulture.

Aside from continuing investigations reported on a year ago, the Horticulturist and his associates organized a cooperative shipping movement for peaches in the Vineland District. The 12 growers who constituted the cooperative shipping association disposed of 98 carloads of peaches within a period of less than one month. Not only were the results of this cooperative shipping gratifying from the monetary standpoint, but they also furnished information of general interest.

The largest peach crop in the life of the orchard at Vineland was harvested during the past season. Some very marked results were noted from the different fertilizer treatments.. It was noted especially that the plots which had been receiving phosphoric acid and potash only gave yields much inferior to those obtained from the plots which had received applications of nitrogen, as well as of phosphoric acid and potash.

Peach breeding work continued during the past season furnished data of value and interest. Several hundred seedlings from known crosses will be ready for planting in the spring of 1916, and there will be several thousand pits from the past season's crosses. Especial mention should be made also of the pruning experiments with peaches. Since the beginning of these experiments a careful record has been kept of the annual twig growth of each tree. Tables have been prepared showing the amount of growth pruned off in each treatment, as well as the yield of fruit from each tree and from the portions of each tree representing the various heights from the ground. This is believed to be the most detailed and complete piece of investigational work on pruning thus far recorded. The trees produced a considerable amount of fruit in 1914 which was the third season of growth, while many of the trees produced as much as eight to ten sixteen-quart baskets of fruit in 1915, which was the fourth season after planting.

Some interesting features have been developed in the lime studies with roses. Pink Killarney roses failed to grow on soils which had received heavy applications of burned and slaked magnesian lime. On the other hand, such vegetables as tomatoes and eggplants made normal growth in the same soils. Results of interest have also been secured in the soil experiments with My Maryland and American Beauty roses.

The studies on types of bench construction as bearing on the culture of carnations have been extended. Marked differences in the behavior of plants are already noted when growing on the so-called solid bench on the one hand and the raised bench on the other.

Bulletin 277, entitled "Humidity, Soil and Fertility Studies with Roses," and Bulletin 284, entitled "Packing and Shipping Peaches in Georgia Carriers," were published during the year. To these may be added the Report of the Horticulturist for 1914, and the papers delivered before the Society for Horticultural Science by the Horticulturist and his associates.

Animal Husbandry.

Serious losses to owners of swine were caused by hog cholera. This disease was particularly destructive in a number of localities in Southern New Jersey. Unfortunately, no provision had been made by legislation for granting both funds and authority to any of the existing State organizations for dealing with this disease. The New Jersey State Board of Agriculture, the State Department of Health, and the Live Stock Commission lacked either the means or the authority to deal with outbreaks of hog cholera promptly and effectively. Hence, the Animal Husbandman of the Station, who is also Secretary of the Live Stock Commission, secured authorization from the State Department of Health, the Live Stock Commission and the Experiment Station to use every means for combatting the disease. He secured information as to sources of hog cholera serum of good quality and, by keeping in touch with the situation and in helping owners of infected animals to secure serum promptly, he was instrumental in checking the spread of the disease in many localities.

The investigations of forage crops for swine and methods of feeding these crops have been continued. Among the crops successfully used during the year were Canada field peas, dwarf Essex rape, red clover, alfalfa and sweet clover. Rye, oats, turnips and mangels were also used. It was found again that the seeding of crop mixtures was in most cases to be preferred to that of single crops. In allowing the animals free access to the different crops it was noted that sweet clover was in many instances eaten as readily as was alfalfa and that rape, particularly when young, was eaten with much relish. Mixtures of oats and oats and peas did not attract the animals until the crop was more or less mature. It was found also that the occasional cutting over of the alfalfa was an advantage and that serious injury was not caused to growing crops when the access of the animals to them was prevented until they were at least eight inches high. It was found expedient, likewise, to keep the animals out of the forage crop plots after very heavy rains. Otherwise there was danger of injury from rooting by the animals.

The Animal Husbandman of the Station and his assistant prepared a directory of the stallions in the State. The names of the owners of these animals, and also their addresses, will appear in a bulletin of the Live Stock Commission. The records show that there has been a revival of interest in the breeding of certain types of horses and that a number of very good stallions have been imported into the State during the past year.

Poultry Husbandry.

The activities of the members of the staff of the Poultry Department may be summarized as follows:

The cross breeding of Leghorns and Langshans has been continued for the purpose of securing data on the mode of inheritance of color pigment. More extensive experiments are also being carried on to obtain data concerning the variation in color of the egg shells produced by individuals of the Rhode Island Red, Barred Plymouth Rock, White Leghorn and Light Brahma breeds. With such data at hand, an attempt will be made to define the causes of the variations noted and to determine the behavior of this characteristic in inheritance. Similarly, experiments are being planned on the subject of tintedness in the eggs of breeds supposed to produce white-shelled eggs. Experiments of a more technical nature on the histology of the shell-secreting glands in the oviduct of the producing fowl have been begun.

The breeding work for higher egg production is being continued by the aid of trap-nests and careful matings. Much stress is being laid on feeding problems and the experimental work incidental to the study of these problems is becoming rather extensive. One of the more important of these feeding experiments concerns the feeding of sour skim-milk to laying hens. This experiment has been in progress for 11 months and has been productive of much valuable information. It appears thus far that skim-milk possesses a very pronounced value as a supplemental feed for laying hens.

A series of experiments dealing with various forms of milk food have been started within the past year. One of these experiments relates to the feeding of sour skim-milk, milk albumen and milk powder as supplemental feeds to the regular chick rations. Several pens of White Leghorns and Barred Plymouth Rock chicks were used in this work. The chicks were kept on these rations for the first 12 weeks, after which time the cockerals were sold as broilers and the pullets transferred to other pens and used for additional experimental work with different milk products. The same materials have also been employed as experimental feeds for the growing of stock on the range and of eight flocks of White Leghorns and Barred Plymouth Rocks.

Five pens of White Leghorns have nearly completed the second year's test of a vegetable protein experiment. Soybean meal, oil meal, cottonseed meal and gluten meal have been compared with meat scrap as sources of protein for laying hens. The experimental data will be available for publication at an early date. It is expected, likewise, that data will be availahle for publication in the near future on the tests of varying proportions of meat scrap in rations fed to laying hens.

Extensive experiments are in progress on the subject of meat production in poultry. Fifty young cockerals of the White Leghorn, Barred Plymouth Rock and Light Brahma breeds are being used. After these birds have been fully matured and fattened, further tests are to be made of representative individuals in each pen in order to determine percentage of flesh to carcass, distribution of fat and other important data. This is a particularly promising field of work. Tests and experiments are also being conducted or planned on the subjects of caponizing, the use of commercial disinfectants and deodorizers and of egg preservatives.

Dairy Husbandry.

The work of the Dairy Department during the present fiscal year may be briefly outlined as follows:

Experimental work. (A) A feeding experiment using cut alfalfa hay as a substitute for purchased concentrates in a grain mixture. (B) An experiment dealing with the control of contagious abortion by the use of the Stockman virus of abortus bacilli.

Herd records of production, and cost of raising calves. Records of production, feed, and cost of production started in previous years have been continued for each individual in the dairy herd. Gains in weight have been recorded for each individual calf, and complete records kept of the cost of feed.

Cow Testing Association work. The Wallkill Valley Cow Testing Association was organized during the fiscal year and two temporary associations organized. Two permanent associations have been reorganized and have started work for another year.

Advanced registry work. Advanced registry work has been continued with six different breeds as follows: Holstein, Guernsey, Jersey, Ayrshire, Dutch Belted, and Brown Swiss. Records of production, feed fed, and cost of production for all cows on test are continued in the report for the present fiscal year.

Educational and extension work. In addition to the above lines of work, considerable time has been spent in handling the correspondence of the Experiment Station relating to dairy husbandry. An exhibit has been arranged to represent the work of the Dairy Department and has been on exhibition at various fairs. The Dairy Husbandman made it a point to attend meetings of Cow Testing Associations and other dairy gatherings whenever possible, and at these meetings has delivered lectures on subjects relating to dairying.

Seed Control.

Apart from the routine work of seed collection and analysis, but little has been done in the Seed Department except of some preliminary experimental work with alfalfa. This work has been largely a cooperative test of strains from different regions. In making this comparison, it was expected to secure information as to the relative hardiness of seeds derived from different portions of the State. It is planned now to make plantings with varying quantities of seed per acre in order to determine what rate of seeding may seem heavy enough to result in a satisfactory stand.

The two main lines of work recently inaugurated deal with the fungi parasitic upon alfalfa and other leguminous seeds and the fungus parasites transmitted upon these seeds. They also relate to the influence of various sterilizing agents upon the viability and vitality of seeds. Other problems which concern the various phases of analytical methods will be given consideration. Thanks to the recent additions to the equipment of the Seed Laboratory, opportunities for more research work will no doubt offer themselves.

Agricultural Extension.

The work of the Division of Extension in Agriculture and Home Economics has made substantial progress during the year. County farm demonstration work is one of the leading projects in the Division. Nine counties are organized for such work and in every instance it is finely supported by the local people. Advisory committees, composed of representatives of various associations and some leading farmers outside of associations, willingly assist the Director in oversight.

Demonstration work is also carried on by specialists. These men and women serve the interests of counties that do not have organized demonstration work within their borders, and they also give much time to assistance of county demonstrators. They have their special lines of work organized in the form of projects, although some time must be given to direct assistance of people in special need of help.

The work in home economics has proved to be peculiarly acceptable to the State. Home economic clubs have been formed among rural women, and girls' clubs, devoted to the canning of fruits and vegetables, sewing, etc., are doing distinct good.

The Division of Extension is specially interested in the improvement of marketing methods. Several bulletins on the marketing of special products have been published, a farmers' exchange has been organized in one county, the support of proper city markets has been encouraged, and preparation has been made for a demonstration in cooperative selling of perishable vegetables in one county.

Agronomy.

The Agronomy Department has begun two definite lines of work. The first has to do with the selection and study of different grains and forage crops adapted to New Jersey. If these principal grains were corn, oats and wheat, before improvement by selection and breeding can be accomplished the varieties best adapted to the State must be ascertained. In the corn varieties a wide range of productivity was found, both in yield of grain and stover. Likewise, habits of growth and leafiness of plants, indicating the greater value of some for ensilage purposes.

For forage purposes alone, 57 different crops were tested on a small scale. Among these was the recently introduced crop known as Sudan Grass. In the latitude of New Brunswick this quick-growing, warm weather annual was found superior in the quantity of forage produced to Japan millet.

The second line of work consists of an investigation of farm organization. This considers the farm from an economic and business standpoint. It considers the capital required to organize a farm, the proper size for a given type of farming, the kind of crops and stock most profitable under given conditions, together with the proportion of income best derived from these various sources.

The Department is much in need of funds to furnish assistance and permit a more effective departmental organization. Crops such as potatoes, corn, alfalfa and many forage plants need much extended investigation in order to serve the needs of the State properly. A building of moderate capacity and equipment is needed to care for the crops under investigation.

The principal crops grown at the College Farm included alfalfa, timothy, oats and peas, soybeans and corn. The average yields for these crops were: alfalfa, 3.8 tons per acre and a total yield of 112 tons; timothy, 2.3 tons per acre and a total yield of 76 tons; oats and peas, 2.1 tons per acre and a total yield of 31 tons; soybeans, 1.16 tons per acre and a total yield of about three tons. All of these yields are recorded in terms of field-cured hay. The corn crop was much below the normal on account of the unfavorable growing conditions of the past season. The average yield from nearly 47 acres was somewhat below six tons of silage corn per acre.

Soil Chemistry and Bacteriology.

The work of this Department has been continued very much along the lines laid down in previous reports. Since the last report, investigations relating to soil protozoa as a factor in soil fertility have been undertaken. Also work has been started with a view to determining the presence, distribution and constancy of the more common types and species of bacteria in soils differing in their origin.

The work of the Department naturally divides itself into (1) Cylinder and Pot Experiments, (2) Field Experiments, (3) Laboratory Investigations and (4) Soil Survey Work.

Cylinder and Pot Experiments.

This work embraces a study of nitrogen accumulation and utilization, and nitrogen availability. Work carried on under such conditions is very much more under the observer's control than is similar work on a field scale, and on account of the small amount of space required it is possible to accumulate a great deal of valuable information in the course of a year.

Three hundred and twenty of these cylinders were set apart for a study of the accumulation and utilization of nitrogen, the study being carried out on eight types of soil. The plan provides for a comparison of nitrate of soda, stable manure and green manure crops in a four-year rotation of rye, corn, potatoes and oats. The work for the past year had been carried out in a satisfactory manner. All crops have been harvested, samples prepared and the nitrogen determinations have already been made on a large number of these samples and the results are being tabulated.

The cylinders on which green manure crops were grown continue to give larger yields than either the nitrate of soda or stable manure cylinders. The differences are in most cases striking. For example, the partial failure of a green manure crop on a particular cylinder usually throws the succeeding crop on that cylinder behind the same crop on the other member of the pair. The green manure crops that were seeded during the past fall are making splendid growth.

The results of this work suggests a much wider use of leguminous crops as a means of maintaining soil fertility, for it is here shown that it is possible to grow the green manure crops without interfering with the main crops of the rotation. A mixture of soybeans and vetch is proving to be an especially desirable combination to follow such crops as rye and potatoes. The soybeans make a fair growth before frost and the vetch grows nicely during the winter.

From the loam soil cylinders, which were planned to give a study of the availability of nitrogen in different materials and also the effect of lime with and without a green manure crop, there have been harvested a crop of oats and a residual crop of corn. The oat crop was especially good, indicating a decided improvement in the physical condition of the soil where manure has been used. The weights have been recorded and samples prepared and the nitrogen determinations have been made. The results are being tabulated but will probably not be published until the completion of the fourth five-year period in 1917. Here, as in the other cylinders, the green manure crop—two crops of vetch and crimson clover during the rotation—has given very striking results.

From the 60 dilution cylinders there was harvested an excellent crop of barley and following the barley these cylinders were seeded to sorghum, of which there was a fair crop. The data from these crops are being tabulated for this year's annual report.

The pot experiments have been directed principally toward the study of the availability of nitrogen compounds, and the factors influencing the nitrogen content of soybeans. Some work has been done on the influence of carbohydrates on nitrogen assimilation.

Field Experiments.

The crops on the field plots have generally been good. The wheat on the nitrogen availability plots was very good. Following the wheat the plots were seeded to timothy in accordance with the general plan. This being one of the five-year rotation experiments, the results are not yet ready for publication. They will be tabulated as soon as the work is completed so that they may be used for comparison.

The crops from the lime and rotation plots were also good. An especially heavy crop of vetch was taken from plots 42-48, but on account of the viney nature of this plant it could not be cut with the machine. It therefore seemed best to change this experiment slightly and introduce wheat or rye with the vetch so that it may be cut with the machine.

The continuous wheat and rye plots with a legume continue to give approximately double the yield given by the wheat and rye plots without a legume. The yield per acre is, however, not large. It would appear that the leguminous crop does not supply the amount of nitrogen required for a maximum crop of wheat or rye.

A poor yield of corn was obtained from the continuous corn plots. No doubt two factors are responsible for this condition. First, *continuous* cropping to corn, and second the fact that the cover crops for last year—both legume and non-legume were very poor as a result of the long dry spell in the fall.

A number of varieties of soybeans have been tried out again during the year. However, the harvesting has not been completed and the results cannot be given at this time. Also some varieties of velvet beans from Florida were planted, but these were slow to germinate and have not made a heavy growth. They will not mature in this latitude and the amount of organic matter does not appear to be any more than would be obtained from soybeans.

Laboratory Investigations.

The Laboratory work has consisted of the routine analyses of crop samples and the analysis of soil samples secured in the soil survey work. Some work has been done with a view to determining the availability of phosphates in certain soils from Monmouth County which show an unusually high percentage of total phosphorous. This work should be ready for publication at an early date.

The work on soil protozoa was not undertaken until late in the year and not a great deal has yet been accomplished.

Biology.

The more important investigations of the Department of Biology consisted of: (a) Relation of green color in oysters to copper content;

(b) Length of free-swimming period of larval oysters; (c) Distribution of oysters larvæ and responses to light; (d) Food and feeding of oyster larvæ in comparison with adults; (e) Best conditions for artificial propagation of oyster larvæ; (f) The biology of the crystalline style in bivalves; (g) Influence of climatic factors in natural oyster propagation.

The results of these investigations comprise: (a) *Practical results*—ability to foretell best date for planting cultch, and ability to produce viable oyster larvæ by artificial fertilization; (b) *Scientific results*—Green color in oysters sometimes indicates great increase in copper content. The length of free larval life of oysters at Tuckerton, N. J., is about two weeks. Oyster larvæ seek the bottom at night. Oyster larvæ fail to discriminate between nutritious and non-nutritious food particles, thus differing from adult oysters, but resembling adult mussels. A cool spring delayed natural propagation a month.

The plans for the cooperation of the State Bureau of Shell-fisheries with the Experiment Station in the observation of oyster propagation were somewhat interfered with by the reorganization of this department by the State. A single Board of Shell-fisheries, with a practical oyster planter as director, displaces the Bureau and various oyster commissions. The new Board has fully endorsed the program projected by its predecessor for cooperation in these researches.

Botany.

The research in the Botanical Department lie within these projects, namely, (1) Plant Heredity, (2) Plant Environment and (3) Plant Toxicology.

Heredity—The leading subjects here are beans, corn, eggplants, peppers, squashes and tomatoes, the so-called vegetable fruits, the growing of which make up a leading feature of New Jersey agriculture. Fully 5000 pepper plants were grown the past season in a study of the inheritance of several of the characters in the first, second, third and fourth generations. The results obtained show a correlation between several qualities and a linking together of parental characters.

A study in inheritance in corn crosses indicate that there may be a marked difference in yield between the first and second generation, and in favor of the immediate cross. In a study of selection among ears of the first generation, it is shown that several ears produced offspring with ears like the parent, thus strengthening the view that the most careful selection, when possible, should be made among the first generation plants. In the crosses between flinty and floury varieties of corn, it is shown that the former is dominant, the floury behaving as does the sugary type in breeding with the flinty kinds.

Among beans and eggplants further evidence has been obtained as to the appearance of sterile plants, when the parents are not close of kin. In like manner, added information is secured concerning the inheritance of prolificness and non-prolificness.

Environment—Here the work is largely with the position of the seed upon the plant whether near the base or elsewhere in the flower cluster. With corn, for example, it is shown that the grains in the second, third, fourth and fifth of the ten zones, counting from the butt, are the best for seed and nearly the whole of the upper half of ordinary ears should be excluded from planting. Similar results show that the more centrally located seeds in the pods of peas, beans, etc., are the strongest. Much data in this connection has been secured to show that the seed ovules of long leguminous fruits are more apt to be abortive than elsewhere, indicating a correlation between the amount of abortiveness in a given region for seed production and lack of vigor in seeds there formed.

It has been found in a study of corn seedlings as related to greenhouse temperatures that a lack of congenial warmth reduces the viability and vigor, and increases the variability. The results suggest that in unfavorable conditions there may reside a practical method of eliminating the weaker seedlings.

Toxicology—The subjects were (1) soybeans and (2) prairie berries in duplicate in greenhouse pots. Lately the research has been limited to a study of the phosphates in various strengths in triplicate, (1) earth, (2) sand, (3) water, with close records of the appearances of the toxic effects upon the plants from day to day.

Entomology.

In the Department of Entomology especial attention has been given to the mosquito, the typhoid fly, the white grub, the peach borer, the potato flea-beetle, the spraying and dusting of potatoes, the influence of climate on insects, the strawberry weevil and insecticides (especially nicotine).

The Mosquito—The salt marshes bordering about 118 miles of our Atlantic Coast line, which have been more or less completely drained, have been patrolled throughout the past summer. More than 500,000 acres have been cared for and about one and one-half millions of people have been benefitted. The low salinity of the marsh waters in the early spring have been found to be the main factor contributing to the dominance of *A. cantator* at that season and the high salinity of mid-summer to the dominance of *A. sollicitans* during that part of the season. These species have been found to fly most readily in winds of high humidity and low velocity (about five miles an hour). Killifish became inactive on the marshes in the month of August—a peculiarity which, if characteristic, would serve to explain the well-known prevalence of *A. sollicitans* during that month. Neither sulphuric acid nor chlorine are promising larvicides because both disappear from the pools too rapidly.

The typhoid fly—Free ammonia appears to be the principal agent in attracting the female to horse manure for egg-laying purposes and the addition of either butyric or valerianic acid (especially the former) materially increases its attractiveness.

Soil-infesting insects—In red shale soil, which ranged in temperature from 70° F to 76° F, and was just moist enough to work well, three-fourths of an ounce of carbon bisulphide to one square foot of surface destroyed the white grubs and one ounce did not damage the blue grass and white clover.

Peach borer—Mechanical protectors such as the "Scott Tree Protectors" and various asphalt covers are very difficult to keep satisfactorily sealed. Inasmuch as they are ineffective if partly unsealed during any part of the season when the moth is on the wing and inasmuch as that season is long, they are at present not promising measures of protection.

Potato flea-beetle—In a field test, a mixture of one pound of pyrethrum, 10 ounces of whale oil soap and 10 gallons of water destroyed the beetles, did not injure the vines, and kept the plants practically free for a period of ten days. The cost of treatment is, however, too great to render it practicable.

The spraying and dusting of potatoes—Both types of mixtures controlled the Colorado beetle, but neither eliminated the damage done by the flea-beetle. The Bordeaux was the more effective, preventing about one-half the normal injury. Increases in yield have indicated that both types of mixture under ordinary conditions of soil and climate stimulate the vines to the production of a materially larger crop. Bordeaux mixture made the best showing, but the dusts of sulphur and arsenicals made increases that were worth considering.

Climate and insects—In the case of *B. obtectus*, 5° Fahrenheit increase in the critical high temperature is much more important than a change of 90 per cent in relative humidity.

The strawberry weevil—Keeping the plant covered with a dust composed of arsenate of lead and sulphur from the time the beetles begin to work until the plants reach full blossom appears to give almost perfect protection. The most effective mixture was made up one part to one part, but one part of lead arsenate to five parts of sulphur gave good results and was materially cheaper.

Insecticides (nicotine)—Spraying proved much more effective than dipping when working with *M. persicæ*. Breaking the surface tension of the spraying mixture with soap doubled the effectiveness. Two pounds of soap to 50 gallons of mixture proved to be the optimum. Adult dark females of the rosæ apple aphis required one part of "Black Leaf 40" to 500 parts of water to kill 100 per cent, even when the surface tension was broken with soap.

Plant Pathology.

The investigations on "brown blotch" and "black spot" of the Kieffer pear, conducted under the immediate supervision of Mr. George W. Martin have given gratifying results. The Department is now ready to make recommendations for the control of both diseases.

Interesting data have been secured by Mr. H. Clay Lint, in his work on the "powdery scab" of the potato. The results will be ready for publication at an early date.

Similarly, the spraying work on potatoes conducted by Mr. Lint have given results of interest and it is hoped that they will be available for publication in the near future. It appears at present that the increase produced by spraying has been rather small. On the other hand, the spraying experiments on grapes, conducted under the immediate supervision of the Plant Pathologist, gave an increase in yield of about 60 per cent.

Good results have also been obtained in cooperative spraying experiments on tomatoes. These experiments have been conducted jointly by the Station and the Campbell Soup Company. The Plant Pathologist of the Station wishes to acknowledge his indebtedness to the Campbell Soup Company for the help extended in the conduct of the cooperative work.

Aside from the activities noted above, the Plant Pathologist of the Experiment Station conducted a cooperative experiment with the Maine Agricultural Experiment Station on the planting of potatoes badly infested with *Rhizoctonia*. Much work of an advisory capacity was done for the farmers in the State either by means of personal visits or by correspondence. Serious epidemics of "fire blight" on the pear and apple, *Rhizoctonia* on the potato, "mosaic" on the tomato, and *Anthracnose* of the beans were responsible for a demand for increased service from the members of the Staff of the Department.

Publications.

Because of the more ample funds that had been appropriated to the Station for the issuing of technical or popular publications, the number of bulletins and circulars printed was greater than that of the preceeding year. The following publications appeared between November 1, 1914 and October 31, 1915.

Bulletins.

273. Analyses of Materials Sold as Insecticides and Fungicides.
274. Analyses and Valuations of Commercial Fertilizers and Ground Bone. Analyses of Agricultural Lime.
275. Fertilizer Registrations.
276. The Mosquitoes of New Jersey and Their Control.
277. Humidity, Soil and Fertility Studies with Roses.
278. Some Results in Size Inheritance.
279. Results of Seed Inspection—1914.
280. Pot Experiments on the Availability of Nitrogen in Mineral and Organic Componds.
281. Nitrogen Utilization in Field and Cylinder Experiments II.
282. Factors Influencing the Protein Content of Soybeans.
283. Concentrated Feeding Stuffs and Registrations for 1915.
284. Packing and Shipping Peaches in Georgia Carriers.
285. Analyses and Valuations of Commercial Fertilizers, Fertilizer Supplies and Home Mixtures.
286. Analyses of Materials Sold as Insecticides and Fungicides.

Circulars.

41. Varieties of Tree Fruits for New Jersey.
42. Spraying and Dusting White Potatoes.
43. Meadows and Pastures.
44. Common Diseases of Apples, Pears and Quinces.
45. Common Diseases of the Peach, Plum and Cherry.
46. The Hessian Fly.
47. The Determination of Humidity in the Greenhouse.
48. Bordeaux Mixture.

Reports.

35-1914. Thirty-Fifth Annual Report New Jersey State Agricultural Experiment Station, and Twenty-Seventh Annual Report New Jersey Agricultural College Experiment Station.

The Experiment Station has also issued during the year the monthly publication, Hints to Poultrymen, Vol. III. Nos. 2 to 12, and Vol. IV, No. I.

Extension Bulletins Published by the State Agricultural College.

Vol. 1. No. 1. Annual Report of the Director of Extension for year ending November 1, 1914.
Vol. 1, No. 2. The Home Vegetable Garden.
Vol. 1, No. 3. Marketing the Sweet Potato Crop in New Jersey.
Vol. 1, No. 4. A Message to the Women of New Jersey.
Vol. 1, No. 5. Marketing White Potatoes in New Jersey.
Vol. 1, No. 6. Marketing Tomatoes in New Jersey.
Vol. 1, No. 7. Milk and Eggs.

The Weekly News Letter, Vol. II, Nos. 1 to 52, was published during the year by the Extension Division of the State Agricultural College.

Cooperation With Other Organizations.

The Station was fortunate to have secured the cooperation of other departments, institutions and organizations in promoting the agricultural interests of the State. The soil survey of the State has been carried on as formerly with the cooperation of the State Geologist and of the Bureau of Soils of the United States Department of Agriculture. An area of between 300 and 400 square miles was surveyed and mapped within the past season. This area comprises portions of Camden, Gloucester, Atlantic and Salem Counties. The territory surveyed in 1915, added to that surveyed in 1914, represents nearly 700 square miles of land surface. In the soil survey work of the past season, particular attention was given to the relationship of soil types and the various truck crops grown in South Jersey.

The Station cooperated with the State Board of Agriculture in organizing and conducting Farmers' Institutes and other farmers' meetings. Similarly, the Station cooperated with the New Jersey State Horticultural Society, the State and Local Poultry Associations, the State Cranberry Growers' Association, the State Department of Education, the Live Stock Commission and the United States Department of Agriculture in an effort to encourage progress in several fields of agricultural activity. The members of the Station Staff feel grateful to the many persons, both within and without the State, for having helped them, directly or indirectly, to render service to members of our rural communities.

REPORT OF THE DEPARTMENT OF CHEMISTRY

Department of Chemistry

Charles S. Cathcart, M.Sc., *Chemist.*

Ralph L. Willis, B.Sc., *Assistant Chemist.*

*Willis H. Pearson, *Assistant Chemist.*

Arthur N. Hutchinson, B.Sc., *Assistant Chemist.*

†Samuel I. Hoddeson, B.Sc., *Assistant Chemist.*

Joseph J. Williams, *Microscopist.*

Archie C. Wark, *Laboratory Assistant.*

W. Andrew Cray, *Sampler and Assistant.*

Herbert P. Rood, *Sampler and Assistant.*

*Resigned February 1, 1915
†Appointed February 1, 1915.

CONTENTS.

Report of the Department of Chemistry.

CHARLES S. CATHCART.

I.

INTRODUCTORY.

The activities of the Department of Chemistry for the fiscal year ending October 31, 1915, were very largely confined to the inspection work as required by the laws regulating the sale of fertilizers, agricultural lime, feeding stuffs and insecticides. In addition to the inspection work, some analyses were made for other departments and for county demonstrators. The department has also been making a study of the cottonseed meal question in order to ascertain, if possible, the maximum quantity of crude fiber which should be found in the cottonseed meal. This work has not been completed and the details are not, therefore published.

The work of the department may be divided into two classes, the first relating to the administration and the second relating to the actual chemical work.

The adminstration of the laws required the following:

Fertilizer registrations and certificates issued	1595
Feeding stuff registrations and certificates issued	2546
Insecticide registrations and certificates issued	172
Lime registrations and certificates issued	83
Total number of reports issued	3122
Number of letters, dictated and circular	6660

The results of the chemical work will be found on the following pages in the reports covering the various inspections.

II.

INSPECTION OF COMMERCIAL FERTILIZERS DURING 1915.

The inspection of the fertilizers sold in the State was made in accordance with the law entitled, "An Act Concerning Fertilizers." which was approved March 27, 1912. The various requirements as enumerated in the law may be summarized as follows: registration, tonnage reports, analyses and the publication of the results.

Registrations.

The date prescribed for making the annual registrations is November 1st, but if a manufacturer desires to offer a new brand, it may be registered at any time during the year, provided that this requirement is complied with before the material is actually placed on the market. The materials that are required to be registered consist of all mixed fertilizers and all fertilizer materials that are sold for more than five dollars a ton, except lime, limestone, marl, plaster and the excrement and litter from domestic animals when sold in their natural state.

During the year, 140 firms or persons registered 1596 brands, 24 of which were cancelled at a later date. Under date of January 7, 1915, the registrations that had been received were published in Bulletin No. 275, and the registrations that were received since that date are published in Bulletin No. 287.

Ninety-four samples were received during the inspection, which represented shipments of brands that had not been registered. These brands were supplied by 45 manufacturers, and their attention was immediately called to the condition. Forty-two of the manufacturers, without unnecessary delay, registered 88 of the brands, and one person responsible for two brands had the registrations made by the company who prepared the mixtures. These manufacturers failed to register all of their hrands offered for sale: The Glaser Co., Plainfield, N. J.; R. A. Reichard, Allentown, Pa.

There were more unregistered brands found this year than during the 1914 inspection. Ordinarily there can be no real reason for failure to comply with this requirement of the law. The excuse for the failure to comply can usually be attributed to putting the work off until finally it is forgotten. The delay in making the various registrations this year may be partially due to the scarcity of potash, thus causing a delay in determining the mixtures that could be prepared; but even this condition is not an acceptable reason for not making the registrations before the shipment of the materials. It is not only desired, but it is necessary that careful attention be given to the question of registrations, and this applies to the accuracy of the statements as well as to the time of filing the registrations.

The law not only prescribes the terms to be used in stating the guarantees which are registered as well as attached to the material as sold, but it also prescribes that no other terms are to be used. The terms that are allowed are the minimum percentages of nitrogen, nitrogen equivalent to ammonia, total and available phosphoric acid and water soluble potash, and, under certain conditions the water soluble potash may be stated in terms of sulphate of potash. It is important to note that only the minimum percentages are allowed, and then only when used with the terms as stated above. There were fewer instances of misbranding this year than were found during previous inspections, and most of these cases could be traced to shipments made during the manufacturers' busiest shipping period. We can appreciate many of the difficulties, due to the different requirements of the inspection laws of the various states, which the manufacturers have to overcome, but inasmuch as the law of New Jersey prescribes a definite method of branding the materials sold, we must insist that it be used on all shipments sold in this State. Dealers and consumers should examine carefully the guarantees given, and if they vary from the prescribed forms as stated above, the State Chemist should be notified so that the question could be taken up with the party responsible and properly adjusted.

Reports on Tonnage.

In accordance with the law, and also with the certified statements made at the time of registering the brands to be offered for sale, reports on the tonnage sold are required to be rendered on April 1st and November 1st of each year. The following is a summary of the reports received during the past three years:

Year.	April Reports: Mixed Fertilizers. Tons.	April Reports: Fertilizer Materials. Tons.	November Reports: Mixed Fertilizers. Tons.	November Reports: Fertilizer Materials. Tons.	Total for the Year. Tons.
1913	87,446.91	10,303.17	51,706.28	7,204.79	156,661.15
1914	78,768.27	8,735.62	59,223.26	8,686.99	155,414.14
1915	87,052.13	7,276.45	53,288.11	5,459.28	153,075.97

Inspection for 1915.

During the inspection every county in the State was visited and 1614 samples were received at the Station, the two inspectors collecting about 95 per cent of this number in duplicate as required by the fertilizer law, and they represented the stock of 551 dealers and consumers. The detailed results of the inspection, with the exception of the analyses of some of the unofficial samples of mixed goods which were reported directly to those submitting the samples, were published in Bulletins 285 and 287.

The samples examined consisted of the following:

543	Samples	Commercial Fertilizers.	
31	"	" "	(Duplicates)
79	"	" "	(Unofficial)
21	"	Home Mixtures.	
35	"	Miscellaneous Mixtures.	
162	"	Fertilizer Materials.	
43	"	Ground Bone.	
90	"	Sundry Materials.	
1004	"	Total.	

The analyses of the above samples required over 12,000 separate determinations.

Wholesale Prices of the Essential Elements of Plant Food for 1914.

The wholesale prices of the unmixed or raw materials, used in preparing the mixed fertilizers, are quoted weekly in the trade journal, "The Oil, Paint and Drug Reporter." In order to express the figures given as prices per pound of actual plant food which is the form adopted by the experiment stations of this country, the quotations have been recalculated and tabulated for the entire year. On account of the fact that the report of the Station is made on October 30th of each year, the prices that have been tabulated are for the year 1914.

The prices that were quoted for the potash salts from August to December were given as "nominal" and are not included in the averages for the year.

Wholesale Cost, Per Pound, in New York.

MONTHS 1914.	OF NITROGEN IN FORM OF—			Of Phosphoric Acid in Form of—		OF POTASH IN FORM OF—			
	Nitrate of soda	Sulphate of ammonia	Dried blood	Acid phosphate		Kainit	Muriate of potash	Double sulphate of potash and magnesia	High grade sulphate of potash
	Min.	Min.	Min.	Max.	Min.	Min.	Min.	Min.	Min.
	cts.	cts.	cts	cts.	cts	cts.	cts.	cts.	cts.
January	14.12	14.15	20.19	2.50	2.25	3.34	3.86	4.82	4.89
February	14.20	13.90	20.34	2.50	2.25	3.34	3.86	4.82	4.89
March	14.20	13.90	20.34	2.50	2.25	3.34	3.86	4.82	4.89
April	14.20	13.90	20.34	2.50	2.25	3.34	3.86	4.82	4.89
May	14.26	13.65	20.19	2.50	2.25	3.34	3.86	4.82	4.89
June	13.99	13.02	19.43	2.50	2.25	3.34	3.86	4.82	4.89
July	13.36	12.45	18.28	2.50	2.25	3.34	3.86	4.82	4.89
August	13.24	12.68	18.22	2.50	2.25	3.39	3.90	4.88	4.92
September	12.69	12.68	18.67	2.50	2.25	3.42	3.91	4.92	4.94
October	12.13	12.44	19.28	2.50	2.25	3.42	3.91	4.92	4.94
November	12.13	12.44	19.73	2.50	2.25	3.42	3.91	4.92	4.94
December	12.13	12.44	19.73	2.50	2.25	3.42	3.91	4.92	4.94
Average, 1914	13.39	13.14	19.56	2.38		*3.34	*3.86	*4.82	*4.89
Average, 1913	15.71	15.35	17.43	2.52		3.80	3.80	4.81	4.81
Average, 1912	15.32	16.03	16.69	2.63		3.36	3.80	4.78	4.79

*Average for 7 months.

Schedule of Trade Values for 1915.

As the manufacturers probably place most of their contracts for raw materials near the close of the year, the quotations, which are published weekly in the "Oil, Paint and Drug Reporter," for the last four months of 1914 and the first two months of 1915 have been averaged and, with the exception of the figures for potash salts, considered a suitable basis for determining the schedule of values for 1915. The figures as published for the potash salts were not definite enough to calculate the values to be allowed for this element, and it was necessary to secure additional information from other sources before any value could be adopted. Various manufacturers were consulted and their figures were obtained and, also, the actual quotations for the salts and for mixed goods were secured from individuals. The information received from these sources was the basis for the calculation of the values for potash as they appear in the schedule, and they are apparently correct for the potash in mixed goods that were sold during the spring. It is quite evident, however, that these values are not correct for the mixtures sold this fall and, consequently, the valuations of any fall goods if calculated by these figures would give results that might be misleading to say the least.

The following is the schedule of values as arranged at a meeting of he station directors and chemists, which was held in the early past of

March, for use in the New England States and New Jersey during the season of 1915:

	Cents. per pound.
Nitrogen in Nitrates	15.0
" " Ammonium Salts	15.5
Organic Nitrogen in fine* ground fish, meat and blood	22.0
" " " cotton-seed meal and castor pomace	20.0
" " " fine* bone and tankage	21.0
" " " mixed fertilizers	19.0
" " " coarse* bone and tankage	17.0
Phosphoric Acid, soluble in water	4.0
" " " " ammonium citrate	3.5
" " in fine* bone and tankage	4.0
" " " cotton-seed meal and castor pomace	3.5
" " " coarse* bone, tankage and ashes	3.5
" " insoluble in water and in ammonium citrate	2.0
Potash in high-grade Sulphate, and in forms free from muriate (chlorides)	9.5
" " Muriate	8.5
" " cotton-seed meal and castor pomace	9.5

Composition as Shown by the Inspection.

All of tbe brands, with two exceptions, were accompanied by the required guarantee at the time of shipment. Some of the brands, however, were not guaranteed in the exact terms as prescribed in the law.

The average amounts of plant food guaranteed and delivered as determined by the analyses of the 545 brands are as follows:

	Av'ge Found %	%	Average Guar'ted %
Nitrogen as Nitrates	0.63		
" " Ammonia Salts	0.90		
" " Water Soluble Organic	0.39		
" " Active Insoluble Organic	0.45		
" " Inactive Insoluble Organic	0.33		
" Total		2.70	2.71
Phosphoric Acid, Total	9.78		
" " Insoluble	1.59		
" " Available		8.19	7.90
Potash		3.54	3.29

In accordance with the figures given for the average analysis, the guarantees were sustained; but by a study of the individual analyses it will be apparent that some of the guarantees were not delivered, while in other cases the guarantees were exceeded. A detailed study of the 543 guaranteed brands shows that 144 fully satisfied every guarantee given, and in addition to this number 223 substantially satisfied the claims of the manufacturers. The remaining 176 brands, or about 32 per cent of the number received, were deficient. Of these deficient brands 151 were deficient in one element, 20 in two elements and 5 in all three of the guaranteed elements.

*"Fine" signifies such as will pass through a sieve with circular holes 1/50 of an inch in diameter, and "coarse" such as will not.

By comparing these figures with those reported in previous years, we find that the results obtained this year show a larger percentage of deficient brands than has been noted since the report of 1912, when the large percentage was due to the requirements of the old law in regard to the method of determining the available phosphoric acid.

In the guaranteed brands examined there were 1629 deficiencies possible, and of this number 208 or 12.8 per cent were found, which is, with the exception of 1912, the highest percentage of deficiencies found since 1910.

This large deficiency can be attributed to the exceedingly large number of brands which did not contain the percentage of nitrogen claimed. There were 94 brands deficient in this element, and this is the greatest number that has been found in any inspection during the past 15 years if we except the results obtained in 1905, 1906 and 1908. If this large number of deficiencies had been found in the potash content, the argument would have followed that it was one of the results of the war, since during the past we have had to depend upon the foreign shipments for this element. Although the potash situation necessarily causes some uneasiness, the nitrogen question is, also, very important and should be given very careful attention, and this applies to the character of the organic nitrogen supplied as well as to the total amount of this element contained in the delivered mixtures.

Four hundred and seventy-one brands contained nitrogen in the form of nitrates or ammonia salts. Two hundred and forty-eight brands contained nitrate nitrogen, 392 contained ammonia salts and 169 brands contained both of these highly available forms.

The average content of organic nitrogen in the brands examined is 1.17 per cent, of which 0.39 per cent is water soluble and 0.45 per cent "active insoluble," while the remainder or 0.33 per cent is "inactive insoluble." Last year the averages were water soluble 0.40, active insoluble 0.50 per cent and the inactive insoluble 0.30 per cent. These figures show that the character of the insoluble nitrogen for the average of the samples examined was poorer than last year.

Analyses of some of the materials more generally used in the manufacture of fertilizers show the availability of the insoluble portion to be as follows:

	Per cent
Dried Blood, High Grade Tankage, Fish	69—76
Cotton-seed Meal, Medium Tankage, Bone Meal	55—67
Leather Preparations	13—59
Garbage Tankage, Peat	•23—41

From the above, it would not be expected to find the availability of the insoluble portions in mixed goods to be lower than 55 per cent if he standard materials had been used or other materials had been treated n order to render them in an available form. The results obtained, iowever, show that 7.1 per cent of the brands contained insoluble organic iitrogen having an availability of 40 per cent or less; 41.7 per cent of the rands had an availability of 40—55 per cent, 48.1 per cent of the brands with an availability of 55—70 per cent and 3.1 per cent with an availability above 70 per cent. These figures show that about 50 per cent of the brands contained a portion, at least, of the nitrogen in an inert form.

It would be a difficult problem to calculate the money spent for this inert nitrogen without the exact tonnage of each brand sold, but it is safe to conclude that it would amount to many thousands of dollars.

From the above statements relating to the nitrogen delivered during the past season, it is evident that the purchaser must insist upon receiving his organic nitrogen in a more available form if he expects to get an adequate return for the money expended.

There were 83 deficiencies in phosphoric acid, which is the smallest number of deficiencies in this element that has been reported for a number of years.

Thirty-one brands were found deficient in potash and, consequently, this is the best record for many years. On account of the scarcity of potash salts, it was anticipated that a large number of deficiencies would be found, but as noted above the results were very satisfactory.

Thirty brands out of the total number examined contained their potash in the form of sulphate.

Summary of the Results of the Inspection.

The following tabulation gives the names and addresses of the manufacturers of mixed fertilizers whose brands have been examined this year, as well as a summary of the results obtained. In tabulating these results, a deficiency of 0.20 per cent or less nitrogen and 0.30 per cent or less phosphoric acid or potash has been disregarded.

Summary of the Results Obtained With the Mixed Fertilizers Examined During the Inspection of 1915.

MANUFACTURER.	ADDRESS.	Number of brands received.	Number of samples examined.	Number of samples satisfied guarantees.	Number of samples substantially equal to guarantees.*	NUMBER OF SAMPLES DEFICIENT IN— Nitrogen.	Phosphoric acid.	Potash.	One element.	Two elements.	Three elements.
Acme Guano Co.	Baltimore, Md.	7	7	4	1	2	....	....	2	....	....
American Agricultural Chemical Co.	New York City.	84	85	26	38	9	9	5	19	2	....
Apgar, William B.	Three Bridges, N. J.	1	1	....	....	....	1	1	....	1	....
Armour Fertilizer Works.	Baltimore, Md. and Chrome, N. J.	12	12	1	7	1	3	....	4	....	....
Ayres, John F.	Alloway, N. J.	2	2	....	1	....	1	....	1	....	....
Baird & Son, Jas. A.	Marlboro, N. J.	5	6	2	1	....	3	....	3	....	....
Baugh & Sons Co.	Philadelphia, Pa.	24	24	8	13	1	1	1	3	....	....
Berg Co., The	Philadelphia, Pa.	7	7	5	1	1	....	....	1	....	....
Bon Arbor Chemical Co.	Paterson, N. J.	1	1	1	....	....	....	....	....	....	....
Bowker Fertilizer Co.	New York City.	13	13	7	4	1	1	....	2	....	....
Brown, William M.	Cedarville, N. J.	1	1	....	....	....	1	....	1	....	....
Burlington County Produce Sales Co.	Mt. Holly, N. J.	2	2	....	1	1	1	....	....	1	....
Burlington Supply Co.	Burlington, N. J.	3	3	....	3	....	....	....	....	....	....
Chamberlain & Barclay	Cranbury, N. J.	1	1	1	....	....	....	....	....	....	....
Coe-Mortimer Co.	New York City.	12	12	2	7	2	1	....	3	....	....
Collins & Son, Inc., J. S.	Moorestown, N. J.	7	7	1	3	3	....	....	3	....	....
Consumers Chemical Corporation.	New York City.	10	10	6	2	2	....	....	2	....	....
Demaris Estate, B. F.	Cedarville, N. J.	2	2	1	1	....	....	....	....	....	....
Dilts, O. H.	Ringoes, N. J.	1	1	....	1	....	....	....	....	....	....
Downward Co., J. G.	Coatsville, Pa.	4	4	....	1	1	3	....	2	1	....
Dugan, John	Moorestown, N. J.	3	3	1	2	....	....	....	....	....	....
Fogg & Hires Co.	Salem, N. J.	3	3	....	....	2	....	2	2	1	....
Glaser Co., The.	Plainfield, N. J.	4	4	1	1	....	....	1	1	....	....
Gloucester County Granges.	Swedesboro, N. J.	2	2	....	2	....	....	....	....	....	....
Godfrey Co-operative Fert. and Chem. Co.	Newark, N. J.	9	9	....	4	4	3	....	3	2	....
Green, Chas. A.	Philadelphia, Pa.	1	1	....	....	1	....	....	1	....	....
Griscom, Jas. C.	Woodbury, N. J.	1	1	....	....	1	....	....	1	....	....
Hackett, Thomas Y.	Daretown, N. J.	3	3	....	2	....	1	....	1	....	....
Hendrickson & Dilatush.	Robbinsville, N. J.	7	7	4	2	1	....	....	1	....	....
Heritage & Bro.	Mullica Hill, N. J.	3	3	....	3	....	....	....	....	....	....

Hess & Bro., Inc., S. M.	Philadelphia, Pa.	8	8	3	3	2			2		
Hill Bros.	Flemington, N. J.	2	2		1		1		1		
Hoffman & Bro., P.	Raubsville, Pa.	2	2	1	1						
Hubbard Fertilizer Co.	Baltimore, Md.	2	2	1	1						
Hutchinson, Jr., H. H.	Robbinsv lle, N. J.	2	2		1		1		1		
International Seed Co.	Rochester, N. Y.	1	1		1		*				
Kemp, H. B.	Long Branch, N. J.	5	5		2		3		3		
Keystone Bone Fertilizer Co.	Philadelphia, Pa.	6	6		2	1	4		3	1	
Lancaster, William	Philadelphia, Pa.	1	1		1						
Lederer & Son, Samuel	New Brunswick, N. J.	1	1			1	1	1			1
Lippincott & Bro., C. A.	Moorestown, N. J.	1	1		1						
Listers Agricultural Chemical Works	Newark, N. J.	17	18	6	8		4		4		
Locke & Black	Swedesboro, N. J.	3	3		3						
Mapes F. and P. Guano Co.	New York City	14	14	3	5	1	6		5	1	
Martin Fertilizer Co.	Philadelphia, Pa.	10	11	1	1	6	5	6	4	2	3
Minch, John E.	Bridgeton, N. J.	7	7	1	2	3	1		4		
Monmouth County Farmers Exchange	Freehold, N. J.	8	9	5	3			1	1		
Moore, Jos. R.	Swedesboro, N. J.	6	6		4	1		1	2		
Nassau Fertilizer Co.	New York City	3	3	1	2						
Nelson, Albert	Allentown, N. J.	4	4	3			1		1		
N. J. Fertilizer and Chemical Co.	New York City	3	3	2				1	1		
Nitrate Agencies Co.	New York City	1	1	1							
Noll & Co., J. F.	Newark, N. J.	2	2	1			1		1		
Patapsco, Guano Co.	Baltimore, Md.	4	4	1	3						
Peerless Fertilizer Co.	Chestertown, Md.	2	2	1	1						
Philadelphia Guano Works	Philadelphia, Pa.	5	5	2	1	1	1		2		
Quaker City Poudrette Co.	Philadelphia, Pa.	1	1		1						
Ramsay, A. L.	Perth Amboy, N. J.	2	3			2	3	2	1		2
Rasin Monumental Co.	Baltimore, Md.	4	4	1	3						
Reading Bone Fertilizer Co.	Reading, Pa.	†6	7	2	2			2	2		
Reichard, Robt. A.	Allentown, Pa.	1	1		1						
Roberts Co., Ellwood	Philadelphia, Pa.	7	7	1	3		3		3		
Rode, William	Swedesboro, N. J.	2	2			1	2	1		2	
Royster Guano Co., F. S.	Baltimore, Md.	8	8		4		4		4		
Ruckman Bros.	New Brunswick, N. J.	4	4	1		1	1	1	3		
Runyon, A. D.	Millington, N. J.	1	1		1						
Schanck, Hutchinson & Field	Hightstown, N. J.	4	4	1	2		1		1		
Scott Fertilizer Co.	Elkton, Md.	5	5	4	1						
Shoemaker & Co., Ltd., M. L.	Philadelphia, Pa.	6	6	5	1						
Sickel, Harry L.	Woodbury, N. J.	7	7	4	2	1			1		
South Jersey Farmers Exchange	Woodstown, N. J.	18	24	5	9	8		2	10		
Standard Guano Co.	Baltimore, Md.	7	9	1	4	2		2	4		
Stanley, Henry	Westville, N. J.	1	1		1						
Strong, E. N.	Ringoes, N. J.	1	1					1	1		
Swift & Co.	Baltimore, Md.	2	2		2						
Swift & Co.	Kearny, N. J.	18	19	3	5	8	5	1	8	3	
Taylor Bros.	Camden, N. J.	1	1	1							

*Not ove: 0.20% ow n t ogen; 0.30% low in phosphoric ac d or potash.
†B. and not gua ante d.

Summary of the Results Obtained With the Mixed Fertilizers Examined During the Inspection of 1915.—Continued.

MANUFACTURER.	ADDRESS.	Number of brands received.	Number of samples examined.	Number of samples satisfied guarantees.	Number of samples substantially equal to guarantees.*	NUMBER OF SAMPLES DEFICIENT IN— Nitrogen.	Phosphoric acid.	Potash.	One element.	Two elements	Three elements.
Taylor Provision Co.	Trenton, N. J.	5	5	....	2	3	....	....	3	....	....
Thomas & Son Co., I. P.	Philadelphia, Pa.	21	25	4	12	6	4	....	8	1	....
Trenton Bone Fertilizer Co.	Trenton, N. J.	13	14	2	6	1	3	....	5	1	....
Tunnell & Co., Inc., F. W.	Philadelphia, Pa.	36	45	10	11	19	2	4	23	1	....
Tygert Co., J. E.	Philadelphia, Pa.	4	4	....	4	....	....	....	....	....	....
Virginia-Carolina Chemical Co.	New York City	17	17	8	7	2	....	....	2	....	....
Vreeland, A. J.	Matawan, N. J.	1	1	1	....	....	....	....	....	....	....
Wenderoth & Sons, J.	Camden, N. J.	4	4	2	2	....	....	....	....	....	....
West Jersey Marl and Trans. Co.	Woodbury, N. J.	10	10	2	6	2	....	....	2	....	....
Whann Co., W. E.	Philadelphia, Pa.	4	4	1	2	1	1	....	....	1	....
Wilde, William	Vineland, N. J.	2	2	1	....	1	....	....	1	....	....
Worthley, Abbott	Marlboro, N. J.	1	2	....	....	....	2	....	2	....	....

*Not over 0.20% low in nitrogen; 0.30% low in phosphoric acid or potash.

III.

INSPECTION OF AGRICULTURAL LIME.

On account of the variability in the various forms of lime that are sold for agricultural purposes, it was deemed necessary to regulate the sale of such products. In accordance with this idea, an act entitled "An Act to Regulate the Sale of Agricultural Lime" was approved on April 1, 1913, and the law became effective on January 1, 1914. The essential features of this law, briefly stated, are:

1. Registration of the brand, name and guarantees that will be attached to the materials as sold.
2. The constituents that must be guaranteed.
3. The name and address of the party responsible for the material.
4. The official inspection of the materials offered for sale.

Registrations.

During the past year 39 manufacturers registered 82 different brands of agricultural lime. The names and addresses of those who have registered their products are:

Alpha Portland Cement Co., Easton, Pa.; J. E. Baker, Co., York, Pa.; S. W. Barrick & Sons, Woodsboro, Md.; Beam & Co., Philadelphia, Pa.; Blair Limestone Co., Martinsburg, W. Va.; Carbo Agricultural Lime Co., Wilmington, Del.; F. E. Conley Stone Co., Utica, N. Y.; Judson Conover, Matawan, N. J.; G. and W. H. Corson, Plymouth Meeting, Pa.; Edison Pulverized Limestone Co., New Village, N. J.; J. Philip Exton, Clinton, N. J.; Fountain Rock Lime Co., Woodsboro, Md.; M. J. Grove, Lime Co., Lime Kiln, Md.; James Heritage & Son, Vineland, N. J.; W. S. Hoffman, Middle Valley, N. J.; Keasbey & Mattison Co., Ambler, Pa.; J. B. King & Co., New York City; Knickerbocker Lime Co., Philadelphia, Pa.; John Kreutz & Sons, Inc., Philadelphia, Pa.; E. J. Lavino & Co., Philadelphia, Pa.; LeGore Combination Lime Co., LeGore, Md.; Weller C. Leigh, Lebanon, N. J.; Lukens & Yerkes, Philadelphia, Pa.; Merion Lime & Stone Co., Norristown, Pa.; M. C. Mulligan & Son, Clinton, N. J.; E. J. Neighbour, German Valley, N. J.; Lowell M. Palmer, York, Pa.; Jeremiah Reed & Son, Beatystown, N. J.; David H. Rising, Easton, Pa; C. T. Russell, Jersey City, N. J.; Security Cement & Lime Co., Hagerstown, Md.; Steacy & Wilton Co., Wrightsville, Pa.; Standard Lime & Stone Co., Buckeystown, Md.; Benjamin Stoner, Hellam, Pa.; Thomasville Stone & Lime Co., Thomasville, Md.; Todd & Cordes, Peapack, N. J.; Twining & Large, Yardley, Pa.; Vanderhoof Lime Co., Hamburg, N. J.; Charles Warner Co., Wilmington, Del.

Inspection.

Forty-five samples of the various brands of lime were analyzed, and the results are given in detail in Bulletin 287.

IV.

INSPECTION OF CONCENTRATED FEEDING STUFFS.

The detailed report of the annual inspection of commercial feeding stuffs was published in Bulletin 283.

In order that the maximum benefits of the law may be secured, it is necessary that every one interested in the sale or use of commercial feeding stuffs should be familiar with the various provisions as annumerated in the law. Every effort has been made by the Experiment Station to supply this information by publishing the full text of the law in the bulletins and reports. It does not seem necessary to reprint the law in full at this time, and a brief summary may be given as follows:

Section 1. Defines "commercial feeding stuffs" and notes the exceptions.

Section 2. Specifies in detail the information that must be attached to the material.

Section 3. Requires the person who desires to sell feeding stuffs to have the brands registered.

Section 4. Requires the person who has made a registration to render reports on July 1st and January 1st, showing the total tonnage sold.

Section 5. Gives the State Chemist authority to refuse any registration if the application is not made accurately.

Section 6. Refers to the duplication of registration and tonnage reports.

Section 7. Gives the State Chemist the authority to secure samples and to have them analyzed.

Section 8. Describes the method to be used in sampling.

Section 9. Relates to the reports which are rendered by the State Chemist.

Section 10. States the penalty for not complying with various provisions of the law.

Section 11. Authorizes the expenditure of the inspection fees.

Registrations.

During the year 1914, 491 manufacturers and jobbers registered 2069 brands which they intended to offer for sale in this State. Two hundred and nineteen brands were found on sale by our inspectors before the registrations had been made. This is an improvement over the previous inspection, when 242 brands were found in this condition. With the exception of 18 brands, all of the 219 brands have been registered and are included in the total number of registered brands.

Many of the unregistered brands that were on the market were sold by jobbers who assumed that it was the duty of the manufacturer to attend to the requirements of the law in regard to the registration; or in those cases where the manufacturers had made registrations, they assumed that the requirements had been complied with. In accordance with our interpretation of the law, the party selling a feeding stuff to a customer in this State must comply with all of the conditions enumerated in the law, which are registration, attaching the guarantee as well as the name and address to the feed that is offered, and to render the tonnage reports on the dates specified. This interpretation is being accepted and the jobbers as well as the manufacturers are attending to the requirements.

Tonnage of Feeding Stuffs Sold.

The law requires reports to be filed on July 1st and January 1st of each year showing the tonnage of feeding stuffs sold during the preceding six months. The following is a summary of the reports received during 1913 and 1914:

Year	July Reports	Jan. Reports	Total for year
1913	93,664.17	102,560.00	196,224.17
1914	88,192.50	114,508,73	202,701.23

Inspection.

During the inspection, 1322 samples were received, and of this number 34 represented samples that were forwarded by individuals for examination and were not official samples.

In order to make the inspection as thorough as possible, the inspectors were instructed to visit every county in the State, and as a result the samples received represented the stock of 309 dealers and consumers, and a list of the addresses of these dealers and consumers would show that the samples represented the materials that were being sold in 156 cities and towns.

Examination of Feeding Stuffs.

The examination of the feeding stuffs consisted of a microscopical examination and a chemical analysis.

Every sample was examined in order to determine the ingredients used in preparing the feed. This kind of an examination has a particular value, as it is well known that different materials have a different feeding value irrespective of the quantity of nutrients present. The information thus secured enables one to compare the ingredients present with those claimed to be used.

A feeding stuff is composed of groups of chemical compounds which have certain functions to perform in the production of energy and in maintaining or building up the animal body. A chemical analysis necessary to determine these various constituents consists in determining the content of moisture, protein, fat, nitrogen-free extract, fiber and ash.

The following is a brief explanation of these terms:

MOISTURE OR WATER. Moisture in feeds is the water found in all grains and feeding stuffs, and the amount varies according to the kind of feeding stuff, its age or state of greenness and method of storing.

PROTEIN. Protein is the nitrogenous constituent of a feeding stuff, and is represented by such substances as gluten of wheat, the albumen or white of an egg, the lean part of beef, etc. An analysis of pure protein will show that it contains about 16 per cent. of the element nitrogen. The term protein as generally used simply means the total nitrogen content multiplied by the factor 6.25.

FAT. Fat, or more correctly called the ether-extract, consists of the fat as well as small quantities of wax, coloring matter and other substances that may be dissolved from a dry feed by anhydrous ether.

NITROGEN-FREE EXTRACT. Nitrogen-free extract, sometimes called carbohydrates, includes such materials as starch, sugar, etc., and is the general term given to those bodies contained in a feed other than water, protein, fat, fiber, and ash. The amount contained in a feed is determined by subtracting the sum of the percentages of the constituents previously mentioned from 100.

FIBER. Fiber or crude fiber is the structural material or woody part of the grains, hay or other feeding stuff.

ASH. Ash is the mineral constitutent of a feed and consists largely of phosphates and carbonates of calcium and potassium.

Results of the Inspection.

Nine hundred and twenty samples were examined during the past year, and of this number 158 or 17.2 per cent did not satisfy the guarantees given for the content of protein, fat or fiber. The number of deficiencies due to the ingredients identified in the various materials is not included in the above. When the percentage of deficient samples is compared with the percentage reported last year, 17.7 per cent, it will be noticed that there has been a slight improvement in the feeds examined, but while this is true the percentage is larger than it should be.

One hundred and thirty-two samples were deficient in one nutrient, 24 samples were deficient in two, and 2 samples were deficient in the three nutrients.

The deficiencies as found consisted of protein 62, fat 63, and fiber 61.

The following tabulation is a summary of the inspection. It will be noted that the average composition and average selling prices of calf meals, feed mixtures, mash foods and poultry grains are not given. These omissions are due to the variable character of the different brands reported under the respective headings.

In preparing this tabulation the protein as found is considered to satisfy its guarantee if it is not more than one per cent below it. An allowance of one-half per cent is made for the fat and the same allowance is made for fiber.

Summary of the Results of the Inspection.

FEEDING STUFF.	Number of samples examined.	Average Composition. Moisture.	Protein.	Fat.	Fiber.	Average retail selling price per ton.	Number of samples satisfied guarantees.	No. of Samples Deficient in— Protein.	Fat.	Fiber.	One nutrient.	Two nutrients.	Three nutrients.
		%	%	%	%	$							
Alfalfa Meal	10	7.86	15.43	1.66	27.46	31.46	8	1	..	1	2	..	..
Bread Meal	1	8.65	13.13	1.48	0.28	44.00	....	..	1	..	1	..	..
Brewers' Dried Grains	17	6.54	28.82	6.50	12.86	28.50	15	..	..	2	2	..	..
Buckwheat Feed	3	10.86	20.90	5.37	6.73	24.63	2	..	..	..	..	..	..
Buckwheat Midlings	16	11.59	29.02	7.69	3.83	29.50	13	1	..	1	2	..	..
Buckwheat Offal	7	9.49	17.13	4.51	16.64	25.43	4	3	1	3	..	2	..
Calf Meals	5	.....	.....	.....	.....	.....	2	1	2	1	2	1	1
Corn Cob, Ground	1	7.40	2.63	0.41	31.46	19.00	....	..	..	..	..	..	..
Corn and Cob Meal	26	12.52	7.40	3.30	4.88	23.10	20	..	1	..	1	..	..
Corn Bran	4	8.12	11.30	6.97	7.40	24.33	4	..	..	..	..	..	..
Corn Feed Meal	18	12.20	8.37	3.76	1.46	33.43	14	2	1	..	1	1	..
Corn, Sifted Cracked	6	12.73	8.94	4.15	1.23	33.66	....	..	..	..	..	..	..
Corn and Oats	28	10.33	9.78	4.70	3.49	34.32	24	..	2	1	3	..	..
Corn Gluten Feed	17	8.21	24.56	3.28	6.20	33.20	16	1	..	..	1	..	..
Cocoanut Meal	1	5.32	22.56	9.00	9.68	.....	1	..	..	..	..	..	..
Cottonseed Meal	20	6.67	41.61	8.68	8.07	33.04	17	3	..	1	2	1	..
Distillers' Dried Grains—Corn	3	7.17	31.17	10.12	8.68	29.80	2	..	1	..	1	..	..
Dried Beet Pulp	3	7.74	8.77	0.52	18.52	28.60	3	..	..	..	..	..	..
Feeding Flour	9	10.26	15.63	4.19	2.37	37.70	8	..	1	..	1	..	
Feed Mixtures	196	.....	.....	.....	.....	.....	149	6	18	23	37	5	..
Hominy Meal and Feed	12	8.59	11.72	7.84	3.54	31.33	12	..	..	..	..	..	..
Laxo Cake Meal	1	9.72	25.13	8.00	9.08	35.00	1	..	..	..	..	..	..
Linseed Oil Meal	11	8.43	35.41	5.97	7.72	36.70	10	..	1	..	1	..	..
Malt Sprouts	4	6.81	25.86	1.20	11.46	27.75	2	2	..	..	2	..	..
Mash Foods	83	.....	.....	.....	.....	.....	63	9	5	11	16	3	1
Meat Meal and Beef Scrap	23	6.83	48.97	14.10	.....	*2.97	12	10	3	..	9	2	..
Middlesex Malt Grains	1	5.42	19.50	6.80	16.56	25.00	1	..	..	..	..	..	..
Oat Hulls	2	5.39	5.00	1.63	27.48	24.00	....	..	1	1	..	1	..
Peanut Meal	2	4.74	35.72	9.01	6.43	.....	....	1	..	1	2	..	..
Poultry Bone and Bone Meal	2	5.75	24.69	3.55	.....	*3.10	1	1	..	..	1	..	..
Poultry Grains	186	.....	.....	.....	.....	.....	155	13	20	1	20	7	..
Rye Bran	16	10.64	13.41	2.88	3.92	28.00	10	1	1	3	5	..	..
Rye Feed	3	10.81	11.79	2.70	2.46	28.00	1	1	..	..	1	..	..
Rye Middlings	19	11.29	12.17	2.57	2.52	32.47	15	..	..	2	2	..	..
Screenings, Ground	1	8.10	10.50	5.95	17.87	25.00	....	..	1	..	1	..	..
Shredded Wheat Waste	1	6.35	10.75	1.93	2.12	.....	1	..	..	..	..	..	..
Wheat Bran	74	9.39	15.22	4.54	8.53	29.13	62	5	2	5	10	1	..
Wheat Feed	10	9.01	15.77	4.73	6.90	29.50	10	..	..	..	..	..	..
Wheat Middlings	50	10.06	16.01	4.81	4.21	33.74	45	1	1	2	4	..	..
Wheat Middlings and Corn Red Dog Flour	1	8.45	14.31	7.45	4.79	36.00	1	..	..	..	..	..	..
Wheat and Rye Bran	1	11.15	14.00	3.30	4.70	27.00	....	..	..	1	1	..	..
Wheat and Rye Middlings	2	9.90	17.41	4.25	5.64	36.50	1	..	..	1	1	..	..

*Average selling price per cwt.

V.

INSPECTION OF INSECTICIDES.

The law of New Jersey regulating the sale of insecticides, Chapter 89, Session of 1912, requires the manufacturers or the persons responsible for materials which are sold for "preventing, destroying, repelling or mitigating any insects which may infest vegetation," to comply with certain requirements before the products are offered for sale. These requirements are, briefly stated, an annual registration of the materials, and attaching the registered guarantee and the name and address of the party responsible for the material to each package. The law also requires an annual inspection of the materials found in our markets, and the publication of the results obtained.

In accordance with these requirements, the results obtained during the year 1915 were published in Bulletin 286.

Registrations.

During the year the following manufacturers registered 172 brands of materials, and the certificates were duly issued.

The registrations were made by the following:

Allen & May, Quakertown, N. J.; Ansbacher Insecticide Co., New York City; Aphine Manufacturing Co., Madison, N. J.; The James A. Blanchard Co., New York City; Bowker Insecticide Co., Boston, Mass.; Cinnakol Chemical Sales Co., Bayonne, N. J.; J. S. Collins & Son, Inc., Moorestown, N. J.; Corona Chemical Co., Milwaukee, Wis.; Danforth Chemical Co., Leominster, Mass.; F. W. De Voe & C. T. Raynolds Co., New York City; The Dow Chemical Co., Midland, Mich.; Felton, Sibley & Co., Inc., Philadelphia, Pa.; Samuel H. French & Co., Philadelphia, Pa.; The Grasselli Chemical Co., Cleveland, O.; Hammond Paint and Slug Shot Works, Beacon, N. Y.; Hemingway & Co., Inc., Bound Brook, N. J.; Morris Herrmann & Co., New York City; Insectine Manufacturing Co., Buffalo, N. Y.; Interstate Chemical Co., Jersey City, N. J.; Kelley Island Lime & Transport Co., Cleveland, O.; The Kil-Tone Co., Newark, N. J.; Fred L. Lavanburg, New York City; Arthur Laver, Bernardsville, N. J.; Leggett & Brother, New York City; Lehn & Fink, New York City; John Lucas & Co., Inc., Gibbsboro, N. J.; Mechling Bros. Manufacturing Co., Camden, N. J.; A. Mendleson's Sons, Albany, N. Y.; Merrimac Chemical Co., Boston, Mass.; Niagara Sprayer Co., Middleport, N. Y.; I. Pfeiffer, New York City; The Plant Life Co., New York City; Powers-Weightman-Rosengarten Co., Philadelphia, Pa.; B. G. Pratt Co., New York City; The Rex Co., Rochester, N. Y.; Schering & Glatz, New York City; Schertzer-Harris Co., Newark, N. J.; The Sherwin-Williams Co., Cleveland, O. and Newark, N. J.; Schieffelin & Co., New York City; H. J. Smith & Co., Utica, N. Y.; Smith, Kline, French & Co., Philadelphia, Pa.; The H. A. Stoothoff Co., York, Pa.; Thomsen Chemical Co., Baltimore, Md.; Vreeland Chemical Co., Little Falls, N. J.

Chemical Examination.

Sixty-eight samples of the various materials were examined and consisted of:

Fifteen samples of Paris green; 19 samples of lead arsenate; 8 samples of lime sulphur; 6 samples of bordeaux mixture; 20 samples of miscellaneous brands.

REPORT OF THE DEPARTMENT OF HORTICULTURE

Department of Horticulture

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*Resigned September 1, 1915
†Appointed March 1, 1915.
‡Appointed October 1, 1915

CONTENTS.

Report of the Department of Horticulture.

M. A. Blake.
C. H. Connors.

I.

INTRODUCTORY.

Two new projects were undertaken by the Horticultural Department during 1915; a soil study with gardenias in the greenhouse and some work with vegetables. The importance of the vegetable industry in the State has made it urgent for a long time that some investigational work be organized. The peach investigations were extended in cooperation with the extension fruit specialist and Vineland peach growers to include a practical demonstration and study of cooperative shipping of peaches. A list of the projects in which this Department is engaged was published in the report for 1914.

The features of the work of the past year were as follows:

The cooperative peach shipments furnished the Station with much valuable data that could not have been secured in any other way.

The experimental peach orchards at Vineland produced the largest crop of fruit secured since the trees were planted. This resulted in much additional data upon the fertilizer experiments.

The trees in the peach pruning experiments at Vineland were making their fourth season's growth during 1915 and produced their second crop of fruit. Data of much value have now been secured from these investigations and will be available for publication as soon as it can be carefully analyzed. A duplicate orchard of these experiments at New Brunswick also produced a crop of fruit during 1915.

Much progress also was made with the greenhouse experiments with roses and carnations, particularly in the lime studies with White Killarney roses and the soil and bench studies with carnations.

Investigational work with vegetables was begun with Mr. L. G. Schermerhorn in charge. Much work of great value along plant breeding lines with vegetables, has been conducted for a number of years by the Botanical Department of the College Station, and this provides an abundance of material for study in other ways.

Additional plantings of bush fruits and strawberries were made at the College Farm.

A number of changes in the staff of the Horticultural Department occurred during the year. Mr. W. W. Oley served as Extension Specialist in Fruit Growing during the year, but will take up county demonstration work beginning November 1, 1915. Mr. William Schieferstein resigned September 1st, to take up commercial work. Mr. Joel Sherman served as Field Assistant during the fall and early winter. Mr. Raymond Stone was appointed Orchard Foreman beginning November 1, 1914. Mr. John W. Bartlett was appointed Field Assistant.

The weather observations have been taken by Mr. A. J. Farley with Mr. William Schieferstein and Mr. Lawrence G. Gillam serving as assistants.

II.

NOTES OF THE SEASON.

The season of 1915 was particularly favorable for fruit in New Jersey with the exception of grapes and pears. Apples were severely attacked by blight in parts of southern New Jersey which greatly reduced the crop.

The yield of peaches and small fruits was exceptionally large. The Central Railroad of New Jersey reports total shipments amounting to 1400 carloads of strawberries, dewberries and blackberries from the Vineland district alone. Shipments are also made from this district over the Pennsylvannia Railroad and by truck to the seacoast resorts.

The weather during March was dry and mild and spring work upon the farms throughout the State progressed much more rapidly than usual.

The weather was also warm and bright at the height of the blooming period of peaches and Keiffer Pears in southern New Jersey. This resulted in a heavy set of peaches, but a rather light set of Keiffer Pears except in certain localities. This was very marked even in limited areas. In the southern part of the town of Vineland the set of Keiffers was generally light while north of Oak Road it was good.

Apples which bloomed early during the period of good weather were severely attacked by fire blight through the blossom clusters. The area of such damage extended as far north as Middlesex County. Some orchards in Monmouth County were affected severely while others escaped. The time of blooming was apparently an important factor in the early spread of the disease. Varieties that are not commonly susceptible to the disease suffered with the rest if they were early-blooming sorts.

The Horticulturist has observed that severe attacks of pear blight in New Jersey are preceded by dry weather. The rainfall during March and April was unusually light during 1915, which was just previous to the blooming of apples in southern New Jersey.

Grapes came into bloom at Vineland, N. J. at a time when rains occurred almost daily, with the result that such sorts as the Roger's hybrids set scarcely any fruit and all varieties produced irregular bunches. The berries in a bunch commonly exhibited a wide range of maturity due to variations in time and the degree of success of pollination.

The frequent rains during the early summer were ideal for the production of a heavy crop of strawberries and dewberries upon the light soils of the State.

Mildew made its appearance upon the fruit of the peach in some localities as illustrated in Fig. 1, but caused little damage.

The peach crop ripened at about the normal season. The frequent rains kept the air more free from dust and dirt about large towns and cities, with the result that the fruit in those sections was brighter and less dull than common. Winter apples were generally late in maturing, due to the large number of cloudy or rainy days during the summer months.

Vegetables in general produced large crops. Peas were an exceptionally fine crop upon the sandy soils of the State. Earliana tomatoes about Swedesboro were more irregular and of poorer quality than usual. Sweet potatoes made an exceptionally good start with but few losses as a result of stem rot. Squashes were generally below standard, especially the winter varieties.

BLOOMING DATES OF VARIOUS FRUITS AT COLLEGE FARM.

The blooming dates of various varieties of fruits are recorded each year at the College Farm. These are often of much value as indicating the character of the early season and for study in connection with the weather records.

Table 1.

Blooming Dates of Standard Apples, 1915.

VARIETY	First bloom	Full bloom	VARIETY	First bloom	Full bloom
Baldwin	4/27	5/2	Monmouth	4/28	5/2
Banana*	4/28	5/2	Oldenburg	4/24	4/28
Ben Davis	4/28	5/2	Rome*	5/1	5/11
Collins (Stark Champion)*	4/26	5/2	Smith	4/27	5/2
Gravenstein	4/24	4/27	Stayman*	4/26	5/3
Henry Clay*	4/28	4/30	King	4/25	5/1
Jonathan	4/27	5/3	Williams	4/28	5/5
King David*	4/28	5/5	Yellow Transparent	4/27	4/30

*Young Trees

Table 2.

Blooming Dates of Dwarf Apples, 1915.

VARIETY	First bloom	Full bloom	VARIETY	First bloom	Full bloom
Alexander	4/27	5/1	Jonathan	4/27	5/4
Astrachan	4/25	5/1	McIntosh	4/26	4/30
Banana	4/26	5/2	Oldenburg	4/24	4/28
Baldwin	4/28	5/3	Opalescent	4/28	5/1
Bismark	4/26	5/2	R. I. Greening	4/27	5/1
Fall Pippin	4/30	5/2	Roxbury	4/26	4/30
Gravenstein	4/23	4/28			

Table 3.

Blooming Dates of Plums, 1915.

DOMESTICA	First bloom	Full bloom	HYBRIDS (So. Dakota)	First bloom	Full bloom
Imperial Gage	4/21	4/24	Emptan	4/23	4/25
Italian Prune	4/23	4/25	Hanska	4/20	4/23
			Inkpa	4/19	4/21
JAPANESE			Kaga	4/20	4/21
Chabot	4/19	4/21	Opata	4/23	4/26
Wickson	4/17	4/19	Sapa	4/21	4/25
			Toka	4/20	4/21

Table 4.

Blooming Dates of Pears, 1915.

VARIETIES	First bloom	Full bloom
Seckel	4/23	4/26
Lawrence	4/21	4/25
Bartlett	4/24	4/25
Kieffer	4/21	4/25
Sheldon	4/23	4/26
Dorset	4/23	4/26

Table 5.

Blooming Dates of Cherries, 1915.

SWEET	First bloom	Full bloom
Napoleon	4/20	4/23
Yellow Spanish	4/20	4/23

SOUR	First bloom	Full bloom
Hortense	4/23	4/26
May Duke	4/24	4/26
Montgomery (large)	4/24	4/26
Morello	4/24	4/26
Ostheim	4/23	4/25
Richmond	4/23	4/27
Royal Duke	4/23	4/25

Table 6.

Blooming Dates of Peaches and Nectarines.

Peaches.

	First bloom	Full bloom
Albright October	4/20	4/23
Augbert	4/19	4/21
Beers Smock	4/20	4/22
Belle	4/19	4/21
Brays Rareripe	4/19	4/21
Carman	4/19	4/21
Champion	4/20	4/23
Connetts	4/20	4/23
Dewey	4/21	4/24
Early Elberta	4/19	4/21
Eaton	4/21	4/23
Elberta	4/19	4/22
Elberta (Sport)	4/21	4/23
Frances	4/20	4/23
Greensboro*	4/20	4/24
Hiley	4/20	4/23
Iron Mountain	4/21	4/23
J. H. Hale	4/19	4/23
Laury Choice	4/21	4/23
Lorentz	4/21	4/23
Mathews	4/21	4/23
Maules Early	4/19	4/23
Mayflower	4/21	4/25
McKay Late	4/21	4/23
Munson Free	4/19	4/21
Nina	4/20	4/23
Pride of Franklin	4/20	4/22
Salway	4/20	4/23
Slappy	4/21	4/24
Stump	4/19	4/21
Susquehanna	4/19	4/22
Triumph	4/20	4/25

*Dwarf tree

Nectarines.

	First bloom	Full bloom
Downtown	4/20	4/25
Elruge	4/20	4/25
Pitmaston Orange	4/21	4/24

Table 7.

Blooming Dates of Trees and Ornamentals, College Farm.

	1914 First bloom	1914 Full bloom	1915 First bloom	1915 Full bloom
Acer platanoides	4/26	4/29	4/19	4/22
Acer pennsylvanicum	5/6	5/9	4/27	4/29
Acer pseudoplatanus	....	....	5/1	5/8
Acer rubrum	4/12	4/18	4/9	4/12
Acer saccharinum	4/20	4/28	4/17	4/20
Æsculus Hippocastanum	....	5/23	5/7	5/11
Æsculus carnea	5/12	5/21	5/3	5/8
Alnus glutinosa	....	....	3/31	4/7
Benzoin (Lindera) æstivale	4/1	4/18	4/12	4/14
Berberis Thunbergii	5/6	5/15	4/25	4/27
Berberis vulgaris	5/16	5/21	5/8	5/12
Betula alba, var. papyrifera	....	....	4/17	4/20
Betula populifolia	....	....	4/20	4/24
Calycanthus florida	....	....	5/11	6/10
Catalpa speciosa	....	....	6/14	6/18
Celastrus scandens	6/7	6/10	5/27	6/7
Celtis occidentalis	5/6	5/8	4/25	4/27
Cercidiphyllum japonicum	....	....	4/9	4/12
Cercis canadensis	5/6	5/8	4/25	4/29
Chionanthus virginica	....	....	5/20	5/25
Clethra alnifolia	....	....	7/12	....
Cornus florida, var. rubra	5/8	5/12	5/6	5/11
Cornus mas	....	....	4/5	4/9
Cornus paniculata	6/5	6/9	5/29	6/7
Cornus sanguinea	5/20	5/27	5/8	5/14
Corylus americana	3/28	3/30	3/23	3/27
Cratægus Crus-galli	....	....	5/31	6/4
Cratægus Coccinea	....	....	5/1	5/4
Cratægus Oxycantha	....	....	....	5/25
Daphne Mezereum	3/29	3/31	3/27	4/10
Deutzia scabra	5/20	....	....	5/14
Diervilla hybrida	5/20	5/28	5/27	6/3
Evonymus alata	4/13	....	5/10	5/15
Evonymus europæa	....	....	5/26	5/31
Forsythia suspensa	4/22	4/26	4/14	4/20
Forsythia viridissima	4/6	4/22	4/17	4/20
Gaylussacia baccata	....	....	4/26	5/1
Ilex verticillata	....	....	....	6/18
Juglans cinerea	5/16	5/20	5/11	5/14
Kalmia latifolia	5/29	6/6	6/5	6/12
Kerria japonica var. floro-pleno	....	5/20	4/29	5/8
Koelreuteria paniculata	7/2	7/7	7/12	7/15
Ligustrum ibota	....	....	....	5/14
Magnolia glauca	6/9	6/12	5/20	6/7
Ostrya virginiana	4/2	4/28	....	....
Philadelphus coronarius grandiflora	....	....	6/10	....
Platanus occidentalis	....	....	4/28	4/30
Populus balsamifera	4/8	4/18	4/10	4/12
Populus deltoides, var. carolinensis	....	....	4/14	4/15
Populus nigra, var. italiaca	....	....	....	....
Prunus avium	4/30	5/4	4/20	4/27
Prunus pennsylvanicum	5/3	5/7	....	....
Prunus pissardi	....	....	4/18	4/20
Prunus serotina	5/20	5/25	5/14	5/20
Ptelea trifoliata	....	....	5/14	....
Pyrus (Sorbus) americana	....	5/23	4/13	4/17
Pyrus (Aronia) arbutifolia	....	....	5/6	5/8
Quercus imbrecaria	5/10	5/14	4/27	4/29
Quercus Muhlenbergii	....	....	5/8	5/10
Quercus pedunculata	5/9	5/12	5/3	5/6
Quercus Prinus	5/17	5/20	4/29	5/10
Rhododendron maximum	5/21	5/28	5/17	5/25
Rhus canadensis	5/12	5/15	5/8	5/11
Rhus typhina	....	....	....	6/26
Robinia Pseudo-Acacia	....	....	5/17	5/20
Rosa multiflora	....	....	6/1	6/8
Rosa rugosa	5/19	5/24	5/29	6/11
Rosa setigera	7/3	....	....	....
Rubus odoratus	....	....	....	6/9
Salix alba	5/4	5/9	4/19	4/22
Salix babylonica	5/6	5/14	4/20	4/22
Salvia greggi	....	....	....	7/12
Sambucus nigra, var. aurea	....	....	6/1	....

Table 7—Continued.

	1914 First bloom	1914 Full bloom	1915 First bloom	1915 Full bloom
Spirea Van Houtii	5/18	5/23	5/8	5/15
Symphoricarpos racemosus	6/1	6/7	6/10	....
Syringa vulgaris	5/12	5/16	4/29	5/6
Tilia americana	....	....	6/18	6/21
Ulmus americana	3/31	4/10	4/1	4/9
Ulmus campestris	4/11	4/20	4/9	4/11
Vaccinium corymbosum	5/11	5/15	4/24	4/27
Viburnum dentatum	5/29	6/11	6/2	6/7
Viburnum Opulus	5/20	5/28	....	....
Wisteria chinensis	....	5/19	4/29	5/8
Yucca filamentosa	....	....	7/3	7/12

NOTE: The nomenclature used follows Gray's New Manual, 7th ed., 1908 and Bailey's Standard Cyclopedia of Horticulture.

III.

PEACH PLANTINGS AT COLLEGE FARM.

Additional material was added to the Station orchards the past season, which will extend the opportunities for the study of the peach. The following peach types and varieties were secured from the United States Department of Agriculture and planted in orchard form just south of the present nursery:

Amygdalus davidiana, a stock from the dry regions of China; Amygdalus persica No. 36,127, a Bolivian freestone peach; Amygdalus persica No. 24,915, a Chinese peach from the hot, humid regions; Amygdalus persica No. 36,126, a Bolivian clingstone peach; Amygdalus nectarina No. 34,684, Quetta nectarine from India; Amygdalus persica No. 36,717 budded from Chinese stock of blood red peach; Amygdalus persica No. 32,373, a Mexican peach much like the Honey peach and Amygdalus persica No. 21,989, a Chinese peach on Mexican stock.

IV.

PEACH SURVEY AT HAMMONTON.

A record of the numbers of peach trees in commercial orchards within a radius of six miles of Hammonton was secured in June, 1915, by the combined efforts of Mr. Cowgill, of the Experiment Station, and Mr. Ellwood Douglas, the county demonstrator of Atlantic County.

A total of 106,025 trees were noted, but complete data as to age and variety could not be obtained for 8165 trees. A detailed tabulation for 97,550 trees is given, however, in Table 8. The number of trees planted of the various varieties is given for each year from 1909 to 1915. All trees planted previous to 1909 are listed together.

Table 8.

Varieties of Peaches, Age and Number of Trees of Each About Hammonton, N. J., June 1915.

VARIETIES.	8 years and over.	Set in 1909.	Set in 1910.	Set in 1911.	Set in 1912.	Set in 1913.	Set in 1914.	Set in 1915.	Total.
Elberta	6,380	2,530	3,690	4,340	3,780	4,070	4,265	3,150	32,205
Carman	915	475	550	1,740	1,835	2,515	2,650	2,875	13,555
Belle	400	500	1,025	1,410	2,500	1,500	2,715	2,885	12,935
Champion	765	470	300	590	710	1,325	350	740	5,250
Connetta	570	400		790		730	800	1,300	4,590
Mt. Rose	875	865	500	390		260	200	100	3,190
L. Crawford	1,775		450	40	490	100			2,855
Old Mixon	600	380	600	90	340	475	100	260	2,845
Greensboro	475	250	300	400	200	400	400	400	2,825
Reeves	680	100	800		340	400			2,320
J. H. Hale								2,000	2,000
Hiley	40			230	800	175	320	450	1,985
Chairs	750			300		90	100		1,240
Niagara	100	400		100	100	350	50	100	1,200
Smock	950				75				1,025
Ray						200	550	250	1,000
E. Crawford	450		150		100	150	100		950
Frances						400	75	380	855
Fitzgerald	250	50		100		20	400		820
Fox	200	100	270			100		80	750
Iron Mt.	500			125				100	725
Stump	230		250	90		100			670
Nectar							100	450	550
Edgemont						450			450
Bequette				150			100	180	430
Salway	230						100		330
	17,135	6,520	8,885	10,855	11,270	13,810	13,375	51,700	97,550

The first fact of interest shown by this survey is the general increase in the number of trees. In 1909 only 6520 trees were planted in the district. An annual increase of about 2000 trees took place in 1910 to be increased further by 2000 trees in 1911. This rate of increase was not maintained in 1912 yet more trees were planted of the varieties Elberta, Belle and Carman than in any previous year. Another considerable increase in planting occurred in 1913, a slight decrease in 1914 and an increase again of about 2000 trees in 1915.

The United States Census for 1910, data for which were obtained in 1909, shows a total of 70,520 peach trees for Atlantic County. In 1916 there will be more trees in bearing within a radius of six miles of Hammonton than there were in the entire county in 1909.

Another fact indicated by the census is that 26 varieties are represented by more than 300 trees. Yet of these 26, only 16 are represented by more than 1000 trees; 10 by more than 2000 trees; 4 by more than 5000 trees and 3 by more than 10,000 trees. This is as it should be. Too many varieties are a detriment to any commercial section.

The popularity of varieties from year to year is clearly indicated in Table 9. Only five varieties are ranked but this is sufficient to indicate the preference of the growers.

Table 9.

Five Most Popular Varieties of Peaches as Indicated in Annual Plantings.

1908 and Older Trees.	1909.	1910.	1911.	1912.	1913.	1914.	1915.
Elberta.	Elberta.	Elberta.	Elberta.	Elberta.	Elberta.	Elberta.	Elberta.
L. Crawford.	Mt. Rose.	Belle.	Carman.	Belle.	Carman.	Belle.	Belle.
Carman.	Belle.	Reeves.	Belle.	Carman.	Belle.	Carman.	Carman.
Smock.	Carman.	Old Mixon.	Connetta.	Connetta.	Champion.	Connetta.	J. H. Hale.
Mt. Rose.	Champion.	Champion.	Champion.	Champion.	Connetta.	Ray.	Connetta.

We may note by Table 9 that Late Crawford, Smock and Mountain Rose are among the five most popular varieties in the older plantings yet do not appear in the lists after 1909. Reeves and Old Mixon enter the list of five in the plantings of 1910 but do not appear again. Elberta ranks first in all of the plantings. Carman is placed among the first five each year and does not rank lower than third after 1910. Belle is equally as popular as Carman beginning in 1909 and even exceeds that variety in some seasons. Champion appears in fifth place in 1909, 1911 and 1912 and in fourth place in 1913, but does not rank among the first five in 1914 and 1915. Connetts begins to appear in the lists in 1911. J. H. Hale is represented by a large planting in 1915.

No plantings of commercial size were made in 1915 of such varieties as Late Crawford, Reeves, Chairs, Early Crawford or Stump. A few trees of the Nectar Peach were planted in 1914 and 1915.

The complete survey includes more than fifty growers. Those having more than 3000 trees include Mr. W. H. Parkhurst, Henry Measley, Prentice Myrick, D. Campanella, Fred Measley, Sr., Philip Westcott, L. M. Parkhurst, Charles Fitting, T. E. Wescott and J. C. Rizotte & Bro.

The production in this district should increase steadily for a number of years. In 1916 there will be 68,475 trees in full bearing and 13,375 producing some fruit. In 1917 there will be about 81,850 trees in full bearing and 15,700 trees producing some fruit if the season is favorable. These figures would be increased somewhat if all the small lots of trees were listed, but they do not enter into the commercial problems of the district to any extent.

Bud Sport of Elberta Peach.

In visiting peach orchards about Vineland a few years ago the Horticulturist examined an orchard that was about to be pulled out. It had produced crops for a number of years and was near the end of its profitable commercial life. Since it was to be destroyed, the orchard had not been cultivated or fertilized that season with the result that the foliage upon all the trees was quite yellow in color.

One Elberta tree however exhibited a branch, the foliage of which was as dark green as any branch would be upon a well-fertilized tree. This appeared to be a true bud sport and several buds were secured for propagation. Every tree propagated from this material has been distinct in character and none have reveted to the true Elbrta type.

The tree is semi-dwarf in its habits of growth as illustrated in Fig. 2. In the experimental orchard at Vineland, trees of this sport had attained a height of only 7 feet while standard Elbertas measured about 11 feet. Its habit of growth is compact, it branches freely and the leaves are vigorous and numerous.

Aside from its round, compact habit of growth the foilage is a much darker green in color than is the case with any other variety in the orchard. This green color is also prominent in the inner layers of the bark of the twigs and branches. The fruit resembles Elberta very closely in form and color and the specimens are commonly somewhat longer and more flattened than normal Elbertas. Owing to its free, although branched and compact, growth it does not come into full bearing quite as soon as Elberta. This sport has been propagated largely because of its ability to present a dark green, vigorous appearance even

PLATE I.

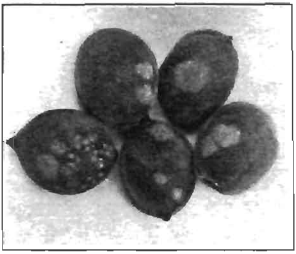


FIG. 1.—Mildew upon peach.

FIG. 2.—Tree propogated from a bud sport of Elberta peach.

PLATE II.

FIG. 3.—Peach flowers emasculated and covered with paper bags.

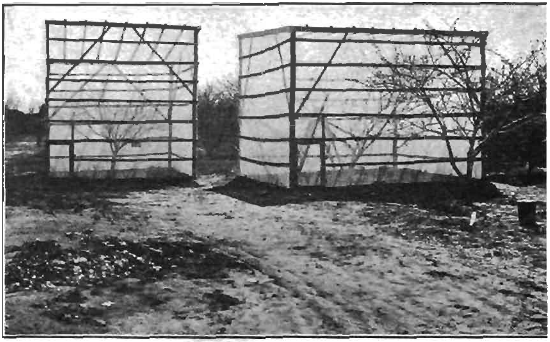


FIG. 4.—Peach trees covered with tents of cheese-cloth.

PLATE III.

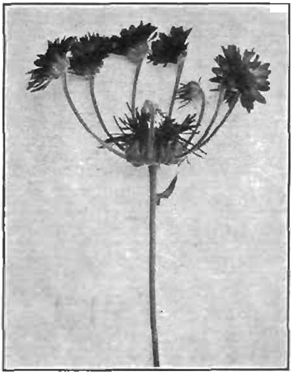


FIG. 5.—Abnormal bloom of *Calendula officinalis*.

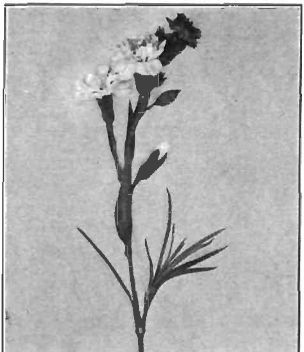


FIG. 6.—Carnation sport.

PLATE IV.

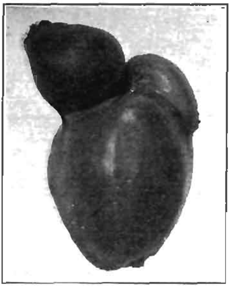


FIG. 7.—A freak apple.

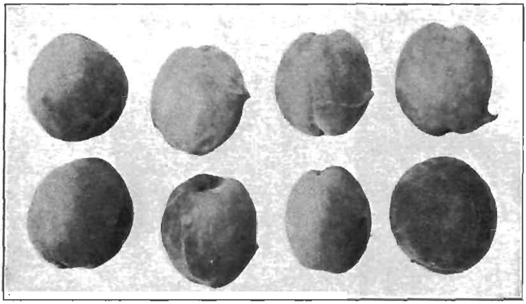


FIG. 8.—Specimens of peaches exhibiting ridges and beaks.

under neglect. It may prove of interest in breeding work and is now being tested with reference to its resistance to yellows and little peach.

VI.

BREEDING WORK WITH PEACHES.

Breeding work with peaches was undertaken in a small way several years ago, but was not very successful because of the methods employed. Most of this work was done at the Vineland orchard where many varieties were available. The method attempted at first was to emasculate a number of blossoms, cover with paper bags, (Fig. 3), and at the proper stage pollinate the flowers. It was found, however, that this method was not practical, for high winds invariably tore the bags. Bags were also torn open by being struck or caught by the harness during the cultivation of the orchard. Twigs confined in paper bags for any length of time also lost vigor. Bags made of mosquito netting were next tried, but, while the loss was not so great, the method was rather slow and not many crosses could be made.

In the spring of 1914, the plan used for insect pollination studies was adopted, entailing the inclosing of the tree in a tent. The frame was made of 2x4 inch timbers, shingle lath, 1 inch by 2 inches, fastened at the proper intervals, and the whole covered with cheese cloth, as illustrated in Fig. 4. A door was left for entrance. These tents excluded all insects and greatly reduced any wind, so there was no danger from the blowing about of the pollen upon the enclosed tree.

In 1914, six tents were erected covering seven trees, two small trees of Belle being enclosed under one tent. The other varieties covered were Elberta, Early Crawford, Greensboro, St. John and Mayflower.

Belle, Elberta, Early Crawford and Greensboro are worked together. In the case of the Belle, one tree was left to pollinate itself and the other tree was emasculated and crossed with each of the other three varieties. Elberta, Early Crawford and Greensboro each had one limb (approximately one-fourth of the tree) left to self-pollinate while the remaining branches were crossed with the desired sorts. The entire tree of St. John was allowed to self-pollinate in 1914 and Mayflower was crossed with St. John.

The tents were allowed to remain over the trees until the fruits had reached the size of hickory-nuts and were then removed. After the fruits had matured sufficiently in 1914, they were taken from the trees and the stones removed. The latter were stratified and planted out in the spring of 1915. It was found with Mayflower and Greensboro that when the fruit had reached market condition, the kernels of the pits had not matured.

In the fall of 1915, the following seedlings were growing in the nursery at the College Farm, as a result of these crosses:

Elberta S-pollinated	6	Belle S-pollinated	129
Elberta x Belle	7	Belle x Elberta	66
Elberta x Early Crawford	26	Belle x Early Crawford	43
Elberta x Greensboro	7	Belle x Greensboro	70

Early Crawford 44

Through a mistake of one of the pickers, all the fruits from the Early Crawford tree were picked into one basket.

In addition to the above, there are also the following seedlings from open pollinated blossoms:

St. John	105	Late Crawford	93
Capt. Ede	11	Fitzgerald	4

In the spring of 1915 the same operations were carried out, with the exception that Early Wheeler was covered instead of Mayflower. Picking was delayed on Greensboro and Early Wheeler until the fruit was just ready to drop from the trees, thus securing better maturity of the kernels.

The pits from this work are being stratified. These number 4305 secured from crossing, and 1071 from open pollination. Of the latter, 237 are from a sport of Elberta.

VII.

ABNORMAL FORMS OF PLANT GROWTH.

During the past year, a few departures from the normal in plant growth have been observed by members of the Department.

The first was in a bloom of Calendula officinalis, a common garden flower belonging to the Compositæ. The plant that produced the abnormal bloom was growing in a pot in the greenhouse, and had been dried off.

All the rays and florets of the main bloom had dried up, but a new impetus to growth caused the formation of eight adventitious buds in the base of the bloom, from which developed the blooms shown in Fig. 5. These blooms, however, consisted only of the bracts and rays, the florets being entirely absent.

"Sporting" in carnations is not so uncommon, but a rather unusual form is shown in Fig. 6. The plant from which the flower stem was taken was propagated from White Enchantress and was growing in the field. The top flower, dead, had been white, the middle one pink and the lower one white. It is usual for a sporting shoot to bear flowers all of one color, but for a shoot to bear flowers of two colors is rather unusual in the carnation.

Faciation in the Apple.

"Twin" apples are occasionally found. Of late years there have been exhibited at the meetings of the New Jersey State Horticultural Society and at the Trenton Fair, specimens of twin apples grown on a tree near Princeton, N. J. Nearly all the specimens which this tree produces are of this type. The cause of this phenomenon is faciation in the blossom, i. e., the blossom has double the usual number of sexual parts, actually two blossoms made into one.

This year the freak shown in Fig. 7 appeared on a dwarf tree of Chenango at the College Farm. There are really three fruits included in this specimen, all attached to the same stem. The formation then is due to the fact that in the bud that produced this specimen there were three sets of sexual organs attached to the same stem.

Superficial Injury to Peaches.

A number of ridged and beaked peaches are shown in Fig. 8. Most of these protuberances are apparently due to some superficial injury to the skin of the peach when it is young and green, such as the scratching of a leaf on the surface or a slight abrasion caused by the tip of a twig. A minute puncture may produce the teat or horn effect noted upon a few of the specimens.

Peculiar Markings Upon Peaches.

Fig. 9 illustrates three peaches which show odd depressed markings. They are entirely distinct from hail injuries and no indictions of any insect attack could be noted. The Horticultural Staff of the Station have had an opportunity to study peaches closely for a number of years and have never before seen specimens of this character.

VIII.

THE STATE ORCHARD AT VINELAND.

Vineland Peach Experiments.

The season of 1915 resulted in the highest yields of peaches upon the fertilizer plots since the experiments were started. Practically no injury occurred to the buds during the winter of 1914-1915, there was no damage from late spring frosts and it appeared as if every blossom set a fruit. The June drop was also light so that a large amount of thinning was necessary to secure fruit of good size and to prevent breakage of branches. Frequent rains during May, June and July encouraged a record vegetative growth, interfered with summer spraying and brought about the most severe attack of peach scab that the district has experienced in years.

The spraying work at the experiment orchards had to be repeated in one instance because of frequent rains. Sprays were applied as follows during the season.

No. 1. Lime-sulphur for scale and leaf curl, March 17th-22nd.

No. 2. Arsenate of lead beginning May 1st.

No. 3. Self-boiled and arsenate of lead May 12th-14th.

No. 4. Self-boiled, only, June 4th-6th.

No. 5. Self-boiled, June 27th-30th, all varieties except those ripening before August 1st.

No. 6. Self-boiled, July 15th, all varieties except those ripening before August 10th.

No. 7. Self-boiled, July 21st, on late varieties such as Smock and Bilyeu.

Much data in regard to the behavior of varieties, thinning of the fruit, and the effect of fertilizers was secured during the season and this will be published in bulletin or circular form.

Peach Borer Observations at Vineland.

A record has been kept of the number of borers removed annually from each tree in the experiment orchard at Vineland. A full report upon these records was made last year and the number of borers found during 1915 is now published as an addition to that report.

The experiments with various repellants in Orchard No. 1, have been continued as outlined. Row 1, has received asphaltum, Row 7, white lead, Row 13 is a check; Row 19, Government whitewash, Row 25, Sulfocide, Row 26, Lime-sulphur 1-9.

The trunks of all the other trees in Orchard 1, except Plots A, B and C, received a spraying of whitewash and concentrated lime-sulphur after the borers were removed in June. None of the materials mentioned above has proved to be satisfactory repellants as used at Vineland.

The borers were removed from the trees in 1915 as described in the previous report except that three examinations were made instead of two as formerly.

The complete removal of Tree 3, Row 21 in Orchard No. 3, because of its failure to grow well since its severe injury by borers from the time of planting indicated another phase of the borer problem.

It is quite generally believed that the borer works in the roots at no great depth from the surface of the ground, yet many small borers were found in the large side roots many inches below the surface when Tree 3 was dug out. A total of 72 borers were finally removed from this tree. It is therefore extremely doubtful if more than a small proportion of the borers in badly infested trees are destroyed by examination of the trunk to a depth of from 8 to 10 inches. The side roots commonly branch out at this depth or less making it very difficult and expensive to examine further.

Diagram I shows a plan of the three orchards and indicates the number of borers that were removed from each tree during 1915. The character of the surroundings about these orchards may be found by referring to Diagram I, opposite page 76 in the N. J. Experiment Station report for 1914.

An examination of the record for Orchard 1 shows first a marked increase in the number of borers throughout the orchard. This is also true in Orchard 2 and Orchard 3.

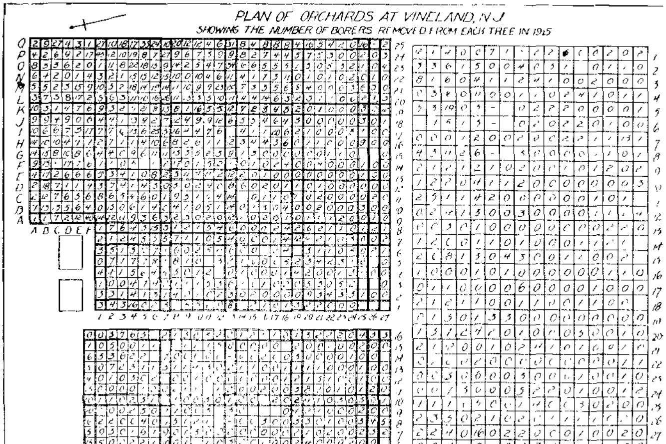
There has been an increase each year in the number of borers found in the trees in spite of thorough work in borer removal.

The greatest increase in number of borers in 1915 occurred in the northeast corner of Orchard 1, where the infestation has always been heavy.

The lightest infestation occurred in the southwest corner of Orchard 1, the southeast corner of No. 2, and in the center and southeast corner of No. 3. These areas correspond to the light infested areas of previous years.

No new facts appear as a result of the 1915 records. Trees which have been badly infested in the past continue to be more susceptible to borer attack than trees which have been relatively free from borers.

Table 10 is a record of the number of borers found in Orchard 1 and offers a comparison between the number of borers removed in 1913, 1914 and 1915. The increase has been large. This orchard contains 675 trees. In 1913 in about half the trees borers were found; in 1915 nearly 75 per cent of the trees had borers. The number of trees infested increased nearly 12 per cent over 1914, while the number of borers has increased from 1311 to 2789 or 110 per cent. It will be noted also that the number of rows that had 20 or more trees infested has increased from 5 in 1914 to 13 in 1915 and that in 1915 two rows had every tree infested. The


PLAN OF ORCHARDS AT VINELAND, N.J.
SHOWING THE NUMBER OF BORERS REMOVED FROM EACH TREE IN 1915

average of Row 1 is considerably increased by the presence in it of two trees of 43 and 27 borers respectively and Row 6, which was the highest row in number of borers found in 1913 and 1914, still has a very large infestation, but Row 13 has taken its place at the head (or foot) of the list.

Table 10.

Record of Borers Found in Orchard No. 1.
May 1913; May 1914; May 1915.

	1913		1914		1915	
ROW	No. Trees Infested	No. Borers Found	No. Trees Infested	No. Borers Found	No. Trees Infested	No. Borers Found
1	18	35	13	41	23	163
2	13	24	15	51	24	156
3	12	26	16	54	20	85
4	11	22	18	72	25	222
5	7	26	18	51	23	200
6	16	55	23	115	24	224
7	17	42	21	63	24	172
8	11	18	22	94	24	200
9	16	41	19	92	19	89
10	13	31	17	54	22	109
11	20	36	21	45	23	113
12	11	22	21	77	22	124
13	12	23	18	50	24	254
14	13	22	13	29	18	70
15	8	10	11	31	15	41
16	9	14	11	32	18	68
17	13	34	13	38	15	74
18	11	18	15	47	21	87
19	15	29	12	21	16	53
20	6	14	15	36	17	73
21	10	12	15	31	17	41
22	13	23	12	29	12	25
23	9	17	17	31	9	21
24	8	18	12	37	11	28
25	10	12	19	57	16	52
26	8	16	9	22	9	14
27	16	53	7	11	11	31
Total	326	693	423	1,311	502	2,789

Each row contains 25 trees.

In Orchard No. 2, a record for which, by rows, is shown in Table 11 there is a decrease both in the number of trees infested and in the total infestation. There is a reduction in the number of borers found in 18 rows, but, of these 9 had had trees removed because of disease. In all, 19 trees removed from this orchard because of diseases or injury. Four of the trees that had the heaviest infestation in 1914, in Row 28, were removed, these having had 24, 22, 15 and 9 borers respectively in that year. The reduction however, is very general in this orchard, as there were in 1915, exclusive of those removed because of disease or injury, 17 fewer trees infested than in 1914. There is an increased infestation in Row 1, the outside row on the north. The number of trees infested in the east row of this orchard is also reduced as is also the number of borers found. The west row also shows an appreciable decrease.

Table 11.

Record of Borers Found in Orchard No. 2.
May 1913; May 1914; May 1915.

ROW	1913 No. Trees Infested	1913 No. Borers Found	1914 No. Trees Infested	1914 No. Borers Found	1915 No. Trees Infested	1915 No. Borers Found
1	16	20	15	70	15	117
2	16	10	12	51	7	22
3	11	15	10	22	10	28
4	8	14	13	46	6	20
5	6	18	11	30	9	22
6	6	8	13	36	15	35
7	11	22	9	27	9	12
8	7	12	12	31	12	57
9	3	4	12	20	7	12
10	4	7	11	25	7	9
11	4	4	10	33	11	24
12	3	4	7	12	11	23
13	4	7	8	18	7	12
14	6	8	14	27	11	20
15	7	11	9	16	3	3
16	4	8	7	14	3	4
17	6	7	9	12	9	14
18	4	4	5	8	4	6
19	5	5	7	8	4	6
20	10	25	12	39	11	27
21	4	10	11	21	13	34
22	4	6	7	16	11	20
23	6	11	12	24	9	16
24	4	7	8	12	8	15
25	5	8	10	16	6	11
26	12	22	8	23	14	35
27	6	12	7	23	7	20
28	4	13	11	86	5	12
Total	*186*	*302*	*280*	*766*	*244*	*636*

Each row contains 16 trees.
Seventeen trees were removed in 1914 because of disease two of these having had the heaviest infestation in 1914.

Table 12 shows the record of Orchard 3 for the past three seasons. Here there has been an increase of over 63 per cent in the number of trees infested and an increase of more than 125 per cent in the number of borers removed. The northeast and the southwest corners are the most infested areas. During the worming season, one tree was removed because it was almost completely girdled with borers. This was Tree 21 in Row 3. This tree was injured by borers when planted and was never able to grow freely.

Table 12.
Record of Borers Found in Orchard No. 3.
May 1913; May 1914; May 1915.

ROW	1913 No. Trees Infested	1913 No. Borers Found	1914 No. Trees Infested	1914 No. Borers Found	1915 No. Trees Infested	1915 No. Borers Found
1	9	14	9	28	20	56
2	9	11	10	13	22	50
3	17	25	21	54	27	187
4	11	14	8	12	13	28
5	14	21	18	35	23	90
6	8	11	14	29	13	28
7	5	5	3	5	9	15
8	1	3	10	18	23	65
9	3	3	7	11	11	29
10	6	12	8	10	11	19
11	6	6	4	7	11	22
12	6	10	11	34	13	28
13	3	3	8	9	14	17
14	6	8	6	17	14	27
15	5	8	9	12	19	48
16	7	11	9	25	10	18
Total	116	165	155	319	253	727

Each row contains 31 trees.

Peach Yellows and Little Peach at Vineland.

Any additional evidence in connection with the spread of yellows and little peach is of interest to peach growers.

Each tree in the experimental orchards at Vineland has been under close observation since the time of planting, and a record has been kept of the number of infested trees. Partial reports upon the number of diseased trees removed from time to time were made in the annual reports of the Station for 1910 and 1911. The object of this report is to complete the data and bring them up-to-date.

Up to and including the season of 1915, there have been lost, because of these two diseases in Orchards Nos. 1 and 2, a total of 102 trees. Diagram 2 shows the location of all trees in the orchard, and, by means of the legend at the right, the year the trees became diseased and whether it was yellows or little peach, can be determined. In Table 13 is given a summary of the losses in Orchard No. 1, planted in 1907*; and Table 14 summarizes the losses from Orchard No. 2, planted in 1908*.

Table 13.
Number of Trees Lost Because of Disease in Orchard No. 1.

YEAR	Yellows	Little Peach	Not determined	Per cent Loss
1909	....	....	2	0.3
1910	....	4	....	0.6
1911	5	....	....	0.74
1912	1	4	....	0.74
1913	8	3	....	1.63
1914	1	5	....	0.9
1915	1	3	....	0.6
Total	16	19	2	
Grand total	37			5.5

NOTE—In the early stages of the diseases in young trees it is difficult to distinguish between yellows and little peach.

*See N. J. Experiment Station Reports 1907, 1908.

Table 14.
Number of Trees Lost Because of Disease in Orchard No. 2, Including Plots A, B, C.

YEAR	Yellows	Little Peach	Per cent Los
1911	3	4	1.27
1912	5	4	1.63
1913	3	11	2.54
1914	3	14	3.09
1915	1	17	3.27
Total	15	50	....
Grand Total	65	....	11.8

Orchard No. 1 contains 675 trees and the total loss from the tw diseases for a period of nine years is 37 trees or 5.5 per cent.

Orchard No. 2, including the A, B, C plots, contains 550 trees ar the total loss from the two diseases for a period of eight years is 65 tre or 11.8 per cent.

Orchard No. 3, planted in 1912, lost 1 tree with yellows in 191 and in 1915, 2 trees with yellows and 1 with little peach. This orchai contains 496 trees; so the total loss in four years is 4 trees or 0.8 p cent. Orchard No. 1, lost in its first four years, 0.9 per cent. Orchai No. 2, 1.27 per cent.

The total loss, then, is not considerable, but the per cent of loss Orchard No. 2, is increasing appreciably every year.

By reference to Diagram 2 it will be seen that the loss of trees becau of yellows and little peach is locallized and that these areas appear, most cases, to start at or near the outside rows of the orchard. Th is true in every case except two, in the experimental orchards.

The importance of removing the trees immediately upon the discove of the disease is evident. In Orchard No. 2, Row 17, Trees 9 and 1 were allowed to remain for a year for the purpose of studying tl disease. *The next year two trees came down with little peach and tl* following year, one tree.

That no one variety is more susceptible than another is also eviden In the infested area in the northwest corner of Orchard No. 2, Tre 1, in Rows 2, 3 and 5 are Hiley; Row 2, Trees 2 and 7 are Wonderfu Row 3, Trees 2, 3 and 5; Row 4, Trees 2 and 3; Row 5, Tree 3 an 5 are Elberta and Row 3 and 5, Trees 4 are Late Crawford.

An illustration of the diseased area in the southwest corner of Orchai No. 2, is shown in Fig. 10. The trees formerly located at "1" an "2" were diseased with little peach in 1912, and the trees now occup ing those positions were replanted in the next year, and have made a excellent growth. The four young trees in the foreground are replan after Trees 3, 4, 5, 6 in Row 28 were removed in 1914. The tr designated in the figure as "3" became diseased with little peach in 191

The following facts may be obtained from the data given:

Trees should be removed as soon as the first symptoms of either of th diseases appear; and care should be exercised to prevent any part of a di seased tree from rubbing against a healthy tree.

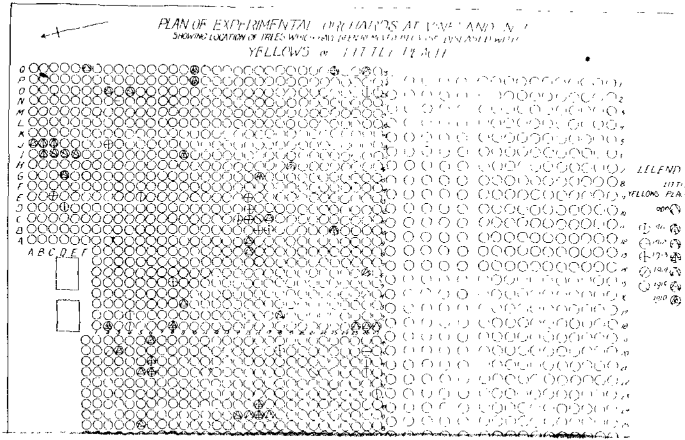

PLAN OF EXPERIMENTAL
YELLOWS
LEGEND
YELLOWS

PLATE V.

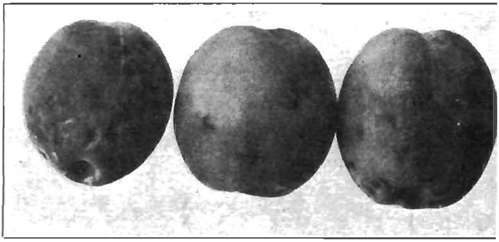


FIG. 9.—Specimens of peaches showing peculiar depressed markings.

FIG. 10.—Corner of Orchard No. 2 at Vineland where disease has continued to spread.

PLATE VI.

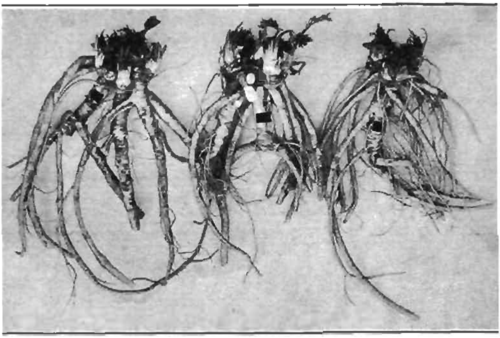


FIG. 11.—Typical horse-radish roots grown from short sets without "stripping" or summer pruning.

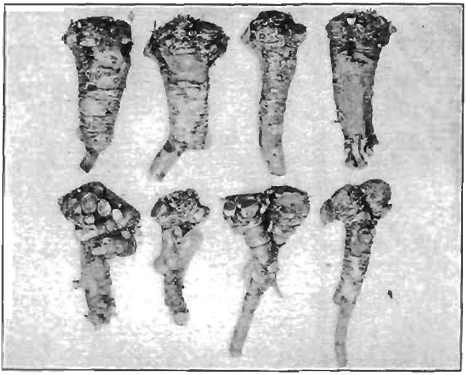


FIG. 12.—Horse-radish roots prepared for market. Upper row represents roots "stripped" or treated during summer. Lower row represents roots not stripped or treated during the summer.

There is apparently no varietal difference as to susceptibility to these diseases.

In the experimental orchards, no tree that has been replanted in a position from which a diseased tree has been removed, has failed to grow, and in no case has any such replant become diseased.

IX.

INVESTIGATIONS WITH VEGETABLES.

L. G. SCHERMERHORN.

The Botanical Department of the College Station has done a large amount of work with vegetables. The work has been largely confined to Adams Fund Projects in plant breeding. The data from these investigations are available to the investigators in the State Station, and will aid materially in putting the vegetable work forward from a commercial standpoint.

No work with vegetables has been done by the State Experiment Station until recently. On November 1, 1914, Mr. L. G. Schermerhorn was appointed to take charge of the teaching of vegetable gardening in the College and to start investigational work with vegetables. Owing to lack of funds only a limited amount of work has been undertaken, but some progress has been made during the past year.

Beets.

Some work was begun by Mr. W. C. Pelton during the summer of 1914 on beet varieties, at which time 55 varieties and strains were sown and studied. The object of the study being to determine the habit of growth, character of leaf, character of root (internal and external), time required to produce edible roots, and the amount of variation occurring in the varieties of garden beets as offered by the seedsman, and to determine if possible a basis for standardizing varieties of garden beets. The results were so striking that it was decided to continue the work in 1915, on a more extensive scale. The same varieties were grown as in 1914 as far as it was possible to obtain them and a large number added to the list.

The study thus far seems to indicate that there is no uniform standard for selection among beet seed growers, there being a notable lack of uniformity in the varietal characters of the stocks.

List of Varieties of Beets Grown in 1915.

Variety and source of seeds sown:

Crosby's Improved Egyptian, Crosby's Improved Egyptian Spec. Strain, Fottler, Fiske, Rawson; Gregory's Improved Crosby's Egyptian, Crosby's Egyptian, J. J. H. Gregory; Crosby's Egyptian, W. A. Burpee & Co.; S. S. Crosby's Egyptian, Stokes Seed Farms; Crosby's Improved Egyptian, J. Bolgiano & Son; Crosby's Egyptian, Dreer's Special Crosby's Egyptian, H. A. Dreer; Crosby's Improved Egyptian, Ex. Sel., Livingston Seed Co.; Crosby's Egyptian, Carter Seed Co.; Crosby's Egyptian, W. H.

Maule; Crosby's Egyptian, Northrup King & Co.; Crosby's Improved Egyptian, Farmer Seed & Nursery Co.; Crosby's Egyptian, Ratekin's Seed House, J. M. Thorburn & Co., Peter Henderson & Co., D. M. Ferry & Co.; Crosby's Egyptian V's Select Stock, Crosby's Egyptian V's Choice, Vaughn's Seed Store; Crosby's Egyptian, H. F. Michell Co.; Dark Red Egyptian, Fottler, Fiske, Rawson Co.; Egyptian, J. J. H. Gregory & Sons; Early Egyptian Turnip, W. A. Burpee & Co.; Extra Early Flat Egyptian, Stokes Seed Farms; Extra Early Red Flat Egyptian, Extra Large Egyptian, J. Bolgiano & Co.; Extra Early Egyptian, H. A. Dreer; Egyptian Turnip Rooted, Carter Seed Co.; Dark Red Egyptian, Ratekin's Seed House; Egyptian, J. M. Thorburn & Co.; Extra Early Egyptian Blood Turnip, D. M. Ferry & Co.; Improved Early Egyptian, Vaughn's Seed Co.; Dark Red Flat Egyptian, Ontario Seed Co.; Edmand's, Fottler, Fiske, Rawson Co.; Edmand's Extra Early Blood Turnip, W. A. Burpee & Co.; Edmand's Blood Turnip, H. A. Dreer; Edmand's Early Blood, Carter Seed Co.; Edmand's Barker's Strain, Joseph Buch & Co.; Edmand's Blood, H. F. Michell Co.; Detroit Dark Red, Fottler, Fiske, Rawson Co., W. A. Burpee & Co., Stokes Seed Farms Co., H. A. Dreer, Stump & Walter Co.; Detroit or Dirigo, Joseph Breck & Sons; Dark Red Dirigo, J. Bolgiano & Sons; Detroit Dark Red, D. M. Ferry & Co., Vaughn's Seed Store; Bastian's Early Turnip, Fottler, Fiske, Rawson Co.; Bastian's Extra Early Blood Turnip, J. Bolgiano & Son; Bastian's Early Blood Turnip, H. A. Dreer; Philadelphia Early Turnip Bastian, D. Landreth Seed Co.; Bassano, Fottler, Fiske, Rawson Co.; Bassano Extra Early, J. Bolgiano & Son; Early Bassano, H. A. Dreer; Bassano, Stump & Walter Co.; Bassano Early Flat Red, Vaughn's Seed Store; Eclipse, Fottler, Fiske, Rawson Co., W. A. Burpee & Co., Stokes Seed Farms Co.; Bolgiano's Extra Early Eclipse, J. Bolgiano & Son; Early Eclipse, D. M. Ferry & Co., Early Eclipse, Vaughn's Seed Store; Dewing's Improved Turnip, Fottler, Fiske, Rawson Co.; Dewing's Improved Blood Turnip, W. A. Burpee & Co.; Dewing's Blood Turnip, J. Bolgiano & Son; Dewing's Improved Blood Turnip, H. A. Dreer; Dewing's Peter Henderson & Co.; Dewing's Blood Turnip, D. M. Ferry & Co.; Dewing's Early Blood Turnip, Vaughn's Seed Store; Arlington Favorite, Fottler, Fiske, Rawson Co., J. J. H. Gregory & Sons; Early Arlington, Joseph Breck & Sons; Arlington Improved, Vaughn's Seed Store; Arlington Favorite, H. F. Michell Co.; Crimson Globe, J. J. H. Gregory & Sons, W. A. Burpee & Co.; New Crimson Globe, J. Bolgiano & Sons; Crimson Globe, H. A. Dreer, W. H. Maule, Vaughn's Seed Store, H. F. Michell Co.; Crimson Ball, Carter Seed Co.; Faust's Early Crimson, J. J. H. Gregory; Dark Stinson, W. A. Burpee & Co.; Robert Buist Co.; Electric, J. Bolgiano & Son, I. N. Simon & Sons, W. H. Maule, Vaughn's Seed Store; Early Model, W. A. Burpee & Co., H. A. Dreer, Peter Henderson & Co.; The Model Red Globe, Stokes Seed Farms; Model Red Globe, J. M. Thorburn & Co.; Red Model, Stump & Walter Co.; Burpee's black Red Ball, W. A. Burpee & Co.; Simon's Dark Leaved Blood Ball, I. N. Simon & Son; Bingar Ball, J. A. Salzer Seed Co.; Fireball, D. Landreth Seed Co.; Vaughn's Fireball, Vaughn's Seed Store; Salzer's Fireball, J. A. Salzer Seed Co.; F. S. & N.'s Co.'s Fireball, F. Seed & Nursery Co.; Witham Fireball, J. M. Thorburn & Co.; Columbia, W. A. Burpee & Co.; Extra Early Columbian, J. Bolgiano & Son; Trevise (Columbia), J. M. Thorburn & Co.; New Century Late, Stokes Seed Farms Co.; Boston Market, Fottler, Fiske, Rawson Co.; Wesley's Early Market, I. N. Simon & Son; Early Market, J. Bolgiano & Son; Maule's Market King, W. H. Maule; N. K. & Co.'s Market Gardener's, Northrup, King & Co.; Market Gardener's F. Seed & Nursery Co.; Burpee's Extra Early, Burpee's Improved Blood Turnip, W. A. Burpee & Co.; Early

Blood Turnip, New Improved, Deep Blood Beauty, Early Ox Blood Dark Red, J. Bolgiano & Son; Dreer's Excelsior Blood, Early Blood Turnip, H. A. Dreer; Landreth's Early Blood Turnip, D. Landreth Seed Co.; Carter's Blood Red, Carter Seed Co.; Early Othello Dark Blood Turnip, Robert Buist Co.; Early Blood Turnip, D. M. Ferry & Co.; Lentz Extra Early (Phila. grown) Stoke's Seed Farms Co.; Lentz Extra Early Blood Turnip, Nutting's Early Gem, American Beauty, Extremely Early Bonfire, J. Bolgiano & Son; Dark Leaved Golden, H. A. Dreer; Carter's Dainty, Carter's Improved Dark Red, Carter's Perfection, Chelten Lawn Green Top, Carter Seed Co.; Uncomparable Second Early, I. N. Simon & Son; Landreth's Best, Landreth's Early Forcing, D. Landreth Seed Co.; Maule's Alpha Black Queen, W. H. Maule; Black Queen, F. S. & N. Co.; Maule's Mid-Summer, F. Seed & Nursery Co.; Philadelphia or Perfection H. L., I. N. Simon & Sons; Philadelphia Half Long, Stoke's Seed Farms; Half Long Blood, Stump & Walter Co.; Half Long Dark Blood, J. Bolgiano & Son; N. K. & Co.'s Sterling, Northrup, King & Co.; Vaughn's Chicago Market, Vaughn's Seed Store; King Beet, Market Gardener, Extra Early Dark Beauty, Extra Early, Ratekin's Seed House; Breck's Beats All, Joseph Breck & Sons; Best of All, Extra Early Red Beauty, J. A. Salzer Seed Co.; Early Yellow Turnip, W. A. Burpee & Co.; Round Half Long, J. A. Salzer Seed Co.; Buist's Scarlet Perfection, Robert Buist Co.; Bastian's Half Long, H. F. Michell Co.; Half Long Blood, H. A. Dreer; Long Red Erfurt, Joseph Breck & Sons; Long Smooth Blood Red, W. A. Burpee & Co.; Long Dark Blood, H. A. Dreer; Long Smooth Blood, J. Bolgiano & Son; Extra Long Deed Blood Red, Ontario Seed Co.; Long Smooth Dark Red, Fottler, Fiske, Rawson Co.

Germination tests of the samples of beet seed are being made, and up to date 100 of the tests have been completed. The results are shown in Table 15. The figures listed as "germination average" represent the number or sprouts from 100 seed balls.

Table 15.

	Variety	Source of Seed	Germ'n Average
1	Crosby's Improved Egyptian	Fottler, Fiske, Rawson Co	114.5
2	Crosby's Improved Egyptian Special Strain	Fottler, Fiske, Rawson Co	91.5
3	Gregory's Improved Crosby's Egyptian	J. J. H Gregory	117.
4	Crosby's Egyptian	J J. H Gregory	144.
5	Crosby's Egyptian	W. A. Burpee & Co	60.5
6	S. S. Crosby's Egyptian	Stokes Seed Farms	103.
7	Crosby's Improved Egyptian	J. Bolgiano & Son	131.5
8	Crosby's Egyptian	H. A. Dreer	158.5
8a	Dreer's Special Crosby's Egyptian	H A. Dreer	126.5
9	Crosby's Improved Egyptian Ex. Sel.	Livingston Seed Co	149.
10	Crosby's Egyptian	Carter Seed Co.	151.5
11	Crosby's Egyptian	W. H Maule	152.
12	Crosby's Egyptian	Northrup King & Co.	139.
13	Crosby's Improved Egyptian	Farmer Seed and Nursery Co	139.
14	Crosby's Egyptian	Ratekin's Seed House	172.
15	Crosby's Egyptian	J. M. Thorburn & Co.	52.
16	Crosby's Egyptian	Peter Henderson & Co	121.
17	Crosby's Egyptian	D. M Ferry & Co.	109.
18	Crosby's Egyptian V's Select Stock	Vaughn's Seed Store	149.
19	Crosby's Egyptian V's Choice Stock	Vaughn's Seed Store	152.
20	Crosby's Egyptian	H F. Michell Co	168.
21	Dark Red Egyptian	Fottler, Fiske, Rawson Co	149.
22	Egyptian	J J. H Gregory & Sons	106.5
23	Early Egyptian Turnip	W A Burpee & Co.	148.
24	Extra Early Flat Egyptian	Stokes' Seed Farms	132.
26	Extra Large Egyptian	J Bolgiano & Co	140.5
27	Extra Early Egyptian	H. A Dreer	126.
27a	Egyptian Turnip Rooted	Carter Seed Co	111.
28	Dark Red Egyptian	Ratekin's Seed House	155.
29	Egyptian	J. M. Thorburn & Co.	131.5
30	Extra Early Egyptian Blood Turnip	D. M Ferry & Co.	126.
31	Improved Early Egyptian	Vaughn's Seed Co.	81.5
32	Dark Red Flat Egyptian	Ontario Seed Co	129.5
33	Edmand's	Fottler, Fiske, Rawson Co	143.5
34	Edmand's Extra Early Blood Turnip	W. A. Burpee & Co	174.
35	Edmand's Blood Turnip	H. A. Dreer	158.5
36	Edmand's Early Blood	Carter Seed Co	142.
37	Edmand's Barker's Strain	Joseph Buch & Son	90.
38	Edmand's Blood	H. F Michell Co.	126.
39	Detroit Dark Red	Fottler, Fiske, Rawson Co.	181.
40	Detroit Dark Red	W. A. Burpee & Co	166.5
41	Detroit Dark Red	Stokes Seed Farms Co	152.5
42	Detroit Dark Red	H. A. Dreer	82.5
42a	Detroit Dark Red	Stump & Walter Co	102.
43	Detroit or Dirigo	Joseph Breck & Sons	144.5
43a	Dark Red Dirigo	J Bolgiano & Son	99.5
44	Detroit Dark Red	D. M. Ferry & Co.	173.5
44a	Detroit Dark Red	Vaughn's Seed Store	190.5
45	Bastian's Early Turnip	Fottler, Fiske, Rawson Co	148.5
46	Bastian's Extra Early Blood Turnip	J Bolgiano & Son	144.5
47	Bastian's Early Blood Turnip	H. A. Dreer	134.5
48	Philadelphia Early Turnip Bastian	D. Landreth Seed Co	102
49	Bassano	Fottler, Fiske, Rawson Co	210.5
50	Bassano Extra Early	J. Bolgiano & Son	131.5
50a	Early Bassano	H. A. Dreer	203.5
51	Bassano	Stump & Walter Co.	162.5
52	Bassano Early Flat Red	Vaughn's Seed Store	118.5
53	Eclipse	Fottler, Fiske, Rawson Co	171.
54	Eclipse	W. A. Burpee & Co.	135.5
55	Eclipse	Stokes Seed Farms Co	130.
56	Bolgiano's Extra Early Eclipse	J. Bolgiano & Son	115.
57	Early Eclipse	D. M. Ferry & Co	129.5
58	Early Eclipse	Vaughn's Seed Store	155.
59	Dewing's Improved Turnip	Fottler, Fiske, Rawson Co.	109.
60	Dewing's Improved Blood Turnip	W. A. Burpee & Co.	171.
61	Dewing's Blood Turnip	J. Bolgiano & Son	154.
62	Dewing's Improved Blood Turnip	H. A. Dreer	130.5
63	Dewing's	Peter Henderson & Co.	198.
64	Dewing's Blood Turnip	D. M. Ferry & Co.	170.5
65	Dewing's Early Blood Turnip	Vaughn's Seed Store	238.
66	Arlington Favorite	Fottler, Fiske, Rawson Co	178.5
67	Arlington Favorite	J. J. H. Gregory & Son	98.5
68	Early Arlington	Joseph Breck & Sons	119.5
69	Arlington Improved	Vaughn's Seed Store	132.
70	Arlington Favorite	H. F. Michell Co.	94.

Table 15—Continued.

	Variety	Source of Seed	Germ'n Average
71	Crimson Globe	J. J. H. Gregory & Sons	92.
72	Crimson Globe	W. A. Burpee & Co	160.
73	New Crimson Globe	J. Bolgiano & Son	139.5
74	Crimson Globe	H. A. Dreer	102.
75	Crimson Globe	W. H Maule	105.
76	Crimson Globe	Vaughn's Seed Store	110.
77	Crimson Globe	H. F. Michell Co.	159.5
78	Crimson Ball	Carter Seed Co.	159.5
79	Faust's Early Crimson	J. J. H. Gregory & Sons	113.5
80	Dark St nson	W. A. Burpee & Co.	131.
81	Dark St nson	Robert Buist Co	103.5
82	Electric	J. Bolgiano & Son	95.
83	Electric	I N Simon & Son	128.5
84	Electric	W. H. Maule	92.5
85	Electric	Vaughn's Seed Store	160.
86	Early Model	W. A. Burpee & Co.	47.5
87	Early Model	H. A. Dreer	123.
88	Early Model	Peter Henderson & Co.	110.5
89	The Model Red Globe	Stokes Seed Farms	130.
90	Model Red Globe	J. M. Thorburn & Co.	133.
90a	Red Model	Stump & Walter Co.	68.
91	Burpee's Black Red Ball	W. A. Burpee & Co.	99.5
92	Simon's Dark Leaved Blood Ball	I. N. Simon & Co	195.
93	Bingar Ball	J. A. Salzer Seed Co.	79.5
94	Fireball	D. Landreth Seed Co	118.5
94a	Vaughn's Fireball	Vaughn's Seed Store	105.
95	Salzer's Fireball	J. A. Salzer Seed Co.	113.
96	F. S. & N's Co's Fireball	F. Seed & Nursery Co.	131.5
97	Witham Fireball	J. M. Thorburn & Co.	95.
98	Columbia	W. A. Burpee & Co.	118.5
99	Extra Early Columbian	J. Bolgiano & Co.	131.5
100	Trevise (Columbia)	J. M. Thorburn & Co	144.5
101	New Century Late	Stokes Seed Farms Co	112.5

X.

A STUDY OF COLOR ZONES IN BEETS.*

A horizontal cross section of a beet reveals to the observer a number of concentric circles forming peripheries of zones whose colors are alternately white and red. The examination of a few such cross sections of beets varying in age, size, etc., has suggested to the writer that the zone formation stands in some functional relation to the age of the beet, its size, and to the number, color and size of its leaves. In order to ascertain the existence of such relation the writer took up the study of the Color Zones in Beets. During the course of the investigation many points have appeared which though of little practical significance, may prove of great value to the scientist.

Material and Method. The first essential in carrying on such work is, of course, a sufficient supply of the necessary material, which in this case was a number of beets of various ages and sizes, ranging from a beet just commencing to grow to one fully grown.

The method pursued in this investigation was as follows: One variety of table beet was selected, "Crosby's Improved Egyptian," of which plantings in twelve pots were made successively from January 29th to April 30th, at intervals of one week. The seed was planted in four-inch flower pots containing a fairly rich sandy loam soil. Twelve beet seeds were planted in each pot and the twelve pots set out in the greenhouse on a bench. Care was taken to water the pots whenever necessary. A temperature of about 65° to 70° F. in the daytime and 5° to 10° less at night was maintained throughout the entire work with these plants. Each week this seeding operation was repeated until April 30th, two weeks before the beets planted on January 29th were to be ready for sectioning as the oldest beets.

*A thesis study by Arthur Kuntz, a senior in Rutgers College in 1914-1915.

On March 19th the first transplanting was made of the first three lots of plants. These were all fairly large, having two well-developed leaves besides the cotyledons or seed leaves. Twenty-four two-inch pots were used for the transplanting of each lot of beets of the same age. All pots were treated alike and the seventy-two pots (twenty-four of each of three lots) set back on the bench. In the meantime the other beets, planted at later dates, began to develop, and on April 12th four more lots of beets were transplanted and treated in the same manner as the first three lots, transplanted on March 19th. The beets transplanted on March 19th had made a rapid growth and were transplanted again, this time to four-inch pots by merely removing beet and soil together from the two-inch pot and placing it into a four-inch pot, filling the latter with soil. After this operation the beets were not transplanted or moved again. The beets planted after this time, however, when of a fair size, were thinned out so as to stand three plants in a four-inch pot, and allowed to grow this way until they were sectioned on May 14th.

Sectioning. The plants, now ready for sectioning, were all arranged in order of age and development. The youngest beet was one planted on April 30th and ready for sectioning May 14th, when just two weeks old. The first leaves, really not true leaves but cotyledons or seed leaves, were fairly well developed, with no true leaves in sight. The root was placed into a slit made in a piece of corn pith and by means of a razor a very thin horizontal section was made of it. This section was placed on a slide, a drop of water was added to it, and the whole examined through the microscope. Only one zone was noted, composed of fibro-vascular bundles in the center of the section. These bundles are found arranged in a group at first, but in the sections of older beets they appear singly in the zones away from the center. These individual bundles are composed of an inner portion or xylem, an outer portion or phloem and a ring of small cells between the xylum and phloem, known as the interfasicular cambium. In the very young beet these bundles are mingled together considerably and hence the appearance of many small cells with still smaller cells between them. The xylem portion of the bundle permits of the passage of water from the root hairs and the phloem permits of the passage of food. The layer of cells surrounding these bundles, is known as parenchyma tissue and has a light blue appearance, though it is not a true zone. The remainder of the section is composed of epidermic utricles, cells which resemble the parenchyma but are transparent and slightly longer and larger.

The next beet sectioned was one having four well developed leaves. In this section two zones were seen. These appeared white without the microscope or transparent under the microscope. There is one red zone formed. The fibro-vascular bundles are in this case divided into five wedge-like groups, the spaces between the groups being medulary rays. The cambium which is red in color is a development and enlargement of the interfasicular cambium cells, which, when mature, take on the pigment due to a chemical action. Interfasicular cambium cells and fibro-vascular bundles respectively go to form the second zone.

In the beet containing six leaves we find an arrangement similar to that of the beet with four leaves, except that in the former there is a third zone formed which occupies some of the space taken up by the parenchyma tissue and epidermic utricles. Likewise, the beet with eight leaves has four zones, and that with ten leaves, five zones. However, at this point the regular and uniform variation in the number of zones corresponding to the number of leaves, ceases and there apparently is no more definite correlation between the number of zones and the number of leaves. The following table makes this clear.

Table 16.

Date of Sowing	*No Leaves Developed*	*No. Zones in Root*
January 29	12—20	5—8
February 5	10—20	5—8
" 17	10—20	5—8
" 26	10—16	5—7
March 5	10—12	5—6
March 12	10—12	5—6
March 19	8	4
March 26	6	3
April 10	4	2
April 30	2	1

However, in any case, when the root has five or more zones they occupy the entire section and no more parenchyma tissue is found. The first ring which is white is composed of fibro-vascular bundles with their interfasicular cambium, then a zone (colored red) of cambium, another zone of bundles and so on to the outside of the beet. The last colored zone, whether fifth, sixth or more, is always on the very outside of the root. Toward the outside there is a thickened dark-colored portion or skin of the beet.

Results Obtained.

Variation in Color. It is interesting to note that the coloring matter in the beet is not always the same, sometimes being a pink or purplish red, and at other times a plain red, even within the same variety. In different varieties this is especially noticeable. Color in the foliage does not always seem to be definitely correlated with the color of the root although it is to some degree.

Beets with light green foliage commonly have a large proportion of white in the root, at least one exception was noted. Beets with dark red foliage commonly show a large proportion of red in the root.

Relation of Foliage to Zone Formation. The size and vigor of the foliage does not apparently affect the width of the zone formation in the root. The variation in the number of zones of beets of the same age seems to follow no definite rule; small beets frequently having as many as, or even more zones, than a larger beet of the same age.

Effect of a Check to Growth on Zone Formation. Beets which have been checked in their growth will be checked in their zone formation, and two beets of different ages but of the same number of leaves formed, will have the same number of zones, providing that number is below five, as above five there is a variation other than that due to a check in growth.

Constancy of Zones Throughout the Beet. Within the same beet the number of zones remains constant, from the tip of the root to the crown, being closer together at the tip and wider apart higher up. A little above the center of the beet the zones are broken up somewhat and no regular arrangement preserved. There is of course a connection between the bundles and cells of the roots and the leaves of the beet which can be traced by making a vertical section throughout the beet, taking in the leaf with part of the root.

Concentricity of Zone Formation. The zones are concentric in their formation and usually almost perfectly circular in form. However, when injured on one side or misshapen for some reason, the central zone is found near the flattened side of the beet, making the other zones closer and narrower near that side, and wider and farther apart on the round or normal side.

CAUSES OF ZONE FORMATION AND ITS COLORING. The formation of zones in beets is apparently due to chemical action that causes some cells to take on pigment, but not others, the cells being arranged in circular bands or zones. The cells taking on the pigment are older and larger than the others. When the cells of the interfasicular cambium develop, they grow out to form a new zone and at the same time take on coloring. The fibro-vascular bundles are always found in the white portion or zones of the beet.

ZONE FORMATION AND NEW LEAVES. The relation between the formation of new leaves and that of new zones in the root is very interesting. When the new leaves are commencing to break through, an examination of the cross section of the beet will reveal the starting of a new zone in the root. The new leaves are therefore related to the new zones formed farther away from the center of the section, and the oldest leaves trace down into the central zone.

These results have been arrived at after a study of the material at hand. As the time devoted to this work was rather limited, the field investigated was of necessity reduced to a few points.

XI.

VEGETABLE VARIETY SURVEY.

ROSCOE W. DEBAUN.

During the months of February and March, 1915, a vegetable variety survey was conducted to determine what varieties were most popular among the commercial growers of the State. The results are given in the following Table 17 and are tabulated to show the number of growers that expressed a preference with regard to the best commercial variety of any vegetable and the three varieties in each case which received the largest number of favorable reports.

An outstanding feature of the results of the survey is that in many cases there is a strong preference given to a single variety of a vegetable while in a majority of cases the two leading varieties of any vegetable include most of the reports on that particular vegetable. In the case of beans, cabbage, sweet corn, cantaloupes, tomatoes and watermelons, however, there were many varieties reported at least once as being commercially desirable. The results of such variety surveys should be helpful to the vegetable grower in indicating the general success and popularity of certain sorts. It may also be of some value to the seedsmen, assisting them to eliminate many varieties. Thus uniformity of product will be promoted both at the seed farm and vegetable farm.

It may be of special interest to note the high esteem in which certain varieties of vegetables are held, such for instance as: Curries' Rust Proof Yellow Wax Beans, Danvers Half Long Carrot, Snowball Cauliflower, Golden Self Blanching Celery, Big Boston Lettuce, Fordhook Bush Lima, Savoy Spinach, Earliana Tomatoes and Stone Tomatoes. Varieties that are gaining popularity very fast are Copenhagen Cabbage, Golden Bantam Sweet Corn, Black Beauty Eggplant, Gradus Peas, and Bonny Best and Matchless Tomatoes.

Table 17.
Detailed Report Upon Varieties of Vegetables.

VEGETABLE.	No Growers reporting on it.	FIRST.	SECOND.	THIRD.
Yellow Wax Beans.	34	Curries' Rust Proof–10	Hodson Wax–4	Black Wax–3
Green String Beans.	34	Black Valentine–9	Stringless Green Podded–4	Bountiful–3
Beets	33	Crosby's Egyptian–9	Detroit Dark Red–6	Crimson Globe–5
Early Cabbage	71	Jersey Wakefield–14	Copenhagen–6	Charlestown Wakefield–5
Late Cabbage		Danish Ball Head–16	Flat Dutch–9	Succession–3
Carrots	29	Danvers Half Long–13	Rubicon–5	Chantenay–4
Cauliflower	19	Snowball–14	Dwarf Erfurt–3	
Celery	22	Golden Self Blanching –13	White Plume–3	Giant Pascal–2
Sweet Corn	62	Stowell's Evergreen–13	Country Gentleman–7	Golden Bantam–6
Cucumbers	28	White Spine–11	Davis Perfect–6	Long Green–4
Eggplants	20	Black Beauty–12	N. Y. Spineless–5	
Lettuce	37	Big Boston–19	Salamander–4	Grand Rapids–2
Leeks	4	Large Amer. Flag–2	Musselburg–1	Giant Carentan–1
Pole Limas	21	King of the Garden–6	Challenger–3	Early Leviathan–2
Bush Limas	18	Fordhook–14	Wonderful–2	
Cantaloupes	33	Fordhook–9	Jenny Lind–6	Rockyford–4
Onions	28	Prizetaker–7	Yellow Globe Danvers–7	White Globe–2
Peas	49	Gradus–12	Alaska–8	Thos. Laxton–6
Parsnips	8	Hollow Crown–8		
Peppers	23	Ruby King–7	Chinese Giant–4	Hot Bullnose–3
Radishes	17	Scarlet Globe–5	Lady Finger–3	White Icicle–2
Spinach	26	Savoy–9	Thick Leaf–7	Long Season–4
Turnips	9	Purple Top Globe–3	Yellow Globe–2	
Early Tomatoes	86	Earliana–18	Bonny Best–11	Chalks Early Jewel–7
Late Tomatoes		Stone–19	Matchless–8	Greater Baltimore–3
Rutabagas	4	Long Island–2	Purple Top–1	Yellow–1
Watermelons	27	Tom Watson–8	Kleckley Sweet–8	White Icing–3

XII.

SWEET CORN SUCKERING EXPERIMENTS.

Roscoe W. DeBaun.

During the early summer of 1915 frequent inquiries came to the New Jersey Experiment Station inquiring as to the advisability of suckering sweet corn, and, if recommended, what was the proper time in the growth of the corn to remove these suckers. But little data could be found on record concerning this point. Many successful sweet corn growers were consulted, who readily gave their opinion. Some said sucker the corn as soon as possible; others said wait until a large root is developed, then just before the corn sends out its tassels, remove the suckers so that the remaining stalk will have full benefit of an immense root system. Only a few growers said it did not pay to remove the suckers. Accordingly, as nothing very definite could be learned it was thought expedient to arrange for test plots that additional results might be obtained.

The Plan of Experiment. Sweet corn growers were sought who were interested in the question. Arrangements were then made with them to establish a test plot ten hills square in that section of a field where they could let the corn mature for seed. It was planned to number the rows

1 to 10. Then, when the first suckers were about six inches long i. e., when the corn was a foot to fifteen inches tall, rows numbered 2, 3, 7, and 8 were carefully suckered. Two or three plants were left in each hill according to the practice of the cooperating farmer. The dates of planting, condition of soil, kind of fertilizer and method of application, growing condition and vigor were all carefully recorded. Two weeks later rows 4 and 9 were suckered on each plot. The number and size of suckers and degree of maturity were carefully recorded. Two weeks later, just as the tassels were beginning to appear above the leaves, rows 5 and 10 were suckered and careful notes taken. Also rows 3 and 8 were re-suckered as small suckers were again developing at the base of these. This left rows 1 and 6 to mature without having their suckers removed.

Five of these test plots were arranged for in Bergen County with the assistance of the county demonstrator. Two were arranged in similar manner in Middlesex County and one was established at the College Farm. Because of severe storms in mid-summer and other factors only three plots and these, all in Bergen County, gave satisfactory results.

When the corn was approaching the proper stage of maturity for market, the development of each row was carefully recorded.

Table 18.

Results of Suckering Test in Pounds of Dried Corn on Cob of Each Row of Ten Hills.

Plots on Farm of—	Row	Not Suckered	Row	Suckered when corn was one foot high	Row	Same as 2 and 7 with second treatment	Row	Suckered when corn was two feet high	Row	Suckered when tassels began to show
Mrs. DeVuet..........	1	22.75	2	16.00	3	16.50	4	15.50	5	14.75
	6	21.25	7	15.25	8	15.00	9	15.75	10	17.50
Trautwein Bros.	1	14.50	2	15.50	3	15.00	4	14.75	5	14.75
	6	19.76	7	15.00	8	13.00	9	16.50	10	11.00
Mr. H. Behnke	1	12.75	2	11.25	3	11.50	4	11.50	5	9.25
	6	11.50	7	12.00	8	9.75	9	8.50	10	7.00
Total number of rows receiving same treatment	6	102.50	....	85.00	....	80.75	....	82.50	....	74.25
Average production in lbs. for rows receiving similar treatment	....	17.08	....	14.17	....	13.46	....	13.75	....	12.87

The rows first suckered were ready for market about three days before the rows not suckered while those suckered later were somewhat earlier than those not suckered. The summary of results show that those hills not suckered gave the heaviest yield while the hills from which the suckers were removed late in their growth gave the smallest yield. Also, of the two sets of rows that were suckered first, it can be seen that those rows which had the second growth of suckers removed gave an even smaller yield than the other set of rows. It is a well known fact that the leaves are the digestive organ of the plants, therefore, when moisture and plant food are abundant in the soil, to reduce the foliage would tend to reduce the yield. In all plots where this experiment was conducted the soil was rich and the rains were especially heavy.

From these results the following may be concluded: During favorable growing seasons the yield of sweet corn is reduced in proportion to the lateness of suckering. Corn not suckered gives the heaviest yield. Sweet corn suckered early in its growth will be ready for market two to four days earlier than that suckered late or not at all.

It is quite possible that somewhat different results might be secured during a dry growing season. The work therefore will be carried on for another year so that more complete results may be obtained.

The writer is especially indebted for these results to Mr. DeVust, Mr. Henry Behnke and to Trautwein Brothers, all Bergen County sweet corn growers and to Mr. L. F. Merrill, Farm Demonstrator for Bergen County, who helped materially in obtaining and recording these results.

XIII.

EXPERIMENTS WITH HORSE-RADISH.

ROSCOE W. DEBAUN.

During the summer of 1915 the methods of growing horse-radish in Burlington County were studied by the writer to determine if there might not be a chance to improve the quality of this important crop. The growers said it was an inexpensive crop to grow and required but little plant food, but it was quite hard to clean for market because the main roots were small and surrounded by many branch roots. The horse-radish graters and dealers were then consulted to determine the condition of the marketable product. They complained that the roots were small and very difficult to clean for the grinders and that each root had several crowns. These crowns had soil in between them which was most difficult to wash or scrape out without cutting the root into pieces. All this cutting and scraping added to the waste of product and the expense of preparation.

Acting on this information the writer decided to try out a method whereby each plant might produce one large main compact root rather than many small roots which are harder to harvest and of less value to the buyers.

Horse-radish is propagated each year from cuttings made from the side roots of the previous year's growth. The cuttings or sets are about the size and length of a lead pencil. Early in spring these are set in a slanting position about twenty inches apart in rows three feet apart. When these start growth branch roots develop the entire length of the main root or set, especially near the top, and several crowns or buds start at and near the top of the set. This development is clearly shown in Fig. 11.

These side roots which develop along the upper half of the set do not increase the size of the main root but tend to form a much branched and divided root system. Therefore, these side roots should be removed early in the growth of the plant (probably the first part of July) so that those roots at the lower end of the set will develop instead and increase the size of the main set or root. If all of the crowns except the strongest one nearest the tip of the root are removed a single compact top will be formed that will be much easier to clean than a top formed of many crowns.

With this idea in mind the writer obtained permission from five prominent horse-radish growers near Burlington and Beverly to make a test on part of a row of horse-radish in each of their fields. During the middle of August the soil was removed from around these roots and the side roots were stripped from the upper part of the main root or set and all but the largest crown cut off. The soil was then replaced. These tests were started so late in the growing season that the plants received a severe setback for many large branch roots were removed as well as much foliage.

On November 8th the roots from each test row were dug and carefully compared with those in the adjacent row, which were untreated.

The two sets of roots shown in Fig. 12 are representative roots prepared for market taken from adjacent rows in a ten-acre field along the Camden Turnpike. The treated plants produced a large, solid, compact root, while the untreated roots show the irregularities caused by the promiscuous development of the side roots and the formation of numerous crowns.

The roots illustrated in Fig. 11 are typical as to the form of the root system when it is allowed to develop of its own accord. That portion of each root marked with a small black square is the main root and was the part planted and intended for development. It requires no imagination to realize the irregular appearance of the roots when prepared for market. When these few feeder or side roots are removed early enough in the season a solid compact root is secured for the market.

The results of these limited tests have been most gratifying and encouraging. The growers and dealers are anxious that this work be carried out more extensively another year. It is reasonable to suppose that even greater benefits would result if the root pruning was practiced earlier in the season so that the plants would not receive as severe a shock or setback.

A little different method of planting is also thought to be advisable. If the roots were set slantingly in small ridges the roots would be more accessible for pruning.

It is expected that this work will be carried on more extensively another year when an effort will be made to determine the cost of the "stripping" and the relative value of the "stripped" and the untreated product. This year's results also indicate that production is increased by the stripping method for twenty stripped roots prepared for market weighed fourteen pounds as compared to eleven and one-half pounds, the weight of twenty unstripped roots taken from the adjacent row.

The writer is especially indebted to Messrs. H. L. Anthony & Son, A. J. Boyd, A. J. Jordan, James Murphy, W. B. Shedeker and C. J. VanSciver & Bro., all of Burlington County, for their hearty cooperation.

XIV.

WEATHER OBSERVATIONS.

ARTHUR J. FARLEY.

The weather conditions during the season of 1915 were rather unusual in many respects.

The heaviest snowfall, 10½ inches, occurred on April 3rd. March was very dry, rain falling only on three days and the total rainfall being only 0.75 inches, a departure of 3.33 inches below the normal. The large amount of bright weather was favorable to the conduct of early spring work. The rainfall was below normal during the months of November, March, April, June, July, September and October, but very heavy precipation occurred during the months of January, February and August. Rain fell on 17 days during May, yet, the total rainfall was but slightly above the normal. The rainfall during the month of August amounted to 9.97 inches of which 7.05 inches fell in two days. The total rainfall for the year was 50.03 inches which is 1.31 inches above the normal for this section. A very light frost occurred on April 16 with a minimum temperature of 33°. The first frost in the fall, sufficient to injure coleus, occurred upon October 11th with a minimum temperature of 32°. A frost sufficient to injure soybeans, cosmos, etc., did not occur until October 25th, when a minimum of 30° F. was experienced. Such plants as geraniums continued to grow upon the grounds at the College Farm without suffering serious injury until after November 1st.

The highest maximum for the year occurred on July 31st, with a temperature of 92°, while the lowest minimum occurred on December 27th, with a temperature of 2°.

Mr. William Schieferstein assisted in recording the weather observations previous to August 5th, when Mr. Lawrence G. Gillam assumed these duties.

Table 19.
Monthly Maximum and Minimum Means of Temperature for the Station; Years of 1914-1915.

YEAR.	NOVEMBER		DECEMBER		YEAR.	JANUARY		FEBRUARY		MARCH		APRIL	
	Max.	Min.	Max.	Min.		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1913	52.8	35.8	43.	28.1	1914	35.9	21.1	31.5	14.5	44.7	26.	56.1	37.1
1914	53.6	33.9	37.1	23.1	1915	40.8	25.9	44.	27.5	46.9	26.6	67.8	42.4

YEAR.	MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1914....	73.6	49.1	77.9	56.	80.7	62.3	82.6	61.5	77.8	49.6	69.	48.6
1915....	69.	48.	77.9	57.3	82.6	62.8	79.3	61.1	78.5	58.3	66.2	48.3

Table 20.

Daily and Monthly Precipitation in Inches at the College Farm for the Year Ending October 31, 1915.

	Nov. 1914	Dec. 1914	Jan. 1915	Feb. 1915	March 1915	April 1915	May 1915	June 1915	July 1915	Aug. 1915	Sept. 1915	Oct. 1915
1				2.00			T		.67	T		[illegible]
2	.09	05		1.35				.01	.24	3.18		[illegible]
3				.18		1.03			.01	.51		
4						.02	.19			3.87		
5							.38		1.06			[illegible]
6		.41	.03	.30	.43	.10	T			.77		
7		1.27	.57		.30	T		.04		.01	.55	[illegible]
8		.55		T	.02		T		.64	.08		[illegible]
9	.09	28					.09		.09	.31		
10												
11						.20		T				
12			1 13	T		.63	.06	06	.30	T		
13		.05	1.67				.78	T		.15		
14		.76						.04	.38			
15	.71			13						.06		[illegible]
16	1.17			.49			.02	1.69	.62			
17			.09				.24	.18			.15	
18			1.47					.19	.05			
19	.45	.04	.06					T	T		.75	
20	.36	.06			T			T	T			[illegible]
21		.96	.10			.03	.35		.02	T	.61	
22							1.32		.29	T		
23			30		T	.02	.07	.12				
24		03	.22	.39			.16		T			
25			.19	.97			.02			.90		
26							.03	.21				
27								T	.45			[illegible]
28						.17		.12	T	T		
29		.51							1.15	.60		
30						.27	.16		.01	.19		
31			.20			.28						
Total	2 87	4.97	6 03	5.81	0.75	2.75	3.87	2.66	5.96	9.97	2.06	[illegible]
Normal	3 30	3.74	3.28	3 61	4.08	3.45	3.72	3.33	6.42	5.75	3.93	[illegible]

* T—Trace

REPORT OF THE DEPARTMENT OF ANIMAL HUSBANDRY

Department of Animal Husbandry

FREDERICK C. MINKLER, B.S.A., *Animal Husbandman.*

*J. MARSHALL HUNTER, B.S., *Assistant Animal Husbandman.*

* Appointed September 1, 1915.

CONTENTS.

Report of the Department of Animal Husbandry.

FREDERICK C. MINKLER

I.

INTRODUCTORY.

The continued interest displayed by the farmers in this State in problems of pork production prompted the Animal Husbandman to study further the question of forage crops as adapted to swine feeding. Notably in South Jersey there is a movement suggesting that the farmers generally realize the importance of reviving the practice of animal production in order that crop yields may be increased, rotations shortened and a home market created for farm produce. Again, it is evident that on those farms where live stock is maintained and where, for the most part, the field crops are utilized as feed for animals, a more stable production is assured. Furthermore, where meat is the end product it is possible to create new dollars and new values, provided care is exercised in selecting the type of animal that will serve as an efficient transfer machine. The modern fat hog is such an animal machine and just now is playing an important part in the re-adjustment of farm practices and problems.

Five factors evidently have encouraged pork production in the East:

The control of hog cholera by means of the serum or the serum simultaneous treatment.

The pig's efficiency in converting waste and refuse products into a meat product that is always salable at an attractive price, thus providing ready cash.

The use of the Self-Feeder and the individual inexpensive colony house systems of management.

The fact that the pig can harvest forage, grain and corn crops without subjecting them to expensive methods of preparation, and this feat without waste and at low labor cost.

The comparatively small initial cost of equipment including breeding stock; the rapidity of increase; the short growing and fattening period, and the continued demand for all pork products.

II.

FORAGE CROPS.

During the past year the work in the Swine Department has been continued along the same general lines as submitted in this report last year. Areas were planned to study the adaptability of certain forage crops for swine feeding, notably dwarf Essex rape, sweet clover, soybeans and alfalfa, or combinations of these forage crops, not only concerning their comparative cost of production, but their palatability, date and period of usefulness, and the total income per unit area where they were used for foraging by the swine herd made up of breeding animals, and those intended for market purposes.

Concerning the area available for investigational work and devoted for use of the Department in the maintenance of the regular breeding herd, it is interesting to note the general plan of this area, which has proved to be especially adapted for both purposes. The arrangement facilitates the feeding, as at a glance it will be seen that all animals can be fed either from the feeding and observation alley not lettered in this map, or from the end areas of Plots A to G and M to K. Plots A, B, C, D, E, F and G each represent an area of one-half an acre, being 41 ft. wide and 445 ft. deep. The area identified as H, constitutes 2.3 acres; area I including the runway alley K, a fraction over 3 acres; area J including runway L, approximately 5 acres. The area identified as M constitutes one-half an acre, and is used as a yard where the breeding males are maintained during the winter months, and pasteured during the summer months. The total area utilized by the Swine Department is 14.88 acres, which is fenced with No. 9 American Steel Wire fencing. The runways are divided by American wire fencing twenty-four inches high, there being a barbed wire at the bottom close to the ground, and another barbed wire at the top. By placing the barbed wire at the bottom of the field fence, rooting under the fence is prevented, and we have experienced no difficulty in keeping the animals within the areas assigned. For convenience, the following information is submitted showing the particular crops and seed mixtures including dates of seeding for the entire area:

A. Seeded with alfalfa in 1909. Three cuttings for hay were made during the seasons of 1910-1911, and the area has been pastured with swine since that date. It has maintained its stand very well.

B. Seeded on April 22, 1915 to a mixture of one-half bushel of peas, 3 pounds of dwarf Essex rape, and 6 pounds of red clover for the one-half acre.

C. Seeded with alfalfa on September 21, 1914, and pastured by swine during the first year of its growth. Shows an impoverished stand.

D. Seeded with alfalfa in 1909, and treated the same as Plot A. Excellent condition.

E. This field was seeded with alfalfa in 1909, the same as Plots A and D, but one-half of the area was plowed during late summer of 1914 and seeded with turnips followed late in the fall with rye. This one-half acre area designated as Ea was seeded March 29th with a mixture of rape and red clover at the rate of 6 pounds of rape and 20 pounds of red clover to the acre.

F. Seeded on April 16th with oats and Canada Field peas, mixed in equal proportions and seeded at the rate of 3 bushels of this mixture to the acre.

G. Seeded April 20th to a mixture of rape, oats and Canada Field peas in the proportion of 1 bushel of oats, 1 bushel of Canada Field peas and 12 pounds of dwarf Essex rape.

H. Seeded with rye in October 1914, pastured slightly by the breeding animals during the late fall season, also during the early spring, and on

PLATE I.

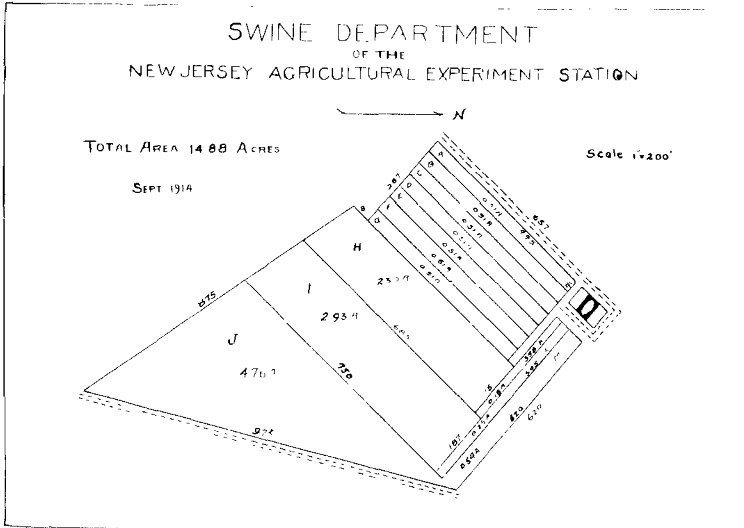


FIG. 1.—Diagram of the swine department of the New Jersey Agricultural Experiment Station

March 29th was seeded with a mixture of oats, Canada Field peas and sweet clover, the proportions being 1 bushel of oats, 1½ bushels of peas and 15 pounds of sweet clover.

I. Seeded with rye in October 1914, was pastured similiary to H during the late fall and early spring, and on May 15th was seeded with a mixture of soybeans, sweet clover and rape in the proportions of 1 bushel and 1 peck of soybeans, 10 pounds of sweet clover and 5 pounds of Dwarf Essex rape to the acre.

J. Seeded to rye in December 1914 following a crop of soybean, rape and sweet clover, also used for pasturing purposes during the early spring, but was plowed and planted with corn during the first week in June.

K. Was used as winter quarters for a portion of the herd during the winter months, three houses being grouped at the lower end of this runway, and it was seeded on April 20th with a mixture similar to that grown on area I.

L. Was used for wintering a portion of the breeding herd, and was seeded during the first week in June with a mixture of rape and sweet clover. It is noted here that this runway was seeded with this same mixture in 1914, and considerable sweet clover survived not only a severe winter season, but evidenced thrift in the spring after being pastured late and early, and with the further test of having breeding animals tramping over this area all winter long.

M. Seeded April 16th with what has been termed the "shotgun mixture," namely, a mixture of 1 bushel of peas, 1 bushel of oats, 4 pounds of dwarf Essex rape, 10 pounds of sweet clover and 10 pounds of red clover.

It will be noted here that for the study of the comparative palatability of each one of the forage crops grown in the areas from A to G the forty-five feet in each lot was seeded with a different mixture. It might be further explained that this portion of each of the plots was temporarily fenced off, and utilized during the winter months for providing quarters for breeding animals, and as soon as the respective forage crops in each main area were ready for pasturing the animals the small portions of each lot were seeded with mixtures identified as follows:

A-1, Sweet Clover; B-1, Alfalfa and Rape; C-1, Rape and Canada Field Peas; D-1, Rape and Sweet Clover; E-1, Rape and Red Clover; F-1, Sweet Clover; G-1, Red Clover. In each case after the various forage crops were from eight to ten inches high, the animals were given their choice of the forage, and had access to both portions of the individual runs. The following observations are significent:

1. The growing animals were permitted to have 1 pound of grain, chiefly corn, middlings and tankage for each 100 pounds of live weight while foraging on all of the above named mixtures, and if there was any evidence of close cropping or a scarcity of the forage crops, all of the animals were removed from said area until such time as there was evidence of vigor and plenty of forage. Fortunately it was not necessary to make many such transfers.

2. Brood sows nursing their young foraged quite as much on sweet clover as on alfalfa when they were permitted to make their own selection.

3. Rape was equally as palatable as alfalfa, in fact in two instances the pigs foraged on the rape with more relish than the alfalfa as evidenced by the clean stripped rape plants.

4. Peas unaccompanied by oats or rape do not seem to attract the animals until they are more or less mature, at which time the animals consumed the pods with relish. It was noted, however, that peas are more palatable when grown in the same area with oats and clover.

5. It is a distinct advantage in case alfalfa is used as a forage with swine that the area be cut over at least twice during the season in order to increase its palatability and revitalize the plants.

6. In two instances during the past year the pigs were not removed during this process of cutting alfalfa to determine whether or not they would injure the young plants at this stage of growth. Light pasturing, that is, not more than one-thousand pounds live weight per acre, was used for such foraging, and no injury was evidenced.

7. Rape and sweet clover proved as attractive as alfalfa; in fact more so until the sweet clover became woody and coarse.

8. Combination mixtures proved more useful and stable than any one of the forage crops by themselves, and not only proved more palatable, but the total amount of pork produced from an area seeded with a combination of forage crops was greater in each case.

9. It is not safe to pasture any of the forage crops early in the spring until they are at least eight inches high, with anything like a sufficient number of animals that would crop down the young tender plants. More injury results from turning animals into a plowed area, where a forage crop has been planted, following a heavy rain, than would result in pasturing the same area with the same number of animals through a period of two weeks under normal conditions. Therefore, we have found it expedient to shut the animals out of the forage crop plots immediately following a heavy rain as a means of protection to the plants, and further to avoid injury from rooting by the animals.

10. If possible it is an advantage to permit some of the oats to seed, and thus provide a catch crop for later summer feeding. Where the combination mixture of oats, rape, peas and clover was seeded, and the areas not cropped close enough to prevent some of the oats from maturing, an elegant catch crop resulted and supplied exceedingly palatable forage during the balance of the season.

Forage Crop Yields.

The thirteen plots seeded as above noted were all supplemented by grain rations. The following data give in pounds of pork the production of each area:

Plot A—Alfalfa. (Sweet Clover in end 45 ft.) 0.51 Acre.

Four aged boars foraged on this area during the entire winter. From May 1st to November 1st, 990 pounds of pork were produced by young pigs which foraged with their dams during their nursing period. This does not provide for the maintenance of the boars during early spring, nor for an average of four brood sows and their litters throughout the entire season. Four-hundred and fifty pounds of cured alfalfa hay were harvested from two cuttings made on June 26th to August 1st, respectively.

The brood sows nursing pigs were fed 1¼ pounds of the following grain mixture for each 100 pounds live weight, per day:

Standard Middlings	50	lbs.
Corn Meal	50	"
Red Dog Flour	50	"
Digested Tankage	12	"
Bone Meal	2	"

The net income from this one-half acre area of alfalfa and sweet clover for the season dating from May 1st to November 1st, after deducting the cost of the grain fed to the brood sows, was the equivalent of 510 pounds of pork, which at 10c a pound would total $51.00. In addition 450 pounds of hay at $20.00 a ton would add an additional $4.50 to this figure.

Plot B.—Canada Field Peas and Sweet Clover. (Alfalfa and Rape in end 45 ft.) 0.51 Acre.

This area was pastured from June 15th to October 31st. During this period growing boars varying in number from ten to thirty-five were foraged on this lot, and gained during the season 1401 pounds of pork. During the early portion of the season, that is from May 15th to June 14th, an average of four sows with their litters of pigs were pastured in this area. The grain cost was equivalent to 701 pounds of pork at 10c a pound, and thus the pastured area should be credited with 700 pounds of pork. This plot throughout the season furnished an abundance of summer feed, and it was amazing to observe the amount of feed that it supplied. At 10c a pound a total of $70.00 worth of pork was produced from the forage on this half acre area.

Plot C.—Alfalfa. (Rape and Canada Field Peas in the end 45 ft.) 0.51 Acre.

Twenty gilts were pastured on this area during the winter of 1914 and 1915 from November 14th to October 31st, and a total of 900 pounds of pork was produced from this area. Forty dollars' worth of grain was fed to these animals during the season which would authorize the crediting of this one-half-acre area with 500 pounds of pork.

Plot D.—Alfalfa. (Rape and Sweet Clover in end 45 ft.). 0.51 Acre.

Eight breeding sows were permitted to run in the end portion of this area during the entire winter. Brood sows and their litters were pastured on this area throughout the season from May 8th to October 31st. Eight mature gilts were pastured from June 6th to November 1st, and gained a total of 475 pounds in weight. Four hundred pounds of alfalfa hay were cut on June 26th. The amount of grain fed to these gilts was very slight, and a safe calculation would credit this area with the production of 400 pounds of pork.

Plot E.—Alfalfa. (Rape and Red Clover in the end 45 ft.). 0.51 Acre.

Two sows with fall litters were permitted to forage on this alfalfa as late as December 1st, 1914. From May 8th to October 31st, a total of 1045 pounds of pork was produced from this area, in addition to 400 pounds of alfalfa hay which was harvested on June 26th. During twenty-four days in September, thirty-one head of fall shoats foraged on this area with access to a self-feeder which was installed in E-I. Deducting the cost of grain consumed, this area was responsible for the equivalent of 490 pounds of pork.

Plot F.—Oats and Peas. (Sweet Clover in end 45 ft.). 0.51 Acre.

From April 20th to October 31st, five head of mature breeding animals obtained their entire livelihood from this plot during the entire season, and in addition 275 pounds of pork were produced. It was an instance of permitting the oats to seed, and produce a catch crop for late summer feeding. A total of 600 pounds of pork is credited to this one-half acre area during the season.

Plot G.—Rape, Oats and Canada Field Peas. (Red Clover in end 45 ft.) 0.51 Acre.

This area was pastured from May 18th to October 31st, and produced 489 pounds of pork net, after deducting the cost of grain consumed. Six head of mature gilts were pastured on this area for the most part of the season, and obtained their livelihood without the addition of any grain whatsoever.

Plot H.—Rye, Oats, Canada Field Peas and Sweet Clover. 2.3 Acres.

The animals were turned into this area on May 11th, and removed on October 18th. The lot was seeded with rye for early spring forage. This area of 2.3 acres produced 781 pounds of pork in addition to providing maintenance for ten head of mature animals from July 1st to October 18th.

Plot I.—Rye, Soybeans, Rape and Sweet Clover. 2.93 Acres.

This plot was seeded with rye in the fall, and during the early spring provided green forage for fifteen head of gilts that farrowed at intervals dating from April 30th to June 7th. At this date, June 7th, the plot was plowed and seeded with rape, soybeans and sweet clover, and from August 12th to October 20th provided complete maintenance for a number of mature sows varying from seventeen to twenty-two without the addition of any grain whatsoever, until October 1st when a small amount of green corn was fed to supplement the forage crop.

Plot J.—Winter Rye and Corn. 4.76 Acres.

This area was pastured from April 20th to May 19th by the breeding herd, and produced a gain of 1270 pounds of pork, largely the result of gain with young pigs running with their dams. This area was plowed and planted to corn on May 29th. Owing to a heavy storm on July 17th the stalks were lodged badly, which made it impossible to put in a cover crop of soybeans and rape as planned, and on October 1st, owing to a shortage of corn, the farm management requested that they be permitted to put this corn in the silo. However, there was considerable residue of ears, and some green forage following the work of the corn harvesting machine, and late in October thirty head of shoats were turned into this

Plate II.

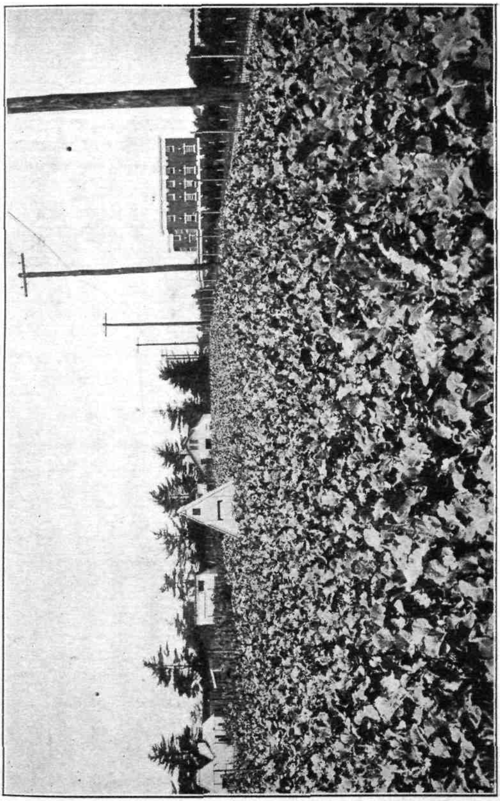


Fig. 2.—Dwarf Essex rape and sweet clover ready for foraging purposes.

area to clean up the waste products, and yielded a gain of 300 pounds of live weight, thus making a total of 1570 pounds of pork credited to this area in addition to the crop of corn approximating eleven tons of green silage per acre, a most creditable and satisfactory showing.

Plot K.—Rape and Sweet Clover. 0.18 Acre.

This area is primarily an alley-way leading to a larger plot designated as area I. Provision was made for the sweet clover to seed itself once in two years, and so far we have been able to perpetuate a crop of sweet clover without reseeding. Early in the spring the area was gone over with a spike-tooth harrow, and 6 pounds of Dwarf Essex rape seeded to the acre. The production of this area is included in the report of Plot I.

Plot L.—Rape and Sweet Clover. 0.26 Acre.

This area constitutes 0.26 of an acre and was pastured from May 14th to August 12th during which time 215 pounds of pork were produced in young pigs that were nursing their dams. Thirty head were allowed to forage on this plot, and produced a gain of 772 pounds of live weight. In addition to the green feed consumed the following amount of grain is charged against them:

1909.5	lbs.	Shelled Corn
382.4	"	Wheat Middlings
157.5	"	Digester Tankage

or a total of 2449.5 pounds of grain which was fed by means of a self-feeder. On this basis 335 pounds of concentrates produced 100 pounds of gain, the rape and sweet clover in this case were responsible for reducing the unit amount of grain required for a pound of gain; as this figure represents unusual efficiency on the part of the swine to utilize concentrates, and the corresponding green forage. Under average conditions, without green forage, 500 pounds of grain produce 100 pounds of gain with such animals.

Plot M.—Rape, Canada Field Peas and Sweet Clover. 0.54 Acre.

From May 19th, the date that a herd of growing animals was turned into this area, to September 20th, this plot produced 1050 pounds of pork and furnished green forage for thirty gilts during the entire summer season. These growing gilts were allowed 1 pound of shelled corn for each 100 pounds of live weight, and were in a fine thrifty condition on September 23rd when an outbreak of hog cholera interrupted all our experimental work, and was responsible for the loss of the majority of the animals that had been grown and developed on this area.

III.

THE HOG CHOLERA SITUATION IN THE STATE.

During the past year hog cholera has prevailed in fourteen out of twenty-one counties in the State. Notably in South Jersey has the disease been most destructive, and during August and the early part of

September it was feared that the pork production industry in South Jersey would be completely stamped out. Unfortunately, there does not exist in this State an agency charged definitely with authority and responsibility to enforce movements of control and prevention designed to stamp out the disease. Provision is made whereby the State Board of Health and the State Tuberculosis Commission can handle outbreaks of foot-and-mouth disease, and enforce the law relating to tuberculosis; but no appropriation is made directly to any agency for the control or eradication of hog cholera.

The Live Stock Commission generously offered to distribute serum at cost, and to provide service and advise concerning the handling of outbreaks, and the administration of protective serum. The county demonstrators cooperating in five counties of the State assisted materially in the hog cholera work, and it is clear that much good was accomplished by the cooperative work of the Experiment Station, the Live Stock Commission, the State Board of Health and the various county agents under the supervision of the Extension Department.

In Salem and Gloucester Counties investigation revealed the fact that since cholera made its appearance during the particularly busy season of the year, owners of animals unfortunate enough to lose their hogs, did not take the trouble, or realize the importance of burning or burying the carcasses, but rather carted the carcasses to a wooded or isolated area as a matter of expediency. As a result buzzards feasted on the carcasses, and in this way virus was distributed throughout the district. Furthermore, in several instances entire creeks became contaminated with the virus and all adjoining farms were infested with hog cholera as a result of this condition of negligence on the part of the swine owner himself. In other instances the Animal Husbandman was able to direct the disposal of carcasses, and to suggest proper means of cleaning and disinfecting the premises, and through prompt use of serum was able to control and isolate additional outbreaks that were not so devastating.

Another unfortunate condition seemingly prevailed, and this likewise was due to lack of authority on the part of State officials to control the manufacture and distribution of hog cholera serum. A certain veterinarian operating in Gloucester County offered to supply serum and treat all animals at a cost of fifty cents an animal, regardless of their age or weight. Naturally, he used serum at low cost, and of necessity would be compelled to inject relatively small doses, and probably failed to use the necessary precautionary measures regarding sanitation in the administration of this anti-serum. The results, of course, were disappointing. The serum did not protect, the animals died of cholera, and the serum treatment was put in bad repute by such mal-practice. When provision was made to supply responsible serum at a cost of two and one-quarter cents per cubic centimeter, and arrangements made to have this serum administered by a competent veterinarian at small cost, the swine owners naturally hesitated, fearing an experience similar to that which prevailed when inferior serum was administered by incompetent hands. Therefore, it was with considerable difficulty that owners of swine in such communities were prevailed upon to use this potent serum, and in the meantime the disease continued its spread.

In Camden County the disease had gained considerable headway, in fact had been encountered in the community for twelve or fourteen weeks before it was generally known that cholera was responsible for the death of hogs on certain farms. However, an enterprising swine owner living near Atco, New Jersey, communicated with the Station concerning his losses, and provision was immediately made for immunizing, not only his herd but those animals in his immediate neighborhood that had not at that time evidenced any symptoms of the disease. The results were very gratifying, and it was but another instance of what can be accomplished if serum is administered into all well animals *before they have evidenced any symptoms of the disease.*

The county agents in Monmouth, Mercer, Atlantic and Cape May Counties successfully treated a number of herds of swine, and checked outbreaks that otherwise might have threatened the industry. Notably in Monmouth, Mercer and Atlantic Counties did the county agents do most effective work with promptness and efficiency. Slightly more than two hundred thousand cubic centimeters of serum were distributed directly or indirectly by the Animal Husbandman during the year.

The other outbreaks in Cumberland, Hunterdon, Middlesex, Burlington, Passaic, Bergen and Hudson Counties were more or less isolated, and thus more easily controlled, and were not responsible for great loss. The appearance of cold, frosty weather during the early fall was a factor which aided in the control of the disease, and it is safe to say that on this date, October 31st, the disease is well under control, and provided ample provision is made to cope with outbreaks immediately in the spring and during the summer season when the disease is most prevalent, there is little doubt that heavy losses can be prevented. With efficient quarantine provision the swine industry can be amply protected. It is recommended, therefore, that an appropriation be made for the purpose of purchasing serum, and distributing same at cost, and for the further purpose of providing demonstrations in each community as to the use and value of serum, and thus emphasize the importance of using this product at the very outset of an attack of the disease. It is positively not a cure, merely a preventative measure, and it is not claimed that it has any curative properties. It is not suggested that provision be made for the production of serum by the Station for it is the belief of the Animal Husbandman that it can be purchased more economically than it can be produced, in case the demand does not exceed the supply that was used or distributed during the past year. Furthermore, definite authority should be provided such as will charge a responsible agency with the elimination of this disease and to more effectively quarantine premises where outbreaks occur, and assist in the thorough cleaning and fumigating of the premises. An appropriation of $6,000.00 would be ample to meet such conditions, and if serum was distributed at cost a large proportion of this amount would be returned, in due time, to the State Treasury. It would mean the saving of an industry that thrives in New Jersey, and is threatened with elimination in case provision is not made for the eradication or control of hog cholera.

It is the belief of the Animal Husbandman that this is the most important live stock problem facing the live stock industry in this State, and presenting itself to the Experiment Station for aid and solution.

Outbreak at the Station Herd.

On September 20th a number of animals in the Station herd evidenced a loss of appetite, and observation disclosed the fact that comparatively all of the animals in two of the runways, evidenced high temperatures. Characteristic symptoms of the disease, however, did not prevail until September 23rd, at which time on the advice of the veterinarian, provision was made to subject the entire herd to the serum treatment.

The H. K. Mulford Co. of Philadelphia had been working for the past two or three years on a refined serum designated as "Globulin Serum," and while it had not as yet been placed upon the market commercially it was used in the laboratory and on herds demonstratively. arrangements were at once completed whereby this station might use this product experimentally to cope with the outbreak of the disease at hand. Unfortunately, the shipment was lost in transportation for the time being, and did not reach New Brunswick until seven days after the first evidence of the disease appeared. As a result thirty-two animals out of a herd of two hundred evidenced the disease in one form or another at the time arrangements were completed for the injection of the serum.

Careful observation was made of each individual and its temperature reading recorded as will be noted from the tabulated records which follow. Two conditions were imposed, or rather suggested by the H. K. Mulford Co. concerning the use of their Globulin Serum. The first one being that all animals regardless of weight or age, (excepting, of course, suckling pigs a few days old) be given thirty cubic centimeters of this serum; and second, that all animals in the herd regardless of whether they evidenced symptoms of the disease be injected with this standard dosage. In each case, however, checks were made, and certain animals varying in age and representative of each group of animals in the herd were left untreated as checks or controls. Again, in order to make sure that all of the animals in the herd were exposed to the infection by contact, rather than by means of the administration of virus, two or more sick animals were placed in each lot of well animals immediately following the administration of the serum alone. The object of this project being, of course, to secure permanent immunity of all animals. The results were most gratifying. It is but fair to state that animals of all ages and conditions of growth and development were among those successfully treated. Herd boars, pregnant brood sows in both early and late stages of pregnacy, brood sows nursing pigs, and suckling pigs varying in age from two days to eight weeks were included, as well as shoats, gilts and fall pigs varying in weight from forty to two hundred pounds.

A standard dosage of 30 c. c. of the concentrated Globulin Serum was administered to each animal with the exceptions noted. Immunity was established in every animal that was injected with this serum, whose temperature was normal at the time of the treatment. All checks (with two exceptions noted) in each lot died from the disease, and their carcasses were left exposed for a few days in order to make sure that all serum treated animals were exposed to the disease, and these two animals, (one Duroc-Jersey Gilt and one Berkshire), were apparently naturally immune to the disease, for they were found at the outset in the lot where symptoms of cholera were first discovered, and they were placed successively into each of the lots where animals were coming down with the disease in various stages, and at no time did they evidence or show any symptoms whatsoever of the disease. Our records show that neither the sire nor the dam of either of these animals were ever immunized against cholera, or encountered or had been exposed to the disease. They still remain in the herd and will be the basis of an experiment to determine, if it is possible to perpetuate such immunity without the use of serum or the simultaneous method of treatment.

The following record in tabulated form will show the exact condition of each animal treated:

Table 1.

Tabulated Record of Animals Treated With Serum.
Injection of Lot M, Spring Gilts.

Ear Tag.	9/24/15 Temp. Deg. F.	9/23/15 Temp. Deg. F.	9/22/15 Injection.	Remarks.
254	107.	....	30 c.c.	Died 9-24.
252	106.4	106.4	"	" 10-2.
253	104.	103.	"	O. K. 10-31.
251	103.	104.2	"	" "
260	103.2	106.	"	Died 9-27.
259	105.4	107.	Check.	" 9-29.
256	104.	108.	30 c.c.	" 9-30.
255	107.	107.4	"	" 10-2.
257	108.	107.4	"	" 9-25.
258	105.2	106.5	"	" 9-28.
280	106.	107.2	"	O. K. 10-31.
261	107.4	106.8	"	Died 9-27.
264	107.2	......	"	" 9-24.
263	107.2	107.	"	" 9-25.
265	107.	107.2	"	" 10-22.
262	105.4	103.2	Check.	Subsequent Temp. 103.2
268	103.	102.4	"	" " 102.4.
272	105.	105.2	30 c.c.	Died 11-3.
273	107.4	106.	"	" 9-30.
267	106.	105.	"	" 9-27.
266	106.	106.2	"	" 11-10.
271	107.	107.2	"	" 10-2.
270	107.	107.4	"	" 10-4.
269	107.2	104.	"	" 9-25.
276	107.	107.	"	" 10-4.
274	105.	107.4	"	" 9-25.
275	105.2	107.	"	O. K. 10-31.
277	106.	106.5	"	Died 10-5.
279	106.2	107.	"	" 9-29.
280	108.	107.4.	"	" 10-8.
278	106.	105.	"	O. K. 10-31.
352	107.	106.	"	Died 9-29.

SUMMARY—Thirty-two gilts averaging in weight from 80 to 100 pounds were treated as above noted. All of these animals evidenced cholera at the time of injection, and were all in the lot where symptoms of the disease were first discovered. The first injection was made on September 22nd, while the table also shows the temperature reading on the 24th. In order to determine whether or not another injection of serum would evidence any curative effects, on September 25th the lot was divided into two groups and half of the animals given another injection of thirty cubic centimeters of serum. A tabulated record of temperatures and results follow:

Table 2.
Second Injection of Lot M.

Ear Tag	9/22/15 Temp. Deg. F.	9/22/15 Injection.	9/24/15 Temp. Deg. F.	9/25/15 Injection.	Remarks.
266	106.	30 c.c.	106.2	30 c.c.	O. K. 10–31.
267	106.	"	105.	"	Died 9–27.
273	107.4	"	106.	"	" 9–30.
272	105.	"	105.2	"	O. K. 10–31.
268	103.	Check.	102.4	Orig. Check. ..	" 10–31.
271	107.	30 c.c.	107.2	2nd Check. ...	Died 10–2.
270	107.	"	107.4	" " ...	" 10–4.
262	105.4	Check.	103.2	Orig. Check. ...	O. K. 10–31.
277	106.	30 c.c.	106.5	30 c.c.	Died 10–5.
261	107.4	"	106.8	"	" 9–27.
276	107.	"	107.	"	" 10–4.
265	107	"	107.2	2nd Check. ...	" 10–22.
275	105.2	"	107	" " ...	O. K. 10–31.
258	105.2	"	106.5	" " ...	Died 9–28.
256	104.	"	108.	30 c.c.	" 9–30.
259	105.4	Check.	....	Orig. Check. ...	" 9–29.
255	107.	30 c.c.	107.4	2nd Check. ...	" 10–2.
280	108.	"	107.4	30 c.c.	" 10–8.
251	103.	"	104.2	"	O. K. 10–31.
278	106.	"	105.	"	" 10–31.
279	106.2	"	107.	"	Died 9–29.
253	104.	"	103.	"	O. K. 10–31.
252	106.4	"	106.4	2nd Check. ...	Died 10–2.
260	103.2	"	106.	" "	" 9–27.
352	105.1	"	106	30 c.c.	" 9–29.

Conclusion.

At the end of three days twenty-four out of twenty-nine head still survived. Fourteen of the twenty-four animals were given a second injection of 30 c. c. of serum. Six out these fourteen survived, which might indicate possible curative properties of the serum. However, two observations are here reported: First, in cases where serum was injected into animals when their temperature was rising and before it reached a maximum of 108° the serum clearly prolonged life: Second, in cases where the serum was injected after the temperature had reached its maximum and was receding, it was of absolutely no value. Again, six out of fourteen pigs, that still survived the second injection, were again divided and three of these animals given a third injection. It was observed that the three pigs that received the three injections of 30 c. c. within six days evidenced more vigor, and for a time it was thought that curative results had been evidenced, but the final observation on October 31st makes it clear that even though the animals may be kept alive by frequent injections of serum, the process is expensive and impractical. The animals were clearly dwarfed, and were what one might easily designate as runts. All of the surviving animals that were actually sick were sold to the butcher at a ridiculously low price, as soon as the carcasses would pass veterinary inspection.

Table 3.

Record of Injection of Twenty Pigs in the Experiment to Determine the Economy and Efficiency of Self Feeder.

Lot 1-4.

20 Head Mixed Lot.

Pen Number.	9/22/15 Temp. Deg. F.	9/27/15 Weight lbs.	9/22/15 Injection.	Remarks.
1 Berk.	103.6	81.	30 c.c.	Healthy Condition.
Duroc.	103.	59.	"	" "
Poland.	103.8	65.	"	" "
Black.	102.	51.	"	" "
York.	105.5	100.	"	" "
2 Berk.	104.	65.	"	" "
Duroc.	102.5	51.	"	" "
Poland.	103.2	58.	"	" "
Black.	104.	72.	"	" "
York.	104.	68.	"	" "
3 Berk.	102.8	78.	"	" "
Duroc.	103.	57.	"	" "
Poland.	103.	53.	"	" "
Black.	103.8	65.	"	Temp. 107; Deg. 9-24 (O.K. 10-31.)
York.	105.5	62.	"	Healthy Condition.
4 Berk.	103.	72.	"	" "
Duroc.	102.4	33.	"	" "
Poland.	103.	41.	"	" "
Black.	103.	44.	"	" "
York.	104.	67.	"	" "

NOTE—All of these animals were normal at the time of injection and none of the animals were off feed, and did not evidence any interruption after treatment. They were confined in pens adjoining lots where the sick animals from the lot of thirty-two gilts were yarded and were clearly exposed to the disease.

Table 4.

Record Sheet of Pigs From Plot L Varying in Weight From 60 to 90 Pounds Each.

Record of Injection of Lot L.

Ear Tag.	Temp. Deg. F.	Injection.	Remarks.
281.	104.	30 c.c.	O. K. 10–31–15. Normal.
282.	104.2	"	" " "
283.	105.	"	" " "
297.	104.4	"	" " "
294.	103.2	"	" " "
293.	106.4	"	Squibbs for virus.
290.	106.4	"	" " "
286.	105.3	Check.	Died 9–30.
292.	106.3	30 c.c.	Squibbs for virus.
303.	103.4	"	" " "
300.	106.2	"	" " "
291.	103.	"	" " "
Sore Ears.	106.	Check.	Died 10–2.
298.	107.	30 c.c.	Squibbs for virus.
289.	104.	"	O. K. 10–31–15. Normal.
287.	104.	"	" " "
296.	103.4	"	" " "
288.	104.	"	Died 10–11.
301.	102.2	"	O. K. 10–31–15. Normal.
299.	103.3	"	" " "
295.	104.1	"	" " "
284.	103.4	"	" " "
302.	106.2	"	Died 9–29.
285.	103.2	Check.	Died 10–5.

NOTE—It will be noted that a number of these animals at the time of injection showed a high temperature for they were running in a lot adjoining an area where the thirty-two first evidenced the disease. Four animals from this lot with temperatures above 106° F and clearly evidencing the disease were given to Squibbs Laboratory to be used for virus animals. Observations of this lot substantiated the statement that where serum was injected in animals of normal temperature protection resulted, but animals with temperatures above 105° F died from the disease.

Table 5.

Small Pigs From Plot E, Average Weight From 50 to 56 Pounds. Record of Injection of Lot E.

Ear Tag.	Temp. Deg. F.	Injection.	Remarks.
346	103.4	30 c.c.	O. K. 10-31-15.
347	103.5	"	" "
326	104.8	"	" "
333	104.4	Check.	Died 10-10.
329	104.	30 c.c.	O. K. 10-31-15.
324	104.4	"	" "
321	104.2	"	" "
339	104.4	"	" "
334	104 2	"	" "
342	107.	"	Runt.
335	104.2	"	O. K. 10-31-15.
340	103.5	"	" "
320	106.4	"	Runt.
351	105.8	"	O. K. 10-31-15.
327	104.	"	" "
328	103.4	"	" "
325	106.2	"	Runt.
343	104.	"	O. K. 10-31-15.
331	103 2	"	" "
344	104.6	"	" "
332	104.	"	" "
323	104.5	"	" "
337	105.8	"	Runt.
322	104.	"	O. K. 10-31-15
336	106.5	"	Died 10-9.
341	104.	"	O. K. 10-31-15.
348	105.	Check.	Died 10-4.
345	106.	30 c.c.	Runt.
338	105.2	"	O. K. 10-31-15.
330	104.	"	" "
349	104 2	"	" "
350	105	"	" "

NOTE—From a lot of thirty-two pigs, four subsequently died, five runts developed, and it is noted that these pigs evidenced a relatively high temperature at the time of injection.

Table 6.

Young Boars From Plot B and C Varying in Weight From 50 to 140 Pounds. Average Weight, 125 Pounds.

Record of Injection of Lot B and C.

Ear Tag.	9/24/15 Temp. Degrees F.	9/24/15 Injection.	Remarks.		
368.	103.	30 c.c.	O. K. 10-31-15.		
371.	104.5	Check	Died 10-7-15.	104.8°	9-25.
363.	102.	30 c.c.	O. K. 10-31-15.		
366.	103.	"	" "	104.°	9-25
365.	103.2	"	" "		
370.	102.	"	" "		
360.	102.4	"	" "		
361.	102 5	"	" "	102.5°	9-25.
355.	103.	"	" "		
354.	104 2	"	" "		
353.	102 5	"	" "		
357.	103.	"	" "		
356.	102.8	"	" "		
359.	103.	"	" "		
362.	103.	"	" "		
369.	103.4	"	" "		
373.	103.	"	" "		
358.	102.4	"	" "		
372	102.2	"	" "		
367.	103.	"	" "	104.°	9-25.
364.	102 4	"	" "		
376.	102.4	"	" "		
375	104.	"	" "		
383.	104.	"	" "		
380.	102.	"	" "		
374.	103 2	"	" "		
379.	102.8	"	" "		
381.	102.4	"	" "		
384	102	"	" "		
385.	102 2	"	" "		
388	101 8	"	" "		
386.	102.2	"	" "		
378.	102 4	"	" "		
377.	101.5	"	" "		
382.	102	"	" "		
387.	102 4	"	" "		
Yr. Duroc Boar	102	"	" "		

NOTE—All of these pigs were in normal condition at the time of injection, and no losses were entailed. Four of the animals evidenced a temperature subsequent to injection, but all survived the treatment.

Table 7.

Record Sheet Showing Injection of Serum Into Thirty-two Aged Brood Sows. Injected September 23d.

Wt in lbs	Identity.	Condition.	Temp. Deg. F.	Injection.	Remarks.
225	Grade, Large Blk. Sow E. T. 160.	Pregnant 6 wks.	101	30 c.c.	O. K. & Healthy.
300	Rutgers Longfellow Ruby 2nd.	Dry open.	101.	"	" "
350	Rutgers Rookwood Lady.	Dry open.	100.	"	" "
320	Jersey Red	Dry open.	101.4	"	" "
360	Fillmore's Beauty 2nd.	Dry open.	101.	"	" "
290	Wonder Queen 1st.	Dry open.	102.	"	" "
250	Jersey Queen.	Dry open.	102.	"	" "
375	Rookwood Lady 49th.	Dry open.	101.4	"	" "
400	Rutgers Ruby 4th.	Dry open.	101.	"	" "
400	Rutgers Cherry Blossom.	Dry open.	101.	"	" "
420	Kinkaids Ruby.	Dry open.	100.2	"	" "
320	Rutgers Oak Princess 2nd.	Pregnant 4 wks.	101	"	" "
275	Grade. Large Blk. Sow E. T. 153.	Dry open.	107.	"	Died 9-29.
450	Rutgers Ruby 6th.	Dry open.	103.	"	Sick—Died 10-6.
260	Rutgers Ruby 7th.	Dry open	102	"	O. K. & Healthy.
450	Rutgers Cherry.	Dry open.	101.	"	" "
325	Rutgers Col. Cherry.	Dry open.	102.	"	" "
200	Minors's 3604.	Dry open.	101.	"	" "
250	Rutgers Kinkaids Girl.	Dry open.	102.	"	" "
275	Rutgers Kinkaids Girl 2nd.	Dry open.	101.	"	" "
200	Rutgers Masterpiece Girl 2nd.	Dry open.	103.	"	Died 10-4.
300	Rutgers Rookwood Rival Boar.		102.		O. K. & Healthy.
280	Rutgers Rookwood Lady 3rd.	Dry open	101.	30 c.c.	Died 10-21.
225	Rutgers Masterpiece Ruby 6th	Dry open.	101.	"	O. K. & Healthy.
360	Rutgers Ruby 5th.	Dry open.	100.	"	" "
275	Rutgers Longfellow Ruby 6th.	Dry open.	101.	"	" "
280	Rutgers Longfellow Ruby 3rd.	Dry open.	102.	"	" "
260	Rutgers Kinkaid Girl 3rd	Pregnant 4 wks.	101.	"	" "
390	Rutgers Longfellow Prince Boar.		101.	"	" "
400	Rutgers Longfellow Princess 3rd.	Pregnant 6 wks.	101.	"	" "
390	Rutgers Ruby 11th.	Dry open	101.2	"	" "
275	Rutgers Rookwood Lady 2nd	Dry open.	101	"	" "

All normal aud healthy, no disorders or abortions.

NOTE—It will be noted that all of these aged sows in various conditions of farrow were apparently normal at the time of injection. Subsequently, however the following died: Grade Large Black Sow E. T. 153, died September 29th; Rutgers Ruby 6th, died October 6th; Rutgers Masterpiece Girl 2nd, died October 4th and Rutgers Rookwood Lady, died October 21st.

Post mortems were perfomed on each one of these animals and all evidenced typical cases of chronic cholera. It is my belief that a dosage of 30 c. c. of serum was probably insufficient to protect these animals, or else they may have been exposed to the disease and were abnormal at the time of the original injection.

Of this group eight were brood sows, four were nursing pigs, two farrowed on the day following injection, and the others have since been bred and are now safely settled in pig. They were bred to boars that were subjected to the serum treatment at the same time.

Table 8.

Record Sheet of Two Chester White Sows and Suckling Pigs From Plot A. Treated With Serum on September 23d, 1915.

Record of Injection of Lot A.

Ear Tag.	Temp. Deg. F.	Injection.	Remarks.
304	104.4	30 c.c.	O. K. and Normal.
307.	104.2	"	" " "
306	107.	"	" " "
309	106.2	"	" " "
308.	105.	"	" " "
305.	104.3	"	" " "
312	105.2	"	" " "
319.	104.	"	" " "
310.	106	"	Died 9-27-15.
315.	105.2	"	O. K. and Normal.
314.	104.4	"	Died 9-24-15.
318.	106.	"	Died 10-11-15 (Ch. W. Berk. Cross.
316.	104.2	"	O. K. and Normal.
317.	104	"	" " "
311.	105.2	"	" " "
313.	103.2	"	" " "
3604.	101.4	"	Ch. White Sow Mature
3605.	106.	"	Died 9-27-15. Subsequent Temp. 9-24-10 Degrees 9-25-107 Degrees.

Note—A number of these pigs including one of the aged sows evidenced preliminary symptoms of cholera at the time of injection, and the high temperature of a number of surviving animals is explained by the fact that they were young pigs two or three weeks old. One of the aged sows subsequently died on September 27th, and two of the small pigs that survived the treatment were sold on October 31st as runts.

General Summary.

Two hundred and one animals, varying in age from suckling pigs to mature breeding animals five years of age were subjected to the serum alone treatment. A total of 38 animals, including suckling pigs, succumbed to the disease; while 31 out of 38 animals lost had a temperature above 105° F. the time of injection.

In the lot of 32 gilts where the disease first appeared 19 animals had a temperature above 105° F.; while 10 others had undoubtedly reached the maximum temperature of 108° in the progress of the disease and their fever was receding, as they were very sick when the injection was made.

Two of the animals in this group of 32, not injected with serum, still survive, and did not at any time during the outbreak show any symptoms of the disease, and were not off feed, even though they were yarded with animals where deaths were frequently occurring.

All of the check control pigs not treated with serum, 12 in number, with the exception of the two mentioned, died subsequently to being turned out in the yards to produce contact exposure with well animals.

On October 4th a litter of 10 pigs farrowed by Rookwood Lady 48th was injected with 10 c. c. of the Globulin Serum. One pig was found dead the following morning, and the others survived. On October 6th, three litters of pigs from the Duroc-Jersey Sows mentioned in

Table No. 9 were injected. All of the pigs survived and are now in a healthy condition.

On October 11th, two litters from Berkshires noted in Table 7 were injected with no evil results.

Three cases of abortion followed injection: one sow farrowing a premature litter of 12 dead pigs two days before due to farrow, the second sow farrowed 14 dead pigs that she carried more than two weeks past her scheduled breeding date, and the other sow was undoubtedly injured at the time of injection, as she resisted treatment and the excitement was undoubtedly a contributary cause.

In every case where serum was injected into pigs whose temperature was normal, and that did not evidence cholera, the Globulin Serum protected, and the controls in all but two cases died. The serum did not establish curative properties of economic worth, but merely prolonged life at the expense of thrift and vigor as the disease progressed.

IV.

THE USE OF THE SELF-FEEDER.

A device that enables swine to choose their own ration as regards kind and quantity has been appropriately designated as a self-feeder for swine. In view of the fact that considerable interest has been manifested concerning the use and value of this feeder it was decided to construct a number of such devices, and run an experiment to determine their comparative value. Prof. John M. Evvard of the Animal Husbandry Staff of the Iowa Experiment Station very kindly forwarded to this department blue prints and specifications relating to certain feeders that be had used extensively and satisfactorily at the Iowa Experiment Station, and with a few modifications, our feeders were built carrying out the same general plans. Photographs and blue prints are submitted showing the plan of construction. It was claimed that self-feeders were useful for the following reasons:

1st. The use of the feeders would eliminate malnutrition, as the animals would have before them at all times a liberal food supply.

2nd. Pigs given their food in dry form would consume a larger amount of concentrates within a given time, which practice would shorten their fattening period.

3rd. The individual animal is given his choice in selecting not only the kind but the amounts of food that his system requires, and it is asserted that under such circumstances the pig will elect an economical and well balanced ration.

4th. The use of such feeders reduces the labor cost and simplifies the practice of determining costs of feed and labor.

5th. There is less actual waste of feed, the animal masticates his food more thoroughly, since he is not compelled to eat or drink his food rapidly in competition with his pen mates.

6th. Brood sows nursing pigs maintain a more vigorous condition and suckling pigs learn to eat earlier and thus grow more uniformly.

Plan of Experiment.

It was arranged to select fifty pigs that had been grown and developed under similar conditions for the experiment, and thus compare the efficiency of the two systems of feeding grain to fattening shoats. The test was to continue until the animals were in prime condition for market. Twenty animals were divided into four lots of five each and placed in dry lots. Thirty head were permitted to forage on rape and obtained their concentrates from wooden self-feeders. Pure bred animals were selected representing the Duroc-Jersey, Berkshire and Poland-China breeds, while twenty cross bred shoats (Yorkshire and Large Black), were distributed among the five lots for comparison. The rations were supplied as follows:

Lot 1. 5 Head—	Shelled Corn Wheat Middlings Digester Tankage		Self-Feeder in dry lot.
Lot 2. 5 Head—	A Mixture of Shelled Corn Wheat Middlings Digester Tankage	 100 lbs. 38 " 12 "	Hand-Fed in dry lot.

Fed in the form of a thick slop in such quantities as the animals would clean up with relish twice daily.

Lot 3. 5 Head—	Shelled Corn Molasses Digester Tankage		Self-Feeder in dry lot.
Lot 4. 5 Head—	Shelled Corn Molasses Digester Tankage	100 lbs. 40 " 15 "	Hand-Fed in dry lot.

Mixed and fed in the form of a thick slop in such quantities as the animals would clean up with relish twice daily.

Lot X. 30 Head—	Shelled Corn Wheat Middlings Digester Tankage	Self-Feeder in rape field.

In addition were permitted to forage on rape that averaged twenty-six inches in height when the animals were turned in on August 13th.

The proportion of the feeds in the mixtures for the hand-fed lots was changed from time to time to insure palatability. In a few instances the shelled corn was fed on the cement floor, and was not mixed with the middlings and tankage. A preliminary feeding period of ten days was arranged in each case in order that the animals might be gradually accustomed to the particular ration as well as the system of feeding. It is interesting to note from the following table the amount of the various feeds that was consumed during the ten days preliminary test by each lot:

Table 9.

Preliminary Feeding Period of Ten Days:		*Amounts of Various Feeds Consumed:*
Lot 1.	Corn	80.77 lbs.
	Middlings	28.46 "
	Tankage	9.23 "
Lot 2.	Corn	50.0 "
	Middlings	19.0 "
	Tankage	6.0 "
Lot 3.	Corn	88.0 "
	Molasses	10.0 "
	Tankage	30.0 "
Lot 4.	Corn	50.0 "
	Molasses	20.0 "
	Tankage	7.5 "
Lot X.	Corn	461.5 "
	Middlings	95.40 "
	Tankage	24.60 "

It will be noted from the above that the pigs given the privilege of operating a self-feeder consumed a surprisingly large amount of feed during the first few days of the test. All of the animals went on full feed without difficulty and without loss of appetite. The following initial weights and averages are recorded:

Table 10.

Initial Weights (In Pounds).

NUMBER PIGS.	Lot No.	Berkshire	Duroc-Jersey.	Poland-China.	Black.	Yorkshire.	Total.	Average.
5............	1	56.0	37.0	39.0	39.0	62.0	233.0	46.6
5............	2	47.5	43.0	39.5	55.5	45.0	230.5	46.1
5............	3	52.5	45.0	44.0	36.0	39.5	217.0	43.4
5............	4	57.0	34.0	35.0	37.0	53.0	216.0	43.2
30............	X	58.0	57.5	32.0	54.0	51.0	1480.0	49.33
Total for breed		271.0	216.5	189.5	221.5	250.5	2376.5	
Aver. for breed		54.2	43.3	37.9	44.3	50.1		

It will be noted from the above table that the weights of the pigs in the different lots ranged from 43.2 pounds in Lot 4 to 46.6 pounds in Lot 1, while the pigs in Lot X averaged 49.33 pounds. It is but fair to state that there was more variation in the size and condition of the pigs in Lot X than prevailed in Lots 1 to 4. Lots 1 to 4 were confined to dry yards 8 by 12 feet with sleeping quarters 8 by 9 feet in a protected building. Lot X had the run of colony houses and foraged in a rape field approximately one-half acre. The test continued seventy-seven days and the following concentrates were consumed:

Table 11.

Record of Feeds Consumed.

Lot. No.	No. Pi.s.	CONCENTRATES. Corn.	Midds.	Tank.	Mols.	Total gain.	Aver. daily gain.	Total concentrates for 100 lbs. gain.
1	5	1356.00	277.50	160.00		481 50	1.25	372.48
2	5	565.30	321 80	90.63		284.00	.73	344.27
3	5	1299 50		213.00	60.00	385.50	1.00	407.65
4	5	525 80	110 25	60.75	118.00	179 00	.46	471.95
X	30	1448.00	287 00	133.00		560 00	.66	333.57

Lot 1, making their own choice of feeds, made a total gain of 481.5 pounds in seventy-seven days, or an average gain of 1.25 pounds to the animal per day. Lot 2, receiving the same ingredients, mixed however, in different proportions, made a total of 284 pounds or an average daily increase of .73 pounds a head per day. Lot 1 required 372.48 pounds of concentrates for 100 pounds of gain; while Lot 2 made 100 pounds of gain from 344.27 pounds of grain. Lot 1, fed from a self-feeder elected the following proportions of ingredients:

76% Shelled Corn
15% Standard Middlings
9% Digester Tankage

while the hand-fed lot were given.

58% Shelled Corn
32% Standard Middlings
10% Digester Tankage

The addition of molasses to the ration of corn and tankage did not reduce the cost or increase the efficiency of the mixture, as it will be noted that Lot 3 operating a self-feeder gained 385.5 pounds in seventy-seven days or an average of 1 pound per day, and required 407.6 pounds of grain including molasses for each 100 pounds of gain in live weight. Lot 4 was less efficient in their use of the grain mixture, making only 179 pounds gain, and required 471.95 pounds of concentrates for 100 pounds gain. Two of the animals in Lot 4 scoured badly during the preliminary feeding trial, and did not fully recover from this set back. They were dwarfed and classed as runts. Lot X due to the interruption of hog cholera, in part, gained only 0.66 pounds to the animal per day, but required only 333.5 pounds of concentrates for each 100 pounds of gain in live weight. The rape and sweet clover were responsible for this low grain requirement. Owing to a number of irregularities, it is clear that Lot X did not make representative gains.

It is interesting to note the proportions of the different feed ingredients consumed by the animals where they were privileged to operate the self-feeder.

Lot 3 consumed the following:

Corn	82.6%	Self-Feeder in dry lot.
Digester Tankage	13.5%	
Molasses	3.9%	

Lot 4—

Corn	62.0%	Hand-Fed dry lot.
Digester Tankage	7.0%	
Molasses	13.5%	
Middlings	17.5%	

The proportion of the different ingredients elected by animals foraging on rape and given all of the grain that they would clean up was as follows:

Lot X*—

Shelled Corn	77.5%	Self-Feeder in rape field.
Standard Middlings	15.0%	
Digester Tankage	7.5%	

In determining the cost of a pound of gain the following retail prices that prevailed at New Brunswick were utilized in the calculation:

Shelled Dent Corn	$32.00	per	ton
Standard Wheat Middlings	33.00	"	"
Swifts Digester Tankage, containing 60% Protein	46.00	"	"
Black Strap Molasses	.10	"	gal.
or approximately	20.00	"	ton

Utilizing the above named prices based upon the feed consumed as noted in Table 11, the following costs are tabulated:

	Corn	*Midds.*	*Tanks.*	*Total*	*Cost per lb. gain*
Lot 1. Self-Fed	$21.69	$4.57	$3.68	$29.94	.0621
Lot 2. Hand-Fed	9.04	5.30	2.08	16.42	.0578

The difference in the cost per pound gain between Lots 1 and 2 was very slight, approximately four-tenths of a cent per pound; but it is significant to note that the lot obtaining their ration from the self-feeder gained 481.5 pounds in seventy-seven days, while Lot 2 in the same period gained only 284 pounds. Under average farm conditions corn could be produced or even purchased at much less than $32.00 a ton, which would reduce the cost of gains in Lot 1 substantially.

From this experiment, therefore, it is evident that the use of the self-feeder does shorten the feeding and fattening period of animals intended for the butcher, and the importance of such early maturity is appreciated when it is considered that the price of pork during the early fall season is usually two or three cents more a pound than the prevailing price in December or January when the bulk of pigs resulting from the spring farrow are in marketable condition.

It was noted that animals that had the run of the self-feeder were more contented and regular in their habits, spending a great deal more time in their beds than those in Lot 2, although every precaution was observed to give these animals all of the feed that they would clean up with relish. Again, pigs in Lot 1 required a great deal less labor as far as feeding was concerned, which is not given consideration in this calculation. It is also observed that under average farm conditions it is very probable that the pigs in Lot 2 would not receive as efficient care as they were given in this experiment, since the herdsman was anxious to match his ability as a feeder against that of the self-feeder. Consequently they were given the very best of care.

Other observations concerning the use of the self-feeder were made during the year, since the feeders were used with substantially every class of animals produced in the herd. It is clear that the use of the self-feeder would prove a very expensive practice if used in feeding breeding animals. The brood sows would take on too much flesh, and would be irregular in their breeding propensities, and would not consume forage crops to any extent. Breeding boars put on altogether too much flesh for maintenance and are not functional at mating time. The self-feeder is very useful when used with brood sows nursing pigs, inasmuch as it enables a more persistent and continuous flow of milk, and the young pigs are prompted to eat at a younger age, and thus maintain in a more uniform condition. The small pig who does not receive his share of the milk from the dam, feeds freely from the self-feeder, and it is possible under such conditions for him to continue his growth.

Uniformity in the growth and development of young pigs nursing their dams is very important, and from our observations during the past year we have found that this is one of the most useful functions of the self-feeder, especially since brood sows forage extensively while patronizing the feeders. The gains of the litters feeding in this way are greater than those that have prevailed at this Station under any other system or practice of feeding. For growing animals after they have been weaned the self-feeder has its advantages, although if it is desired that forage crops be utilized in abundance, the self-feeder will not operate to its best advantage. After the pigs are weaned they require concentrated feed in order to maintain their growth and vigor, and naturally if the concentrates are provided in self-feeders they will give very little attention to any forage crop that may be supplied. Even alfalfa and rape in their prime condition, as far as palatability is concerned, would not particularly attract animals that had access at all times to shelled corn, wheat middlings and digester tankage.

This condition was not evidenced, however, in the case of brood sows nursing pigs, for evidently they felt the need of a succulent feed and foraged extensively on the alfalfa crop. On the other hand, ear corn and digester tankage were fed in the proportion of ninety pounds of corn to ten pounds of tankage to shoats and young animals after they had been weaned and where they were running on forage crops. The gains were most economical and the pigs more vigorous and active. Under such conditions they cleaned up all of the forage crops nicely, and when the same animals were confined to the feeding pens they evidenced an increased appetite and gained more rapidly and economically than those animals that had been supplied with all of the concentrates they would consume from birth by means of a self-feeder.

Photographs of the various types of feeders that were utilized during the year are submitted herewith, and upon request the Department will be very glad to send blue prints and specifications enabling any farmer to construct a practical feeder. The cost is approximately $8.00 for

PLATE III.

FIG. 3.—Single hopper self-feeder.

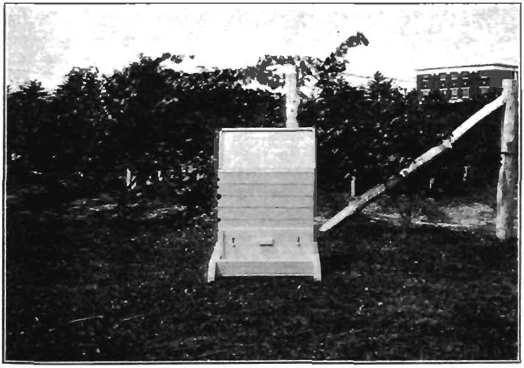


FIG. 4.—Detail of self-feeder.

PLATE IV.

FIG. 5.—Side view, mineral hopper.

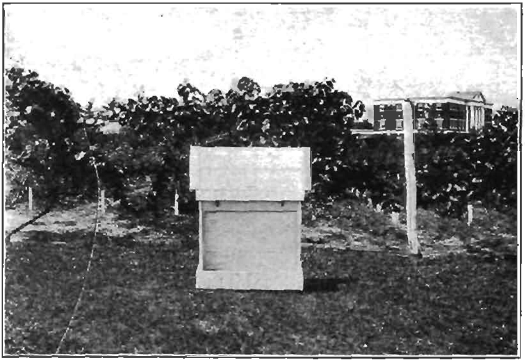


FIG. 6.—Feeder for digester tankage.

PLATE V.

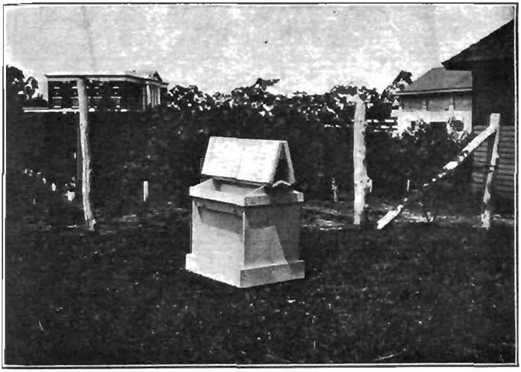


FIG. 7.—Two-hopper self-feeder. See specifications in Plate VI.

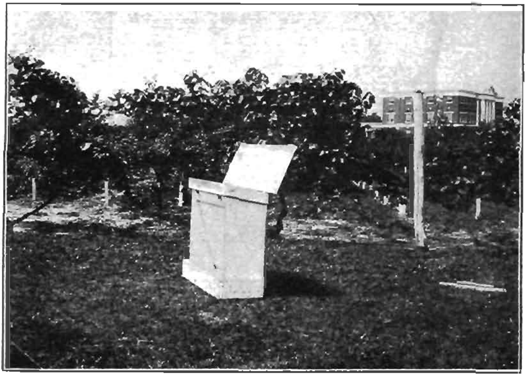


FIG. 8.—Hopper for supplying mineral mixture.

PLATE VI.

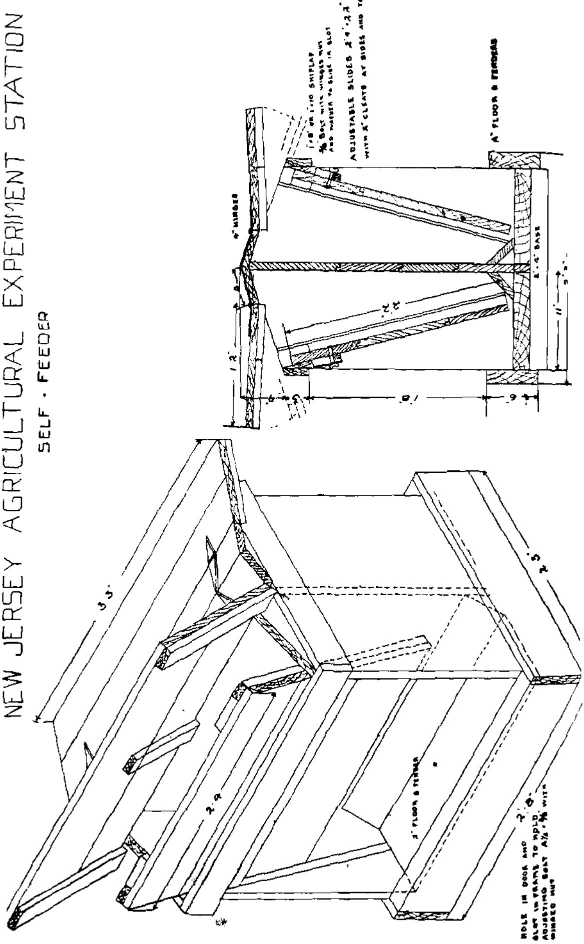


FIG. 9.—Plans and specifications for self-feeder.

a three-bin feeder. The home made wooden feeders have proved more advantagous and practical than the metal feeders manufactured commercially. Where the feeders are set up on a cement or wooden base there is absolutely no loss of food materials provided the feed is kept dry before them at all times. As a result of our experience with feeders during the past year we can recommend them unreservedly for use in feeding the following animals: Brood sows nursing pigs, after the youngsters are fifteen days old; pigs that have been weaned, provided they do not have access to a green forage crop; shoats that are being fattened either in dry lot, or forage crop, after they reach one-hundred pounds live weight, and for fattening any animal in a dry lot where rapidity of gains is an advantage.

The self-feeder should not be used for animals intended for breeding purposes as such animals will put on too much flesh and develop a tendency towards irregularity in their breeding propensities. Herd boars and sows that are being maintained preparatory for breeding should not have access to a self-feeder, for the practice will be expensive and a distinctive disadvantage unless the animals are out of condition and it is desired to put them in better flesh.

REPORT OF THE DEPARTMENT OF POULTRY HUSBANDRY

Department of Poultry Husbandry

HARRY R. LEWIS, B. SC., *Poultry Husbandman.*

WILLARD C. THOMPSON, B. SC., *Assistant in Poultry Research.*

MORRIS SIEGEL, *Poultry Foreman.*

ELMER H. WENE, *Poultry Foreman.*

CONTENTS.

Report of the Department of Poultry Husbandry.

HARRY R. LEWIS.
WILLARD C. THOMPSON.

I.

INTRODUCTORY.

The Poultry Husbandman is pleased to be able to report continued progress during the year just completed. The results of certain experiments have been brought to a close, which have been running from one to three years, and are very gratifying in view of the completeness of the work and the definiteness of the results. A number of new projects have been started, most of them being breeding problems. The work of moving the poultry plant to the new location is progressing satisfactorily and it is hoped that the work will be completed in another year. The demand for extension work has exceeded all expectations, both in volume and in distribution. Considered from all angles the Department has had a most satisfactory year, due in large part to the cooperation and hard work of the staff members.

The report of the Poultry Husbandman is presented under three heads, namely, Administration, Experimental Work and Educational Activities.

II.

ADMINISTRATION.

CHANGES IN PERSONNEL—The Poultry Husbandman wishes, at this time, to express his appreciation to all members of the staff for the spirit of good will and cooperation which has prevailed throughout the year. This spirit of working together has been enhanced by the holding of regular weekly staff meetings, at which time the work of the various divisions is discussed in order that each member of the Department may be well acquainted with the work which the other members are doing. The accuracy and completeness with which the research records have been kept is very gratifying, and it is due to the fact that one man's time is devoted entirely to these details that this can be announced. There have been no changes in the organization of the research division. Mr. C. E. Brett, who was employed as Instructor in Poultry Husbandry and who carried on many cooperative experiments with the educational flock, resigned to take up commercial activities in Northern New Jersey. His place has been very ably filled by Mr. Roy F. Irvin, a graduate of the Michigan Agricultural College, and who for the past two years has had charge of the poultry work at the University of Georgia, Athens, Georgia. While Mr. Irvin's time is largely devoted to teaching in the long and short courses in agriculture, yet he finds considerable time to conduct observation experiments in incubation and brooding. During the recent months, Mr. Horace V. Cory, a graduate of Rutgers, 1915, in the Department of Agriculture, specializing in Poultry Husbandry, has been engaged to aid in establishing certain breeding experiments and to take charge of the moving operations incidental to moving the birds and buildings from the old to the new location. Mr. Cory's employment is but temporary.

The following is the make up of the staff of the Department of Poultry Husbandry as it exists November 1, 1915:

Harry R. Lewis, Poultry Husbandman.
Willard C. Thompson, Assistant in Research.
Victor G. Aubry, Extension Specialist.
Roy F. Irvin, Instructor.
Horace V. Cory, Temporary Research Assistant.
Morris Siegel, Foreman Production Plant.
Elmer H. Wene, Foreman Instruction Plant
William Pape, Assistant.
Richard Wagner, Assistant.
Antal Kiss, Assistant.
Mary B. Reed, Stenographer.
Kathryn L. Reed, Stenographer.

The New Poultry Farm—The work of laying out and developing the new poultry farm which has been previously mentioned in the last three reports has progressed slowly but continuously. Roads have been built, all foundations completed, and at this time the large laying houses are being placed on their new foundations. A new duck house has been constructed and properly connected with the artificial pond. The eight-acre range for chicks has been completely fenced and equipped with colony houses. This acreage, which is located in a forestry nursery, proved very satisfactory as range ground during the past summer. It is hoped that by another year complete plans and descriptions of the new poultry farm can be given, together with cost of all equipments and other features of interest. The five thousand dollars which was appropriated for developing the new plant is being spent in the moving of the old buildings, in a complete watering system, and in the construction of two new laying houses. Between five and six thousand dollars will be needed next year to complete the work. It is hoped that this money will be appropriated by the present Legislature for the next fiscal year.

An Appreciation of Gifts—Numerous pens of birds have been presented to the Department during the year largely for educational purposes. These include a pen of White Wyandottes from J. Harry Wolsieffer, Vineland, N. J., a pen of Light Brahmas from Harvey

Wood, Bound Brook, N. J., a pen of Lakenvelders from Miss L. E. Osgood, North Plainfield, N. J., and a pen of Sycilian Buttercups from Elmer H. Wene, Pittstown, N. J. A number of small gifts in cash have been received from members interested in the work, and these have been expended in the purchasing of equipment as intended by the donor. The poultry husbandman herewith wishes, at this time, to express his appreciation to those persons who have showed their willingness to cooperate in making our work more efficient.

NEED OF A NEW POULTRY HUSBANDRY BUILDING—It is urgent that the few remarks in the last year's annual report relating to the need of enlarged facilities for the teaching and research work again be emphasized. As stated, plans have been prepared for a group of buildings to be used exclusively for poultry work. It is hoped that in the near future an appropriation can be secured from the Legislature for the construction of the largest and most important building of the group. The laboratory and lecture rooms for the teaching as well, as offices and laboratories for research occupations which are at present available, are far inadequate for the needs.

Financial Statement.

The following is a statement of the total amount of cash and credit sales made by the Poultry Department during the year November 1, 1914 to November 1, 1915. Due to the fact that fences were being moved and it was necessary to confine the birds during the year, production has been curtailed and thus material reduction in revenue is apparent. This reduction in revenue will continue through the next year, but with the increased size of the flocks and increased facilities for care, the revenue will be materially increased as soon as the new plant is complete. The revenue received during the past year has just paid for the cost of feed and labor hired to care for the birds. The aim has been to manage the experimental flock carefully and in such a way that nothing will be allowed to go to waste. All things which were of a salable nature and which were not needed for experimental work would be marketed at the most propitious time.

Following is the revenue by months:

November, $138.38; December, $144.64; January, $204.76; February, $192.60; March, $295.16; April, $317.10; May, $241.17; June, $64.50; July, $230.85; August, $163.18; September, $117.59; October, $123.78. Total, $2,233.71.

ADMINISTRATION ACTIVITIES—It is probably proper to call attention at this time to the great increase in administration activities which have grown to such an extent that the time of the Poultry Husbandman is largely spent on administration matters. This has been due to two direct causes, first, the material enlargement of the work with its increased obligation and the need of careful attention to details and the planning of work for present and future experiments. Second, it has been due in part to the new requisition system which requires not only much more time on the part of the Poultry Husbandman, but a very material increase in clerical help as well. It is hoped that some way can be found which will reduce the necessity of so large an amount of clerical labor in the ordering and purchasing of supplies.

III.

EXPERIMENTAL WORK.

During the past year several very definite lines of experimental work have been under way. The major part of these projects has had to do with problems that are continually arising before the poultry keeper's mind. Considerable work has been carried on dealing with the fundamental problem of poultry nutrition. During the past, general as well as specific feeding problems have been studied, but it has been deemed advisable this year to attempt problems of a more specific nature only. The exact nature of these has been determined very largely by the many inquiries received from all sections of the State of New Jersey, these being taken as an indication of the feeding problems that are at the present time perplexing our poultry keepers. A particularly notable example of this popular demand for information on specific feeds is found in the sour skim-milk proposition. It has become a popular idea among poultry raisers, and this idea is justly founded, that sour skim-milk is more and more becoming an important factor in poultry production. As a result of the spread of this idea, numerous inquirers have asked the value of certain commercial forms of milk, which, in particular localities, are more easily available than the sour skim-milk. Another example of general interest in specific feeding problems is to be found in the many inquiries regarding the comparative nutritive values of the protein-bearing food stuffs from animal sources and those from vegetable sources. Together with the experiments which have been operated along nutrition lines are projects dealing with other factors in economical poultry culture. Not only has it been considered essential to make as complete a study as possible of the limiting factors in the production of eggs, but it has also been considered necessary to study the egg itself. The consuming public is growing more and more critical each year of the quality of market eggs. The color, size, and condition of market eggs are determining factors in establishing the market prices. Tintedness in white-shelled eggs has come to be considered an almost alarming condition, so that investigation as to its prevalence and causes has seemed in order. Closely related with problems of this kind are the investigations of various egg preservatives. Turning abruptly from the egg production side of poultry keeping, attention has been given to the problem of meat production. During the last few years, with the tremendous growth of the egg producing business, there seems to have been a tendency toward slighting the flesh production end. It is particularly important that all egg producers, as well as meat producers, should understand the fundamental principles of flesh production, as on all poultry farms there are certain numbers of birds to be marketed for meat purposes each year. The field for poultry experimentation is, therefore, a very wide one, offering important lines of investigation in every phase of the business. It is a physical impossibility to start or carry on all lines of work that are this year puzzling New Jersey poultrymen. The following report indicates the nature and extent of such experiments as have already been undertaken and are outlined for the coming year.

Sour Skim-Milk for Laying Hens.

During the past three or four years, poultry raisers have been reading more or less about sour skimmed milk as a food-stuff for poultry of all kinds. Particularly has the public been told through many poultry papers and station publications of the probable value of this by-product of the dairy as a food for baby chicks. In localities where sour skimmed milk can be obtained for a fair price, the question has often been raised as to whether or not it is an economical food for the laying flocks. The experiment which has been conducted during the past year has been made with the idea in mind of determining the exact value of sour skim-milk as a supplementary food-stuff for laying fowls, measuring this value in terms of surplus eggs produced.

Two pens of Single Comb White Leghorn pullets, all March hatched, were selected. These birds were as uniform in size, development and quality as was possible to obtain. Both flocks were kept in a hollow-tile laying house, both pens being exactly the same in size, and complete furnishings, so that both flocks were managed under absolutely similar conditions. The regulation New Jersey rations were fed in both pens. Pen No. 22 received sour skim-milk in unlimited amount daily. Pen No. 25 received no milk. No definite measurement of milk consumed was kept; however, a fairly accurate approximation has been made.

Table I gives a summary of the results obtained in this experiment.

Table I.

Sour Skim-Milk for Laying Hens. 1914-1915.

MONTH.	PEN NO. 22					PEN NO. 25				
	No. of eggs.	% Production.	Value of eggs.	Cost of food.	+ Profit or − loss.	No. of eggs.	% Production.	Value of eggs.	Cost of food.	+ Profit or − loss.
October, 1914	431	13.90	$20.16	$9.29	+ $10.87	221	7.12	$10.31	$9.07	+ $1.24
November	650	21.67	31.40	7.27	+ 24.13	240	8.00	11.59	7.07	+ 4.52
December	542	17.48	26.18	7.93	+ 18.25	318	10.26	15.26	6.96	+ 8.30
January, 1915	613	20.43	25.01	8.60	+ 16.41	532	17.33	21.71	7.83	+ 13.88
February	1,045	38.74	35.63	8.42	+ 27.21	798	28.87	27.21	8.50	+ 18.71
March	1,774	58.39	51.62	9.17	+ 42.45	1,388	45.68	40.39	9.09	+ 31.30
April	1,846	64.09	47.63	10.19	+ 37.44	1,433	50.28	36.97	9.02	+ 27.95
May	1,648	55.95	41.20	11.19	+ 30.01	1,134	48.91	28.35	8.97	+ 19.38
June	1,363	48.33	35.17	8.52	+ 26.65	874	31.32	22.55	7.23	+ 15.32
July	1,090	37.40	28.12	9.19	+ 18.93	767	26.60	20.79	8.75	+ 12.04
August	654	23.14	19.03	8.53	+ 10.50	487	17.45	14.17	8.23	+ 5.94
September	388	14.37	13.89	8.57	+ 5.32	191	7.40	6.84	8.49	− 1.65
Total	12,044	....	$375.04	$106.87	+ $268.17	8,383	....	$256.14	$99.21	+ $156.93

PLATE I.

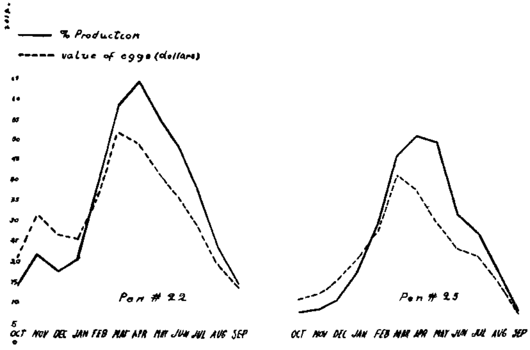


FIG. 1.—Curves showing results of sour skim-milk experiment.

It will be noticed, upon examination of this table, that the flock receiving sour skimmed milk produced 12,044 eggs, as against 8,383 by the pen receiving no milk. This made a difference in profit of $111.84, in favor of the pen receiving the skim-milk. Figuring the value of the sour skim-milk at 25 cents per 100 pounds, the cost of milk consumed by the birds in Pen 22 was approximated at $9.50, thus leaving an actual profit of $101.74. The actual total profit in Pen 22 was $258.67, and in Pen 25, $156.93. The cost of labor was not figured, as it was the same in both pens. Due to the fact that the supply of sour skim-milk has been at least temporarily cut off, the birds in this experiment were turned into the regular laying flocks on November 1st, thus closing the experiment with the first year's egg production.

Table II shows the amount of food consumed by the two pens in this experiment. The slight increase in food consumed by the milk-fed pen was probably due to the fact that those birds were in somewhat better physical condition throughout the year.

Table II.

Sour Skim-Milk for Laying Hens. Food Consumption.
Pounds of Food Consumed.

MONTH.	PEN No. 22. 1 Dry mash.	PEN No. 22. 2 Morning grain.	PEN No. 22. 3 Evening grain.	PEN No. 25. 1 Dry mash.	PEN No. 25. 2 Morning grain.	PEN No. 25. 3 Evening grain.
October, 1914	87	155	310	74	155	310
November	72	120	240	60	120	240
December	100	124	248	42	124	248
January, 1915	140	124	248	94	124	248
February	165	112	224	134	124	248
March	144	124	279	139	124	279
April	217	120	270	176	120	240
May	264	124	279	132	124	279
June	118	120	270	98	120	210
July	145	124	279	119	124	279
August	106	124	279	88	124	279
September	121	120	270	116	120	270
Total	1,679	1,491	3,196	1,272	1,503	3,130

The conclusions reached upon a close study of the above tables are:

1. *Sour skim-milk has a very definite place in the nutrition of laying* hens, being a splendid source of protein food, the element so necessary for the production of eggs.

2. The returns measured in number of surplus eggs produced indicate that the sour skim-milk has nearly five times the value paid for it.

3. The feeding of sour milk kept the birds in better physical condition, lowering mortality and keeping them practically free from disease.

4. The feeding of skim-milk slightly increased the consumption of other parts of the ration, probably because the skim-milk kept the digestive organs in splendid running order so that they were able to handle large amounts of food. It is thought that on a commercial basis this factor would appear more strongly than it did in this somewhat limited experiment.

5. Egg producers can afford to pay from 20 to 45 cents per 100 pounds for sour skim-milk.

6. Sour skim-milk can be fed in open pans, thus necessitating very little labor.

7. Plate I gives in graphic form the tested worth of sour skim-milk as a supplementary food for laying hens.

Milk Products as Poultry Feeds.

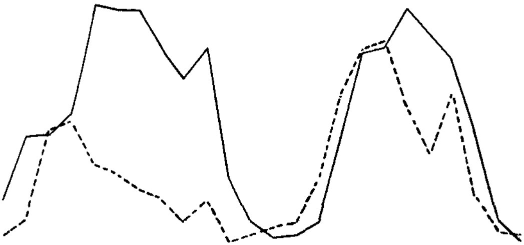
The difficulty which has been met with in many sections of the State in obtaining a constant supply of sour skim-milk has lead numerous poultry keepers to inquire concerning the comparative value of certain forms of milk which can be obtained on the market. Questions have been asked as to whether milk powders, granulated milks, milk albumens, or flaked milks, all commercial forms, can be used in place of sour skim-milk with as satisfactory and as economical results. As these various milk by-products are comparatively recent in appearance on the markets little investigational work has been done with them. In order to test out some of the common forms which are possible to obtain in New Jersey, a definite and rather extensive series of experiments were started during the past year.

Several brooder pens of Single Comb Leghorn and Barred Plymouth Rock chicks were available for use in this work, all having been hatched March 24th, and all being from good strong stock. Two pens of Leghorn chicks were given the regulation New Jersey chick rations, and in addition, free access to sour skim-milk. Two Barred Rock pens were fed similarly. Two pens of Leghorns and two of Barred Rocks were given the regulation ration, plus 10 per cent milk albumen in their dry mash. Another set of four pens, two of each breed, were given the regulation rations, together with 10 per cent of milk powder in the dry mash. The last series of four pens were given regulation rations with no supplementary foods. These chicks were all carefully weighed each week and the total food consumption was measured. At the close of the twelfth week the pullets in each series were selected and placed together on ranges of appropriate size. The cockerels were sold as broilers. The pullets were continued on rations throughout the summer growing period which had the same milk supplements as did their respective chick rations. On October 1st, thirty of the best pullets in each series were placed in uniform laying houses, and, at the present writing, are beginning the pullet year of production, receiving the same supplementary feeds which they have received since removal from the incubator. The weekly weights are being continued and at the close of another year valuable data will undoubtedly be at hand from which conclusions may be drawn as to the value of these various milks.

Animal vs. Vegetable Protein.

Persons interested in the nutrition of poultry, either for growth, egg production, or meat production, readily acknowledge the importance of high protein-bearing feeds in the rations given to all kinds of poultry. Protein is a food material that plays an important part in the formation of the muscular tissues of the growing chick, the development of its organs and plumage, in the maintenance of the various body processes, in the formation of eggs, and in the building up of new tissues in flesh production. Because of its controlling importance in the nutrition of poultry, feeders have become extremely interested in the various commercial forms in which protein can be secured at economical rates.

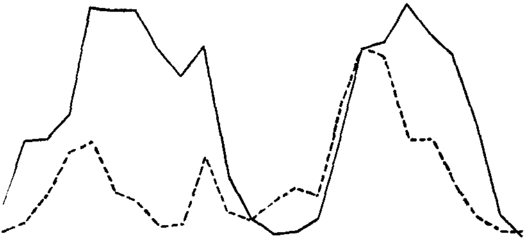
Plate II.



Meat scrap______________
Soybean meal- - - - - - - - - - -

Fig. 2.—Curves showing results of egg production experiment: meat scrap vs. soybean meal.

PLATE III.



Meat scrap ————
Gluten feed - - - - - - - - -

FIG. 3.—Curves showing results of egg production experiment; meat scrap vs. gluten feed.

PLATE IV.

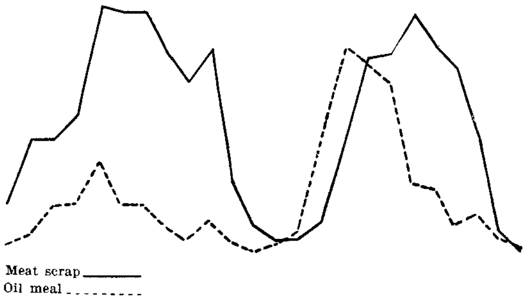


FIG. 4.—Curves showing results of egg production experiment: meat scrap vs. oil meal.

PLATE V.

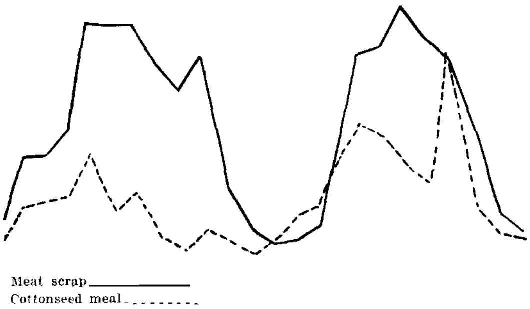


FIG. 5.—Curves showing results of egg production experiment: meat scrap vs. cottonseed meal.

There are two important sources of protein, that obtained from animals and that obtained from plants. Among the animal sources of protein are to be found the various types and brands of meat scraps, beef scraps, bone meals, blood meals, fish scraps, milk albumen, milk powders, and flaked milks. All of these are either directly or indirectly derived from animals, being by-products of the slaughter houses, glue, and soap factories, or creameries. All of these protein bearers have been used by careful poultry feeders for a number of years to greater or less extent. In some localities the prevailing prices for these feeds have been prohibitive, and in some localities it has been impossible to secure them. Particularly in such localities the question arises as to the comparative value of protein from vegetable or plant sources. Among such protein bearers are found gluten meal, gluten feed, oil meal, soybean meal, sunflower meal, and other similar products, most of these being by-products of the manufacture of some of our important commercial oils. Some of these vegetable food-stuffs are cheaper than the animal feeds. In order to make a comparison of the relative feeding value of certain common sources of high protein-carrying food-stuffs from both animal and vegetable sources, an experiment was planned and has been under way for two complete laying years, beginning November 1, 1913, and closing November 1, 1915.

Five pens of Single Comb White Leghorn pullets were selected for this work. All flocks were housed in the long laying house so that each pen was exactly the same, thereby surrounding each flock with identically the same environments. All flocks were fed and managed in the same manner with the exception of the kind of dry mash afforded. There were fifty females in each flock at the beginning of the experiment. All birds were selected from the same-aged flock of pullets, and were as uniform in size and development as it was possible to obtain. The regulation New Jersey morning and evening grain rations were used.

Morning Grain Ration.

1 part wheat
1 part oats
1 lb. to 20 birds, fed in deep litter.

Evening Grain Ration.

2 parts cracked corn
1 part wheat
1 part oats
1 lb. to 10 birds, fed in deep litter.

The five sources of protein used in this experiment were meat scrap, soybean meal, gluten feed, oil meal, and cottonseed meal. These were placed in the dry mashes in maximum amounts, i. e. 33 per cent of the whole mash by weight. All flocks were allowed free access to these mashes.

Pen No. 42 received the following mash:

Wheat Bran, 40 lbs.; Ground Oats, 40 lbs.; Corn Meal, 20 lbs.; Meat Scrap, 50 lbs.

Pen No. 43 received the following mash:

Wheat Bran, 40 lbs.; Ground Oats, 40 lbs.; Corn Meal, 20 lbs.; Soybean Meal, 100 lbs.

Pen No. 46 received the following mash:

Wheat Bran, 40 lbs.; Ground Oats, 40 lbs.; Corn Meal, 20 lbs.; Gluten Feed, 100 lbs.

Pen No. 47 received the following mash:

Wheat Bran, 40 lbs.; Ground Oats, 40 lbs.; Corn Meal, 20 lbs.; Oil Meal, 100 lbs.

Pen No. 48 received the following mash:

Wheat Bran, 40 lbs.; Ground Oats, 40 lbs.; Corn Meal, 20 lbs.; Cottonseed Meal, 100 lbs.

On studying the above mashes, it will be seen that protein from four vegetable sources, namely, soybean meal, gluten feed, oil meal, and cottonseed meal was compared with meat scraps, a common form of protein from an animal source.

The birds in this experiment were kept in the same pens during the entire period of two years, being yarded during the summer in the same kind of yards. An alternate yarding system was used in order to supply a constant source of succulent food during the summer. All pens received mangel beets as a source of winter succulence.

Table III presents a statement of the total mash, morning grain and evening grain consumption in each pen.

Table III (A).
Vegetable Protein Experiment. Food Consumption.
Pounds of Food Consumed.

	Pen 42.			Pen 43.			Pen 46.			Pen 47.			Pen 48.		
	1 Dry mash	2 Morning grain.	3 Evening grain.	1 Dry mash.	2 Morning grain.	3 Evening grain.	1 Dry mash	2 Morning grain.	3 Evening grain.	1 Dry mash.	2 Morning grain.	3 Evening grain.	1 Dry mash.	2 Morning grain.	3 Evening grain.
November, 1913....	30.0	62.0	98.0	32.5	62.0	62.0	37.0	62.0	104.0	29.0	62.0	108.5	40.0	62.0	113.5
December.........	67.5	55.0	117.0	88.0	62.0	93.0	82.0	62.0	124.0	63.0	62.0	108.5	68.0	62.0	124.0
January, 1914......	81.5	71.5	141.5	111.0	87.0	118.0	80.5	62.0	124.0	58.0	62.0	108.5	88.0	68.5	140.0
February.........	50.25	70.0	133.0	75.0	84.0	112.0	55.0	56.0	112.0	39.0	73.0	128.5	74.0	43.0	124.5
March.............	77.0	77.5	155.0	41.0	77.5	155.0	62.0	55.0	147.0	40.0	60.0	155.0	48.5	58.0	147.0
April..............	90.0	75.0	150.0	54.0	45.0	90.0	64.0	60.0	90.0	55.0	60.0	90.0	53.0	45.0	75.0
May...............	74.0	77.5	155.0	58.0	46.5	95.0	57.0	62.0	93.0	41.0	62.0	93.0	48.0	46.5	77.5
June..............	69.0	75.0	150.0	49.0	45.0	90.0	29.0	60.0	90.0	25.0	60.0	90.0	25.0	45.0	75.0
July..............	83.0	62.0	124.0	50.0	46.5	93.0	75.0	62.0	93.0	28.0	62.0	93.0	29.0	46.5	77.5
August...........	63.0	62.0	124.0	67.0	46.5	93.0	75.0	62.0	93.0	26.0	62.0	108.5	23.0	62.0	108.5
September........	51.0	60.0	120.0	43.0	45.0	90.0	72.0	60.0	90.0	21.0	60.0	105.0	38.0	60.0	105.0
October...........	34.0	62.0	124.0	51.0	62.0	124.0	66.0	62.0	108.5	42.0	62.0	108.0	30.0	38.0	108.0
Total.........	770.25	809.5	1591.5	719.5	709.0	1215.0	754.5	725.0	1268.5	467.0	747.0	1296.5	564.5	636.5	1275.5

Table III (B).
Vegetable Protein Experiment. Food Consumption.
Pounds of Food Consumed.

	Pen 42.			Pen 43			Pen 46			Pen 47.			Pen 48.		
	1 Dry mash.	2 Morning grain.	3 Evening grain.	1 Dry mash.	2 Morning grain.	3 Evening grain.	1 Dry mash.	2 Morning grain.	3 Evening grain.	1 Dry mash.	2. Morning grain.	3 Evening grain.	1 Dry mash.	2 Morning grain.	3 Evening grain.
November, 1914..	32.0	60.0	120.0	28 0	60.0	120.0	37 25	60.0	105.0	21.0	45 0	90.0	34.5	45.0	90.0
December.	46 25	62.0	124.0	74.5	93 0	155 0	38 25	62 0	124.0	14.0	46.5	46.5	19.5	46.5	93.0
January, 1915. . . .	49.0	49.5	99.0	110.0	62.0	124.0	2 00	62.0	124.0	30 0	46.5	46 5	3 0	46.5	93.0
February.	46.0	56 0	112.0	95.0	56.0	112.0	45.0	56 0	112 0	40.0	56 0	56 0	18.0	56.0	112.0
March.	42.5	62.0	124.0	61.0	62.0	124 0	79.0	62.0	124 0	28.0	62 0	62.0	24.0	62 0	108.5
April.	56.0	60.0	120.0	75.0	60.0	120.0	80.0	60 0	120.0	34.0	60.0	60.0	24.0	60.0	105.0
May.	44.5	62.0	124.0	113.0	62.0	124 0	94.0	62.0	124.0	53.0	62.0	62.0	21.0	62.0	108.5
June.	41.0	60.0	120.0	43.0	60 0	120 0	43.5	60 0	120 0	18 0	60.0	60 0	16.0	60.0	105.0
July.	37.5	62.0	124.0	64.0	62.0	124.0	68.5	62.0	124 0	30.5	62.0	62.0	26.0	62.0	108.5
August.	46.0	62.0	124.0	54.5	62.0	124 0	52.0	62 0	124 0	45.0	62 0	62.0	40 0	62.0	93.0
September.	50.0	60.0	120.0	40 5	60.0	120.0	43.5	60.0	120.0	33.5	60.0	60.0	32.5	60.0	90.0
October.	29.0	62.0	108.5	18.5	62.0	108.5	20.5	62.0	108.5	34.5	31.0	31.0	23.0	31.0	90.0
Total.	519.75	717.5	1419.5	786.0	761.0	1475.5	603.50	730.0	1429.50	381 5	653.0	698.0	281.5	653.0	1196.5

The egg production in each pen was carefully recorded, as was also the number of birds in each pen during the entire period of the experiment.

Table IV.

Vegetable Protein Experiment. Egg Production.

First Year.

Number of Eggs Produced.

MONTH	Pen 42	Pen 43	Pen 46	Pen 47	Pen 48
November, 1913	138	35	50	11	85
December	361	86	92	47	206
January, 1914	381	391	200	144	226
February	408	390	303	149	210
March	810	284	359	308	374
April	754	284	185	160	173
May	758	216	158	154	220
June	609	176	59	78	73
July	544	96	70	29	29
August	566	158	272	93	78
September	193	36	87	27	37
October	74	53	68	0	4
	5596	2205	1903	1200	1715

Egg Production.

Second Year.

Number of Eggs Produced.

MONTH.	Pen 42	Pen 43	Pen 46	Pen 47	Pen 48
November, 1914	24	58	110	13	38
December	34	75	137	43	73
January, 1915	77	179	119	243	98
February	239	338	283	352	180
March	463	454	446	348	264
April	500	468	388	294	226
May	500	297	223	122	164
June	407	169	199	102	118
July	376	308	115	41	38
August	236	116	46	61	69
September	45	26	17	22	12
October	4	17	17	6	0
	2905	2505	2100	1647	1280
Total egg production of two year period	8501	4710	4003	2847	2995

The birds receiving protein from an animal source, meat scrap, produced a total of 8501 eggs, as compared with 4710 by the soybean meal pen, 4003 by the gluten feed pen, 2847 by the oil meal pen, and 2995 by the cottonseed meal pen.

It will be noticed that the high production by the flock receiving meat scrap was largely due to the comparatively high production during the first year of the experiment when 5596 eggs were produced. As the number of birds in each pen varied from time to time, due to losses by disease and accident, the percentage of production in each pen is really the best measure of the comparative efficiency of these feeds in egg production.

Table V gives the percentage egg production in each pen for the entire period.

Table V.

Vegetable Protein Experiment. Percentage Egg Production. First Year.

MONTH	Pen 42	Pen 43	Pen 46	Pen 47	Pen 48
November, 1913	9.2	2 3	3.8	0.73	5.6
December	24.0	5.5	5.8	3.0	13.0
January, 1914	24.0	25.0	12.0	9.2	14.0
February	29.0	28.0	21.0	10.0	15.0
March	53.0	19.0	23.0	19.0	24.0
April	52 0	17.0	12.0	10.0	11.0
May	52.0	14.0	10.0	10 0	15.0
June	43.0	12 0	4.2	5.7	4.8
July	37.0	6.8	4.8	2.1	2.1
August	44.0	11.0	19.0	6.7	5.8
September	15.3	2.8	7.2	2.1	3.0
October	5.6	4.1	5.4	.0	small

Percentage Egg Production. Second Year.

MONTH.	Pen 42	Pen 43	Pen 46	Pen 47	Pen 48
November, 1914	2.05	5.26	9.17	1.27	3.73
December	2 81	6.54	12 28	4.08	7.36
January 1915	6 54	16.50	10.97	26 13	9.88
February	23.71	34.49	29.73	44.90	20.09
March	42 67	44 38	42.31	41.58	27.47
April	43 71	48 75	40 42	37.69	24.30
May	52 03	31.94	22.50	15.14	17.63
June	45 33	19.43	22.87	14.17	13.11
July	40 43	34 26	12.49	6.01	42.22
August	25.38	13 36	5.30	8.94	7.42
September	5.0	3.09	2.02	3.67	1.33
October	0.43	2 19	1.96	0.97	.0

The financial statement of the results of this experiment is very important, as every poultryman must measure the efficiency of certain feeding stuffs by the dollars and cents which its use will bring in. The average New York market prices for each month were the ones used in estimating the value of the eggs produced by each flock. The cost of feeding stuffs was obtained by using the average cost of each ration for each year.

Table VI gives the value and number of eggs, cost of feed, and the profit or loss above or below feed. As the labor required in the management of these pens was the same in each case, it was not figured in this experiment.

Table VII records a summary of results obtained in this experiment.

Table VI.
Vegetable Protein Experiment. Financial Statement.
First Year.

MONTH.	Pen 42.			Pen 43.			Pen 46.			Pen 47.			Pen 48.		
	Value of eggs.	Cost of feed.	+ Profit or — loss.	Value of eggs.	Cost of feed.	+ Profit or — loss.	Value of eggs	Cost of feed.	+ Profit or — loss.	Value of eggs.	Cost of feed.	+ Profit or — loss.	Value of eggs.	Cost of feed.	+ Profit or — loss.
November, 1913	$4.37	$3.51	+ .86	$1.11	$2.88	— 1.77	$1.80	$3.57	— 1.77	$0.35	$3.55	— 3.20	$2.69	$3.83	— 1.14
December	16.24	4.52	+11.72	4.05	3.91	+ 0.11	4.14	4.66	— 0.52	2.29	4.16	— 1.87	9.27	4.52	+ 4.95
January, 1914	9.84	5.45	+ 4.39	10.10	5.87	+ 4.23	5.16	4.93	+ 0.23	3.72	4.20	— 0.48	5.83	5.51	+ .32
February	14.96	4.82	+10.14	14.30	5.00	+ 9.30	11.11	4.11	+ 7.00	5.46	4.37	+ 1.09	7.70	4.48	+ 3.22
March	24.30	5.19	+19.11	8.52	4.97	+ 3.55	10.77	4.86	+ 5.91	9.24	4.65	+ 4.59	11.22	4.64	+ 6.58
April	18.22	6.04	+12.18	6.86	3.67	+ 3.19	4.47	4.15	+ 0.32	3.86	3.95	— .09	4.18	3.35	+ .83
May	17.05	5.85	+11.20	4.86	3.78	+ 1.08	3.54	4.05	— 0.51	3.46	3.73	— .27	4.95	3.30	+ 1.65
June	14.72	5.62	+ 9.10	4.25	3.54	+ 0.71	1.42	3.13	— 2.01	1.88	3.35	— 1.47	1.76	2.79	— 1.03
July	14.96	5.11	+ 9.85	2.64	3.62	— 0.98	1.92	4.41	— 2.49	0.79	3.47	— 2.68	0.79	3.08	— 2.29
August	17.95	4.81	+13.14	5.00	4.49	+ 0.51	8.51	4.14	+ 4.37	2.94	3.69	— 0.75	2.47	3.64	— 1.17
September	6.75	4.41	+ 2.34	1.26	3.75	— 2.49	3.05	1.60	— 1.55	0.95	3.50	— 2.55	1.30	4.81	— 3.51
October	3.08	4.18	— 1.10	2.21	4.22	— 2.01	2.83	4.29	— 1.46	.00	3.51	— 3.51	0.17	3.29	— 3.12
Total	$162.44	$59.51	+102.93	$65.16	$49.73	+15.43	$58.72	$51.20	+ 7.52	$31.94	$46.13	—11.19	$52.33	$47.24	+ 5.[illegible]9

Table VI. (Continued).
Vegetable Protein Experiment. Financial Statement.
Second Year.

MONTH	Pen 42.			Pen 43.			Pen 16.			Pen 47.			Pen 48.		
	Value of eggs	Cost of feed	+ Profit or — loss	Value of eggs	Cost of feed	+ Profit or — loss	Value of eggs.	Cost of feed.	+ Profit or — loss.	Value of eggs.	Cost of feed.	+ Profit or — loss.	Value of eggs.	Cost of feed.	+ Profit or — loss.
ovember 1914	$1.16	$3.67	— 2.51	$2.80	$3.81	— 1.07	$5.31	$3.39	+ 1.92	$0.63	$2.65	— 2.02	$1.84	$2.89	— 1.05
ecember	1.64	4.06	— 2.42	3.62	6.29	— 2.67	5.62	3.74	+ 1.88	2.08	2.60	— .52	3.53	2.70	+ .83
nuary, 1915	3.14	3.60	— .46	7.30	6.46	+ .84	4.86	3.16	+ 1.70	9.91	2.89	+ 7.02	4.00	2.40	+ 1.60
bruary	8.15	3.89	+ 4.26	11.53	5.49	+ 6.04	9.45	3.55	+ 5.90	12.00	3.55	+ 8.45	6.14	2.55	+ 3.59
arch	13.47	4.13	+ 9.34	13.21	4.84	+ 8.37	12.98	4.39	+ 8.59	10.13	3.39	+ 6.74	7.68	3.32	+ 4.36
ril	12.84	4.30	+ 8.54	12.07	5.13	+ 6.94	10.01	4.15	+ 5.86	7.59	3.40	+ 4.19	5.83	3.22	+ 2.61
ay	12.00	4.17	+ 7.83	7.43	6.29	+ 1.14	5.58	4.63	+ .95	3.05	3.84	— .79	4.10	3.27	+ .83
ne	10.50	4.00	+ 6.50	4.36	4.23	+ .13	5.13	3.83	+ 1.30	2.63	3.11	— .48	2.94	3.06	— .12
ly	9.70	4.03	+ 5.67	7.95	4.92	+ 3.03	2.97	4.21	— 1.24	1.06	3.16	— 2.10	0.98	3.36	— 2.38
gust	6.87	4.20	+ 2.67	3.38	4.66	— 1.28	1.34	3.96	— 2.62	1.78	3.45	— 1.67	2.01	3.35	— 1.34
ptember	1.61	4.18	— 2.57	0.93	4.16	— 3.23	0.60	3.83	— 3.23	0.79	3.15	— 2.36	0.43	3.14	— 2.71
tober	0.18	3.46	— 3.28	0.78	3.40	— 2.62	0.78	3.21	— 2.43	0.28	2.08	— 1.78	0.00	1.85	— 1.85
Total	$81.26	$47.69	+$33.57	$75.36	$59.68	+15.62	$64.63	$46.05	+18.58	$51.93	$37.25	+14.68	$39.48	$35.11	+ 4.37

Table VII.

Summary of Vegetable Protein Experiment.

Item.	Pen 42			Pen 43			Pen 46.			Pen 47			Pen 48		
	1914	1915	Total.	1914	1915	Total	1914	1915	Total	1914	1915	Total.	1914	1915	Total.
tal egg yield	5,596	2,905	8,501	2,205	2,505	4,710	1,903	2,100	4,003	1,200	1,647	2,847	1,715	1,280	2,995
tal cost of feed	$59.51	$47.69	$107.20	$49.73	$59.68	$109.41	$51.20	$46.05	$97.25	$46.13	$37.25	$83.38	$47.24	$35.11	$82.35
tal egg value	162.44	81.26	243.70	65.16	75.36	140.52	58.72	64.63	123.35	39.94	51.93	91.87	52.33	39.48	91.81
tal profit....	102.93	33.57	136.50	15.43	15.62	31.05	7.52	18.58	26.10	....	14.68	3.49	5.29	4.37	9.66
tal loss	....	....	....	....	....	....	....	....	....	11.19	....	....	....	....	....

Plates II, III, IV and V show a concrete comparison of the sources of protein with the annual source.

Conclusions Reached.

1. In comparison with the four vegetable sources of prot meat scrap proved to be the most efficient egg producer, nearl ling the next highest, the soybean meal.
2. The egg production by the flock receiving the protein animal source was during the first year, running nearer the ave second year.
3. The protein from an animal source apparently forced production more than did any of the proteins from vegetable so
4. In the order of egg production, the four sources of v protein are named as follows: soybean meal, gluten feed, co meal, and oil meal.
5. The mortality was considerably less in the meat scrap p
6. The flock receiving cottonseed meal and oil meal ap broke down during the second year when the mortality was c tively high.
7. The ration containing the soybean meal was the most ex meat scrap second, gluten feed third, old meal fourth, and co meal fifth.
8. A profit above feed was made in all pens both years w exception of the pen receiving oil meal, which suffered a loss of during the first year of production.
9. By far, the greatest profits were realized from the meat sc
10. From the standpoint of egg production and the genera of the birds, the protein was found from the animal source experiment to be the most efficient, and most economical.

Percentage of Meat Scrap.

In the economical feeding of poultry of all kinds, particularl stock, it has been, during recent years, a recognized fact that high protein-bearing food-stuffs were necessary. The reason f siderable protein being necessary in the ration of laying hens is f the fact that eggs, the great product of the laying flocks, ar tially protein substances. In order to obtain any number of the it is necessary that the fowl, the machine, should be supplied wi cient raw material. Meat scraps and beef scraps are probab more universally than any other common source of protein food exact amount, or percentage, which materials of this kind shou in the rations of laying fowls is still a debated question. Th many things to take into consideration. With a view toward the relative efficiencies of a low and medium percentage of me in the mash of laying hens, an experiment has been conducted fo full laying years, starting on November 1, 1912.

Single Comb White Leghorn pullets were used for this wo being selected for each two pens. Both pens were alike i

PLATE VI.

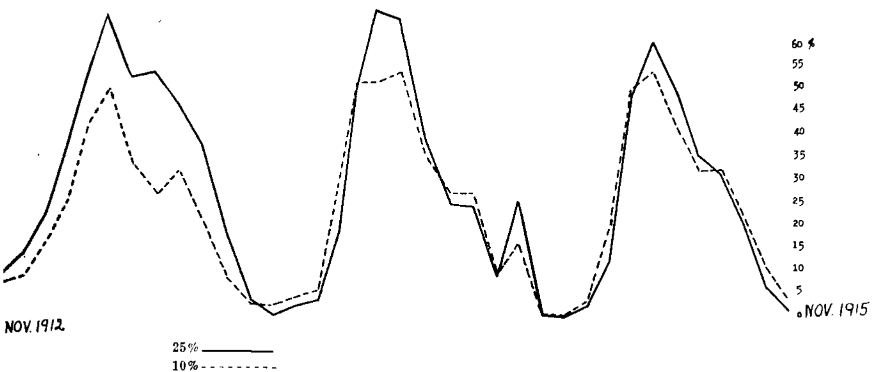


FIG. 6.—Curves showing results of egg production experiment: 25 per cent. meat scrap vs. 10 per cent. meat scrap.

respect, and the birds placed in them were as uniform in size, development and condition as was possible to obtain. The only varying factor was the percentage of meat scrap in the dry mash afforded these pens. Pen No. 54 received 25 per cent meat scrap in its dry mash, and Pen No. 55 received 10 per cent. The regulation New Jersey State rations were used, with the exception of the meat scrap content, as has been noted.

Table VIII gives the food consumption for the entire three years, during which time accurate records were kept in each pen.

Table VIII. (A).

Meat Scrap Experiment. Food Consumption. Pounds of Food Consumed. First Year.

	Pen No. 54			Pen No. 55.		
	1 Dry mash.	2 Morning grain.	3 Evening grain.	1 Dry grain.	2 Morning grain.	3 Evening grain.
November, 1912	52.5	75.0	150.0	31.0	75.0	150.0
December	51.5	77.5	160.0	47.0	77.5	155.0
January, 1913	81.0	75.0	150.0	69.0	77.5	155.0
February	86.0	70.0	135.0	68.0	70.0	140.0
March	134.0	75.0	150.0	96.5	75.0	150.0
April	129.5	75.0	150.0	85.5	75.0	150.0
May	116.0	77.5	155.0	75.0	75.0	155.0
June	92.0	69.0	150.0	58.0	75.0	150.0
July	77.0	46.5	155.0	56.0	77.5	155.0
August	54.0	46.5	155.0	53.0	46.5	155.0
September	35.0	45.0	150.0	46.0	45.0	150.0
October	23.0	60.0	80.0	35.0	62.0	124.0
Total	931.5	792.0	1740.0	720.0	831.0	1789.0

Table VIII. (B).

Food Consumption. Pounds of Food Consumed. Second Year.

	Pen No. 54			Pen No. 55		
	1 Dry mash.	2 Morning grain.	3 Evening grain.	1 Dry mash.	2 Morning grain.	3 Evening grain.
November, 1913	23.0	62.0	124.0	37.0	26.0	124.0
December	38.0	68.5	130.5	66.0	62.0	137.0
January, 1914	45.5	77.5	139.5	76.5	74.5	160.5
February	31.5	70.0	126.0	46.0	70.0	154.0
March	67.0	77.5	139.5	65.0	77.5	155.0
April	74.0	75.0	150.0	64.0	75.0	150.0
May	83.0	77.5	155.0	95.0	77.5	155.0
June	49.0	75.0	150.0	35.0	75.0	150.0
July	51.0	62.0	124.0	57.0	62.0	124.0
August	46.0	62.0	124.0	63.0	62.0	124.0
September	36.0	62.0	124.0	32.0	62.0	124.0
October	50.5	60.0	120.0	58.0	60.0	120.0
Total	594.5	829.0	1606.5	694.5	783.5	1677.5

Table VIII. (C).
Food Consumption. Pounds of Food Consumed.
Third Year.

	Pen No. 54			Pen No. 55		
	1 Dry mash.	2 Morning grain.	3 Evening grain.	1 Dry Mash.	2 Morning grain.	3 Evening grain.
November, 1914	12.0	60.0	120.0	34.0	60.0	120.0
December	31.0	62.0	124.0	66.5	62.0	124.0
January, 1915	47.75	62.0	124.0	57.5	62.0	124.0
February	57 0	56 0	112.0	25.0	56.0	112.0
March	53.0	62.0	124.0	44.0	62.0	124.0
April	69 5	60.0	120.0	49.0	60.0	120.0
May	61.0	62 0	124 0	55.0	62.0	124.0
June	37.0	60.0	120 0	8.0	60.0	120.0
July	35.0	62.0	124.0	36.5	62.0	124.0
August	35 0	62.0	124 0	25.0	62.0	124.0
September	38.0	60.0	120.0	30.0	60.0	124.0
October	14.0	62.0	124.0	17.0	62.0	124.0
Total	490.25	730.0	1460.0	447.5	730.0	1464.0

Table IX gives the egg production in these two pens during the period of three years, over which the experiment was running.

Table IX.
Percentage Meat Scrap Production. Egg Production.
Number of Eggs Produced.

	Pen No 54			Pen No. 55		
	1913	1914	1915	1913	1914	1915
November	199	31	7	173	65	5
December	284	56	0	215	83	11
January	409	74	30	319	96	43
February	560	243	133	419	351	185
March	869	686	566	684	711	520
April	1015	811	702	770	688	555
May	839	817	547	547	780	418
June	834	457	388	431	477	298
July	742	325	353	517	384	303
August	590	304	213	343	385	212
September	280	104	59	152	122	95
October	90	299	16	69	216	29
Total	6711	4207	3014	4639	4358	2674

This table is very interesting as it indicates the relative efficiency of the two rations. It will be noticed, upon a close study of these figures, that the production by the flock receiving the 25 per cent meat scrap ration was 6711 eggs during the pullet year, as contrasted to the 4639 produced by the flock receiving the lower percentage of meat scrap. During the second year of production, the first pen dropped considerably in egg yield, whereas the others dropped only 300 eggs. During the third year, the drop in egg production was less pronounced in the 10 per cent meat scrap pen. From these results, it is seen that evidently a high production during the pullet year resulted in a comparatively decreased production in ensuing years.

Table X indicates the percentage of production for these pens during the third year. While it is essentially like the above table, it is a somewhat more accurate measure of efficiency, as it takes into consideration the mortality in each pen.

Table X.
Percentage Meat Scrap Experiment. Percentage Egg Production.

	Pen No 54			Pen No 55		
	1913	1914	1915	1913	1914	1915
November	13.25	2.4	.57	11.5	4.9	.44
December	18.00	4.2	.00	13.0	6.2	.98
January	26.00	5.5	2 42	20.0	7.2	3.96
February	40.00	20.0	12.50	29.0	29.0	19.43
March	56.00	51.0	48.05	45.0	53.0	49.33
April	70 00	69.0	61.58	53.0	53.0	54.41
May	56.00	67.0	50.65	37 0	55.0	42.14
June	57.00	39.0	35.92	30.0	36 0	32.04
July	50 00	26.0	31.63	35.0	28.0	32.58
August	41.00	25.0	20.20	24.0	28.0	22.79
September	21.00	9.1	6.55	11.0	9.6	11.31
October	6.00	26.0	1.91	5.0	17.0	3.46

Table XI is the financial statement of the two pens.

Table XI. (A).
Percentage Meat Scrap Experiment. Financial Statement.
Pen No. 54.

	Value of Eggs			Cost of Feed			+ Profit or − Loss		
	1913	1914	1915	1913	1914	1915	1913	1914	1915
November	$8.62	$1.49	$ .54	$5.31	$3 68	$3.26	+ 3.31	− 2.19	− 2.72
December	11.36	2.70	.00	5.50	4.21	3.72	+ 5.86	− 1.51	− 3.72
January	14.31	1.91	1.22	5.85	4.85	3.98	+ 8.44	− 2.94	− 2.76
February	18.66	9 02	4.54	5.61	4.13	3.91	+13.05	+ 4.89	+ .63
March	23.17	20 58	16.47	5.97	5.20	4.14	+17.20	+15.36	+12.33
April	22 11	22.78	18.11	6.88	5.72	4.35	+15.23	+17.06	+13.76
May	19.57	18.38	14.53	6.73	6.04	4.29	+12.84	+12.34	+10.24
June	20.85	11.04	10.01	5.98	5 22	3.73	+14.87	+ 5.82	+ 6 28
July	21.02	8.93	9.11	4.90	5.52	3 80	+16.12	+ 3.41	+ 5.31
August	18.58	9.62	6.20	4.43	5.21	3.80	+14.15	+ 4.41	+ 2.40
September	10.96	4.33	2.22	4.32	4.19	3 75	+ 6.64	+ .14	− 1.53
October	3.90	10.45	.72	3.73	3.88	3.37	+ .17	+ 6.57	− 2.65
Total	$193.11	$121.23	$83.67	$65.21	$57.85	$46.10	+127.88	+63.36	+37.57

Table XI. (B).
Percentage Meat Scrap Experiment. Financial Statement.
Pen No. 55.

	Value of Eggs			Cost of Feed			+ Profit or − Loss		
	1913	1914	1913	1913	1914	1915	1913	1914	1915
November	$7.49	$3.14	$.24	$4.76	$3.96	$3.60	+ 2.73	− .82	− 3.36
December	8.60	3.73	.53	5.12	4.76	4.25	+ 3.48	− 1.03	− 3.72
January	11.16	2.48	1.75	5.48	5.60	4.10	+ 5.69	− 3.12	− 2.35
February	13.96	12.77	6.31	5.05	4.93	3.25	+ 8.91	+ 7.84	− 3.06
March	18.24	21.33	15.13	5.80	5.45	3.87	+12.44	+19.88	+11.26
April	18.60	16.62	14.32	5.62	5.52	3.85	+12.98	+11.10	+10.47
May	12.76	16.65	10.45	5.54	6.28	4.05	+ 7.22	+10.37	+ 6.40
June	10.77	11.34	7.69	4.80	5.64	3.16	+ 5.97	+ 5.70	+ 4.53
July	14.64	10 56	7.82	5.27	5.64	3.74	+ 9.37	+ 4.92	+ 4.08
August	10.86	12.19	6.16	4.59	5.15	3.55	+ 6.27	+ 7.04	+ 2.61
September	5.95	5.08	3.40	4.35	4.05	3.53	+ 1.60	+ 1.03	− .13
October	2.99	7.56	1.31	4.04	4.00	3.43	− 1.05	+ 3.56	− 2.12
Total	$136.02	$123.45	$75.11	$60.42	$60.98	$44.38	+75.61	+66.47	+24.61

The total profit derived from the egg production of these two pens for the three years was $228.91 for the pen receiving 25 per cent meat scrap, as against $166.69 in the other pen.

As this experiment has been carefully carried on for three full laying years, it is deemed possible to draw the following conclusions. It is entirely possible that these results might be somewhat different, if larger flocks were used and other breeds, but as these flocks were operated under average normal conditions, the results obtained will undoubtedly hold in the great majority of cases.

1. The higher percentage of meat scrap in the dry mash was justified, at least during the pullet year, as the profit above feed was $127.88 as against $75.61 in the pen receiving the low percentage of meat scrap.
2. The first year of egg production in the first mentioned pen was followed by a comparatively low production, whereas, the production in the pen which had not been forced during the pullet year was just slightly decreased. The same results seemed to show during the third year, so that the general conclusion is that high production during the pullet year is apt to be followed by decreased production in future years.
3. The mortality was practically uniform in each pen, the birds in both pens remaining in good condition in general throughout the period.
4. The hatchability in each pen was practically uniform.
5. The size and weight of eggs in each pen were not noticeably different.
6. Under systems of management where birds are kept for two laying years only, a higher percentage of meat scrap can undoubtedly be advised, as the increased production during the first year will more than balance the difference during the second year.
7. No general bad effects were noticed from the use of 25 per cent meat scrap in the dry mash.

Shell Color.

One of the principle factors in the successful marketing of table eggs has long been recognized to be uniformity in shell color. The consumer buying from either a retail producer or from the stores is coming more and more to demand eggs of a uniform standard color. Consumers, as a general rule, are willing to pay a higher price, if the product secured is of uniform quality and color. A good example of the attitude taken in regard to shell color is found in the great city of New York, which market demands white-shelled eggs. The daily quotations published from that city indicate a decided preference for the white-shelled eggs. Shipments of mixed colored eggs do not command the top market prices. In some of the New England cities, notably Boston, the popular demand is for the brown-shelled eggs, such eggs receiving the premium over white-shelled eggs. Whatever the color demanded by the market in any locality may be, the best trade will demand uniformity in that color.

Within the last few years, since the consumption of eggs has so greatly increased, the fact has been observed over and over again that there is considerable variation in shade of color among birds producing brown-shelled eggs, and even among the producers of entirely white-shelled eggs. For example, in the Single Comb White Leghorn breed, that breed which caters so tremendously to New York markets, there have been found hundreds of fowls which produce tinted eggs, that is, white-shelled eggs not of pure color, but inclined toward a yellow or pink tint. The prevalence of this tintedness among white eggs has come to necessitate careful grading and selection by Leghorn breeders. The same careful selection has even heen more necessary in cases of brown-shelled egg layers.

The cause of variations in shade and shell color have been investigated very little during the past years. Factors influencing or affecting the degree of color in egg shells have been little understood. Hints have been suggested that such colors were due, perhaps, to food stuffs or methods of feeding, age and condition of the bird, season and other factors. It has also been thought by some that this characteristic was inherited from generation to generation, but scarcely any definite data has been collected which would prove or disprove the importance of heredity in the determination of shell color. In order to start investigations along this important line of work with the view, not only to discover the scientific basis of such variations, as well as their occurrence, but also to determine practical facts that will help egg farmers to solve the marketing problem in a more efficient manner, several detailed experiments have been started during the past year.

Good individual females from Barred Plymouth Rocks, Rhode Island Reds, Light Brahma, and Single Comb White Leghorn breeds have been carefully and systematically trap nested. Over one hundred and fifty Barred Plymouth Rocks are being trap nested in this work as well as over one hundred and fifty White Leghorns, and from twenty-five to seventy-five each of the other breeds. Each egg has been graded according to a standard of color made especially for this work, which includes all the definite shades found in eggs of these breeds. Particularly careful attention is being paid to the grading of white-shelled eggs in order to determine the degrees of tintedness in-so-far as is possible. It has been considered very necessary to obtain a large amount of data on the natural, normal variations in shell color in these individuals. Striking results have already been obtained, among which were found records of birds which very widely in color of shell, and others that showed marked uniformity in the same respect. As the accumulation of this data takes place, analyses will be made in an attempt to find any environmental causes which may have affected the shell color. During the next breeding season numerous matings will be made in an attempt to investigate the behavior in heredity of this characteristic. This work, which has just been under way for a few months, promises to be an extremely interesting and important project.

Egg Preservation.

Many housewives, as well as egg producers, desire at seasons of the year when high quality eggs can be obtained at comparatively cheap prices, tu preserve such eggs for use during the winter months when the market value of fresh eggs is extremely high. Several methods of preservation have been used in the past. Many people have tried simply storing eggs in large baskets or boxes in cool cellars and even in refrigerator rooms. The great objection to systems of this kind has been that the access of air to the surface of the eggs has caused gradual, but continuous evaporation of water from the eggs, with the result that the air cell has been very much enlarged and the nature of the contents of the egg materially changed. Some people have attempted to store eggs by packing them away in chopped straw, oats, and other similar materials. This system has somewhat modified the one first mentioned, and caused less evaporation to take place, but has not been entirely satisfactory in that evaporation was still possible, and bacterial growth in and about the egg was active.

In order to preserve eggs in as nearly natural condition as possible, two important things must be borne in mind. In the first place, the eggs must be kept in a cool place in order to decrease evaporation and check bacterial and mold growth. In the second place, it is necessary to keep the eggs away from the air in order, not only to check evaporation, but also to prevent the absorption of undesirable odors by the eggs. Aside from these two qualities, a preservative should have little or no odor of its own, should be easy to prepare and apply, and cheap in cost.

Two distinct forms of egg preservatives have been used during the past year in experiments that are still under observation. The basis of the first is sodium silicate, or more commonly known as water-glass. One jar of one hundred eggs was put down on March tenth in a normal 10 per cent liquid silicate solution. Another jar of one hundred eggs was put down in a similar solution, using another commercial brand of silicate. A third jar containing one hundred eggs was put down in a strong alkaline solution. A fourth jar containing one hundred eggs was put down in Goudy's Egg Preserver, (commercial), one pound to two pounds of water. A sixth jar of one hundred eggs was put down in the same material, one part to sixteen parts by weight. In September, 1915, a careful inspection was made of each of the above mentioned jars. Eggs were broken and examined as to consistency, color, appearance, odor, and taste. No perceptible loss of weight had occurred in any of the samples. Several disinterested parties failed to detect any difference in taste of the boiled eggs from each sample, nor any variation from the normal egg, other than the pronounced settling of the yolk in some of the jars. The eggs in the jars containing the alkaline solution, as a whole, were not in as satisfactory condition as were the eggs in other jars.

The second form of preservative used was in the form of an ointment, known as Fleming's Egg Preserver. Several dozen eggs were carefully annointed with this material, wrapped in papers, and stored away in cartons and crates according to the directions of the manufacturer. At the close of the fourth months' test, all eggs were in splendid condition of preservation.

Both of these sets of jars and crates will be examined from time to time throughout the coming year in an attempt to find out the length of time over which these preservatives will be efficient.

February Hatching.

It has been the practice among many New Jersey poultrymen, especially the general farmers, to do their hatching the last week in March and during the month of April, due, perhaps, to the fact that the February hatched pullets usually go in to the molt during the early part of the winter, and, therefore, have not been considered profitable. Also most of the general farmers do their hatching and brooding with hens, which would make it practically impossible for them to hatch earlier in the season.

The possibilities in February hatching for the poultrymen, especially the egg farmer, should be of great interest. He could hatch at least one-third of his pullets for his early layers, or sell them at a good profit. It is possible at this time of the year for him to give them better care than he would be able to give later in the season.

During the past year, experiments have been carried on with Single Comb White Leghorns that were hatched February 7, 1915. The eggs, the product of strong vigorous stock, were bought of a reliable poultryman and placed in the incubators about the middle of January. Special care was given to the machines, due to the prevailing cold weather at this time of the year.

At the close of the hatch, the chicks were moved to the brooders when about forty-eight hours old. Here they received grit and water. The following day they were fed rolled oats. Beginning with the third day commercial chick feed was fed up until the fifth week; wheat bran was fed the first week, after which they received the regular chick mash. At the end of the fifth week, the regular New Jersey growing ration was fed in place of the chick feed. Sour milk and water were before them all the time.

When the chicks were eight weeks old, they were moved from the brooder house to the ranges in flocks of fifty pullets each, the cockerels being separated from the flocks and sold as broilers.

About the third week in July, one hundred and ninety pullets were moved into the New Jersey Multiple Open Front Laying House supplied with plenty of sunshine and fresh air. They were fed the regular New Jersey grain rations and dry mash, the grain being scattered on the floor in a deep litter to make the birds exercise. Sour milk was fed during the whole year in practically unlimited amounts, the pans being kept full at all times. The care and management of these birds was the same as might be given on a commercial poultry farm. The following table (XII) gives a general summary of the results obtained. The cost of food-stuffs was the actual price paid and the eggs were valued according to the daily market quotations from New York City.

Table XII.
February Hatched Pullets.
Pens No. 20-21

MONTH	Number of eggs produced	Average price of eggs	Value of eggs	Percentage production	Food consumed; pounds 1 Dry mash	2 Morning grain	3 Evening grain	Total cost of food	+ Profit or − loss.
Aug. 1914	1,245	38c	$39.42	21.1	213	310	620	$17.43	+ $21.99
Sept.	1,756	39c	57.07	29.6	226	300	600	17.23	+ 39.84
Oct.	1,934	49 ½c	79.78	32.9	158	266	532	14.51	+ 65.27
Nov.	593	59c	29.11	1.1	107	248	480	15.58	+ 13.53
Dec.	132	58c	6.38	0.2	134	248	496	16.75	− 10.37
Jan. 1915	847	46c	32.47	1.4	229	300	600	24.51	+ 7.96
Feb.	2,155	35c	62.85	40.	231	280	560	20.99	+ 41.86
March	4,014	25c	83.62	68.	393	310	620	27.50	+ 56.14
April	3,984	24c	79.68	68.	342	300	600	27.84	+ 51.83
May	3,619	24c	72.48	61.1	315	310	620	28.50	+ 43.98
June	2,972	26c	64.48	51.4	222	300	600	24.75	+ 39.78
July	3,029	28c	71.96	52.0	213	310	620	21.94	+ 50.02
Aug.	2,080	34c	58.93	35.5	164	310	620	21.44	+ 37.49
Sept.	1,120	40 ½c	37.80	19.6	120	300	600	19.85	+ 18.95
Oct.	324	54c	15.66	5.5	115	310	620	19.57	− 3.91
Total	29,804	....	$791.69	....	3,182	4,402	8,788	$318.39	+ $483.30

Plate VII graphically shows the results obtained with these pullets. Advantages of February hatching.

1. The farmer can give his chicks better care, as this work will come before the rush of the spring season.
2. Cockerels will sell at a higher price than broilers, for the height of the broiler market is early in the spring.
3. Chicks will make a good growth before hot weather comes.
4. Cockerels for breeders reach big, strong development early in the season.
5. The pullets will produce a large number of eggs when the older hens are in the molt and the prices are high.
6. The high production during August, September and October more than counter-balances the falling off in egg production during November and December.
7. The females reach full maturity long before winter sets in with its cold days.
8. Pullets may be used the following year as breeders.
9. A part of each year's flock can very economically be February hatched.

Slaughter Test.

The production of poultry as a source of meat for human consumption has been, and always will be, an important part of the poultry industry. The recently developed egg farms in many sections of our State have appreciated the necessity of putting a large number of surplus cockerels and culled birds on the market for table purposes each year. The main part of such products have been broilers and roasters. On many general farms, as well as on a number of specialized farms, special attention has been given to the production of broilers, roasting fowls, and capons. However, in spite of this wide-spread interest in the production of poultry meats, comparatively little investigational work has been done with a view toward determining the most economical and efficient rations to be used in such production, the most convenient

PLATE VII.

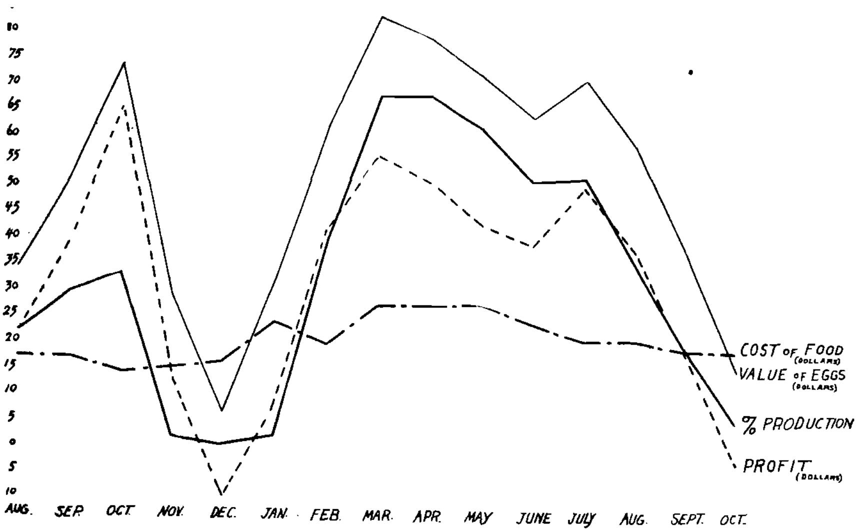


FIG. 7.—Curves showing results obtained in experiment on February hatched pullets.

PLATE VIII.

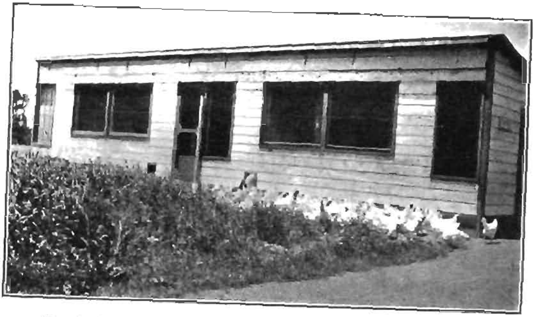


FIG. 8.—February hatched pullets in front of laying house.

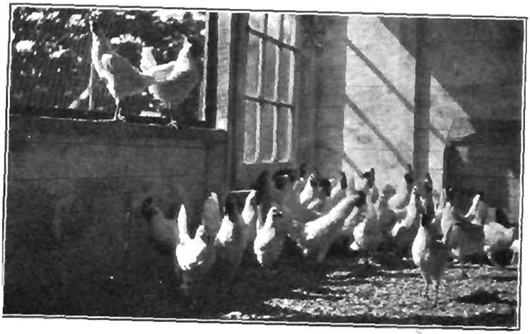


FIG. 9.—Single comb white Leghorn cockerels used in meat production experiment.

and suitable systems of management necessary for the handling of such birds, and the factors which limit or determine successful meat production. The experiment which is briefly outlined here has been started during the past year, particularly for the purpose of obtaining valuable and often desired data with regard to the quality and quantity of flesh produced on birds of different standard breeds under the same conditions of feeding and management. It is thought that a knowledge of the distribution of flesh and fat on the carcasses of birds of different breeds, as well as a knowledge of the comparative value of such flesh and cost of production, would be a valuable aid in future fattening work.

Fifty normal, active vigorous cockerels of each of the breeds, Barred Plymouth Rock, Light Brahma and Single Comb White Leghorn were selected early in the summer, and each flock placed in comfortable, convenient, and sanitary quarters, and furnished with suitable yards in which green food was constantly growing. All birds in this test have been carefully weighed weekly up to the time of writing, November 1st. During the winter all birds will be finished on fattening rations and carefully slaughtered. At this writing it is not possible to give any figures or draw any conclusions, but only to state the nature of the work and its importance in poultry production.

New Experimental Projects.

With the additional equipment which is anticipated for the coming year, several new lines of experimental work are to be made possible. Some of the projects reported in brief above are to be continued, particularly those dealing with variations in shell color, meat production, milk feeding, and percentage of meat scrap feeding. Several well known commercial egg preservatives are to be added to the list of those already under observation.

During the past few months, numerous requests have been made of the Station authorities to test, in a practical manner, some of the commercial disinfectants that are being sold to the poultrymen of our State. There are a large number of these that are of splendid value in sanitary work on poultry buildings. A dozen or more of these different commercial disinfectants are to be tried thoroughly on the houses which are being erected at the present on the new poultry farm. Most of these houses are the old ones moved from the other plant, so that they are in need of careful overhauling and sanitary cleaning at this particular time. An attempt will be made to determine the efficiency of these various disinfectants, as well as the economical value which they may have in the operations concerned with poultry keeping. Closely allied to this project of disinfectant testing will be an extensive study of parasites which are commonly found, either on or within the body of domestic fowls. The many forms of body lice, red mites, and other common external parasites will be studied, an attempt being made to classify them both in a scientific way and with regard to their injurious effects and extermination. This offers a large field for investigational work in a line that is extremely important in the development and maintenance of the health of poultry flocks.

The slaughter test work with the Light Brahma, Barred Plymouth Rock, and Single Comb White Leghorn cockerels will be finished, as outlined in the above treatise. This work will be greatly enlarged during the coming year, partly because of the fact that in order for experimental work to become conclusive, several checks should be run on all projects. Then, it is also desired to make the same type of slaughter test on capons in those same breeds, as well as certain others that are to be used including the White Plymouth Rocks and the White Cornish. Probably considerable cross-breeding will also be carried out in an effort to obtain most efficient birds for capon and the roaster production. This line of work will be intensely practical in character, and upon a large enough scale to warrant its results taken as conclusive under such conditions as will be in force at this place and time. In addition to the cross breeding, which will be accomplished primarily for the purpose of capon production, several extensive experiments are being planned which will deal with the inheritance of color pigment in certain crosses. Several years ago, Black Langshan and White Leghorn fowls were crossed to form the foundation work for this inheritance study. Due to the necessary shortage of space in the moving of the poultry buildings during the past two years, this work has been temporarily brought to standstill. This work will be a continuation or re-checking of the work already done, as well as the launching out into wider fields. This is a line of work, which will, from time to time, be acknowledged as one of ever increasing importance in poultry management. Breeding is one of the powerful factors in the economical and successful production of fowls for any purpose. Not only will this work give us valuable information as to the inheritance of color pigments, but undoubtedly it will further explain certain breeding laws, which, at present, are not well enough understood. There are several branches of science which go hand in hand with the practical side of poultry husbandry, and one of these is histology, that science which treats of the form and function of the various living organisms. During the coming year, considerable detailed work has been planned on the general subject of the shell glands, those parts of the oviduct which secrete the shell materials used in the form of eggs. The end in view will be to determine whether or not any variation in egg shell color may be due to difference in the glands secreting the shell materials. Altogether, the work planned for the coming year should be of such nature as to have scientific value, as well as highly important practical bearing.

Disease Observations.

During the past year over two hundred disease specimens have been brought to the attention of this Department for diagnosis. They have come from practically every section of the State and have been distributed fairly regularly throughout the season, with a possible exception

PLATE IX.

FIG. 10.—Light Brahma cockerels used in meat production experiment.

FIG. 11.—Barred Plymouth Rock cockerels used in meat production experiment.

that during the hot summer months the number of examinations made was greater than at other times. In order for this advisory work to be satisfactory, it is absolutely assential that any poultryman in the State taking advantage of this opportunity should follow closely the regulations as set forth on the following card, a number of copies of which have been sent to every poultry association in the State.

New Jersey Agricultural Experiment Stations

NEW BRUNSWICK, N. J.

Poultry diseases are accountable for the greater part of the serious losses that are suffered each year in poultry raising areas. Many of the losses could have been averted, if a careful diagnosis of the diseased birds had been made. If a disease is identified, especially in the earlier stages, steps can often be taken toward preventing the spread of the infection, or correcting the causative conditions, if it is not a contagious trouble. In order to be of service to the poultry raisers of NEW JERSEY in this respect the POULTRY HUSBANDRY DEPARTMENT OF THE NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS will make a careful examination of sick or dead birds sent the department, as per directions below. In so far as possible letters will be sent stating the probable causes, symptoms, treatment and prevention of the trouble in each case. This will be done free of charge, except that express charges must be paid by parties sending birds for diagnosis. More satisfactory results will often be obtained in cases where it is possible to send in the sick birds. In cases where birds have died and it is desired to send in the bodies for examination, care should be taken to send them in as good a condition as possible. In making shipment of either dead or live birds, please follow the suggestions below:

1. Send all boxes by PREPAID EXPRESS.
2. Pack dead birds in strong boxes WHICH WILL NOT BE BROKEN IN TRANSIT.
3. In warm weather pack dead birds IN ICE, to prevent decay.
4. Send dead birds as SOON AFTER DEATH as possible.
5. Send dead birds at the FIRST OF THE WEEK, or so that they will reach this office BEFORE SATURDAY.
6. Accompany all shipments with a letter answering the following questions. (VERY IMPORTANT).
   A. How long was the bird, or birds, sick?
   B. How many have been similarly affected?
   C. How did they act?
   D. Did you notice any signs of diarrhea?
   E. Did they lose their appetite?
   F. What was the color of the comb and wattles before death?
   G. How have you been feeding the birds?
   H. In what kind of quarters have they been housed?
7. Address all letters to W. C. THOMPSON, POULTRY DEPT., COLLEGE FARM, NEW BRUNSWICK, N. J.

As a result of studying the reports of these disease diagnoses, several important facts have appeared. During the hot summer months a great many cases of what has been termed "summer poisoning" were brought under the observations of the Department. In the great majority of cases, this trouble appeared to be some form of ptomaine poisoning, the result of birds eating decayed flesh of some kind. On many ranges where tall plants or weeds were growing, dead carcasses were found which had not been properly covered up or destroyed. The extremely hot weather brought about the quick decay of such carcasses. Birds roaming over ranges of this kind found carcasses and naturally picked at them with the result that their digestive systems were completely upset, some cases even resulting fatally because of the amount of poison taken into their bodies. The symptoms in all these cases were practically the same. The birds were more or less prostrated and helpless. The wings were allowed to drop on the ground, and were fluttered more or less as the bird was approached. The legs became more or less completely paralyzed, and in most cases the muscles of the necks were uncontrolable. Death resulted on many farms in a few hours. It was thought that the degree of fatality probably depended upon the amount and source of poison which was obtained. The only treatment which was found practical in case of "summer poisoning" was a dose of epsom salts given to each individual, one-half teaspoonful dissolved in a little warm water being poured down the throat. This tended to cleanse the intestinal tract and, when the birds were not too far advanced in the trouble, would remove the cause before the fatal stage had been reached. After visiting several places on which outbreaks of this kind were reported, and after diagnosing several other cases by letter, the following suggestions are made:

1. During the hot summer months, watch the ranges very carefully in order to remove any dead birds that may accumulate.
2. Go over the ranges in order to remove any other possible source of decayed flesh, such as cats, dogs, etc. This source was particularly serious in suburban districts.
3. When birds are found showing the above symptoms, remove them at once from the flock and institute an immediate search for the possible cause of the trouble.
4. Give epsom salts to those cases for which there appears to be some hope of recovery.
5. Burn all dead birds and those which have been killed being thought too far advanced for possible recovery.
6. Close, careful observation of the birds on range during the summer ought to prevent troubles of this kind.

Throughout the spring and fall seasons, many cases of chicken-pox, roup, and canker were reported. The wet summer probably caused the prevalence of so much trouble from these diseases. Careful sanitation, together with a local application of mild disinfectants to diseased parts have been the general suggestions given. Chicken-pox appears to be one of the most important diseases which New Jersey poultrymen have to combat, as it appears in flocks of all ages and in all sections.

Among the scattering diseases which have claimed several victims each are peritonitis, tuberculosis, aspergillosis, gout, leg weakness, white diarrhea, and many cases of lice and mite infestations.

PLATE X.

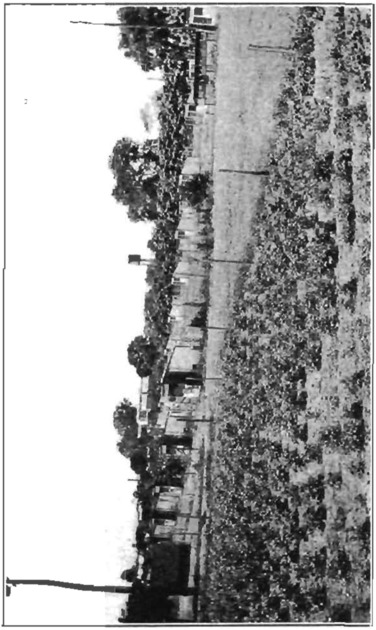


FIG. 12.—Breed testing plots where twenty different varieties of standard bred poultry are being studied.

IV.

EDUCATIONAL ACTIVITIES.

It is proper, at this time, to mention briefly the work of the Department along educational lines, for these activities are very intimately connected with experimental problems. These activities are of two distinct kinds, first, the teaching work at the college, and second, the extension activities about the State. During the last few years the poultry instruction given in the long and short courses at the College have been materially increased with very successful results. This year four senior students are specializing in Poultry Husbandry for the degree of B. S. in Agriculture, and thirty-two students are enrolled in the winter short course which has just convened. The cooperation between the research and instruction staff make it possible to materially benefit each line, for the students in developing thesis and research problems can be of much benefit to the research department, while the presence of experimental work cannot but make the poultry instruction much more complete.

Twelve numbers of the regular "Hints to Poultrymen" have been issued. The demand for these is far greater than the supply, and it is believed that this is the most efficient of all publication activities which the Department attempts. These publications are sent to the forty odd poultry associations in the State in limited numbers, and are then distributed individually to the members. Over three thousand copies have been printed of each number, and in many cases it has been necessary to issue reprints. The following is a list of 'Hints to Poultrymen" issued during the fiscal year.

October	Sanitation on the Poultry Plant.	W. C. Thompson
November	Caring for the Poultry Flock.	H. R. Lewis.
December	Sprouted Oats as a Winter Succulence.	C. E. Brett.
January	The Business End of Poultry Keeping.	H. R. Lewis.
February	The N. J. State Poultry Association.	H. R. Lewis.
March	The Setting Hen.	H. R. Lewis
April	Boys' and Girls' Poultry Contest.	V. G. Aubry
May	Mangel Beets for Poultry.	H. R. Lewis.
June	Summer Troubles in the Poultry Flock.	W. C. Thompson
July	Market Poultry.	V. G. Aubry
August	New Jersey Double Pen Breeding House.	C. E. Brett
September	The Fall Management of Pullets.	V. G. Aubry

The following is a list of subjects which will be presented in the form of "Hints to Poultrymen" during the year 1915-1916.

October	Keeping the Poultry Flock Healthy.	H. R. Lewis
November	Cooperative Buying of Poultry Feeds.	V. G. Aubry
December	Litters for the Poultry House.	W. C. Thompson
January	The February Hatched Pullets.	E. H. Wene
February	Artificial Incubation.	R. F. Irvin
March	Water-glass Preservation of Eggs.	H. R. Lewis
April	Producing High Quality Market Eggs.	V. G. Aubry
May	Disposing of Surplus Cockerels.	W. C. Thompson

June	*How to Acquire a Complete Poultry Farm.*	R. F. Irvin
July	Green Crops for the Poultry Yard.	V. G. Aubry
August	Standard Unit Poultry Houses.	H. R. Lewis
September	Balance in the Poultry Flocks.	W. C. Thompson

The Department has ready for publication a complete research bulletin on "Poultry Houses." This is one of a series of five which are being prepared covering the construction and equipment of all kinds of poultry houses. The first is one dealing with laying houses.

The Department has been represented at a number of conventions during the past year. Our research assistant represented us at the annual convention of the American Association of Instructors and Investigators in Poultry Husbandry which was held at the Connecticut Agricultural College, Storrs, Connecticut, in August, 1915. At this meeting papers were read by the different members of the Station as follows: "The Organization and Administration of a College and Experimental Poultry Department," by H. R. Lewis, a paper on "Sanitary Efficiency," by W. C. Thompson, and a paper on "Extension Activities in New Jersey," by the Extension Specialist, V. G. Aubry. Members of the staff attended the two large poultry shows in New York City at which time complete educational programs were presented, the meeting being jointly held by Connecticut, New York and New Jersey. It is believed that these meetings were eminently successful and were responsible for making known our work in a more general and complete way. Many papers have been prepared for publication by the different members of the staff, all of which go to disseminate more completely the results of the experimental activities which are being carried on.

The correspondence of the Department during the past year was considerably in excess of six thousand letters. Of these, about half were of an extension nature, while the remaining dealt with matters of instruction and administration. This figure does not include the letters written by the Extension Specialist, which would bring the total to 8500. The correspondence was handled by the various members of the Department according to their particular specialty. In answering letters, the "Hints to Poultrymen" and circulars issued by the Station were used freely, thus making possible a more complete answer and the saving of much time.

Conclusion.

In conclusion, we are gratified to report continued growth and development and the feeling that our work is being used and appreciated by the poultrymen of New Jersey, as is emphasized by the increase in demands for time and thought, and as measured by increased appropriations which make possible greater effort.

With our new poultry farm nearing completion and a larger staff working in cooperation, we are looking forward to a very prosperous year.

REPORT OF THE DEPARTMENT OF DAIRY HUSBANDRY

Department of Dairy Husbandry

*Alfred S. Cook, *Dairy Husbandman.*

†Lloyd S. Riford, A.M., *Assistant Dairy Husbandman.*

*Resigned September 1, 1915. Succeeded by William J. Carson, B.S.A., who assumed the position on November 1, 1915.

†Appointed September 1, 1915.

CONTENTS.

Report of the Department of Dairy Husbandry

ALFRED S. COOK.

I.

INTRODUCTORY.

The work of the Dairy Department during the last fiscal year may be outlined as follows:

1. Feeding Experiment.—Cut alfalfa hay fed in a grain mixture as a substitute for purchased grains.
2. Investigational Work.—Continuation of records giving the production and cost of production in the dairy herd, and a study of the cost of raising calves.
3. Cow Testing Associations.—One permanent Cow Testing Association has been organized during the year in addition to two associations which have been reorganized, making a total of three active associations in the State at the present time. Two temporary associations have been organized which will elect officers and begin work as soon as possible.
4. Advanced Registry Work.—The advanced registry work in the State has continued along the lines outlined in previous reports, and careful attention has been paid to the accumulation of records of feed, fed to cows while on these tests.

II.

FEEDING EXPERIMENT.

Cut Alfalfa Hay as a Supplemental Feed for Purchased Grains.

Alfalfa hay is one of the most economical sources of food nutrients, and in New Jersey, where this crop can be raised successfully, it is important to feed as much as can be economically handled in the dairy ration. After considerable experimenting, it was found that the maximum amount of alfalfa hay that the average cow in the Station herd would consume, with 35 pounds of corn silage, was between 10 and 12 pounds. If alfalfa hay, when cut and mixed with other grains, could he successfully used to supplement purchased grains, the cost of feed could be reduced considerahly. The object of this experiment may be stated as follows:

1. To determine the feeding value of cut alfalfa hay when fed in a grain mixture, as compared with purchased grains furnishing the same amount of nutrients.
2. To determine whether cows would consume alfalfa hay that had been cut and mixed with a grain mixture when they were receiving all that would be eaten in the form of alfalfa hay.
3. To determine the palatibility of cut alfalfa hay fed in a grain mixture with a small amount of molasses, and the effect of this mixture upon the physical condition of the cow.

PLAN.—Twelve cows in the early stages of their lactation periods were selected for this experiment. They were divided into two groups in such a way that the average milk production and average weight per cow were practically the same for both groups. In a ten-day period immediately preceding the beginning of this experiment, the average weight of Group 1 was 912 pounds and for Group 2, it was 934 pounds, while the average milk production per cow for the same period was 39.4 pounds for Group 1 and 40 pounds for Group 2. The experiment covered 100 days, and the arrangement of periods and rations fed in each group are shown in Table 1.

Table 1.

Arrangement of Groups.

	First 10 day preliminary period	First 30 day experimental period	Second 10 day preliminary period	Second 30 day experimental period
Home-Grown Ration	Group 1	Group 1	Group 2	Group 2
Purchased Ration	Group 2	Group 2	Group 1	Group 1

Space will not permit the detailed figures on daily rations fed and milk produced. However, the summaries, dealiug with the production and the feed which was fed during the experimental periods, are given. A preliminary period of 10 days preceded the first experimental period in order that both groups might become accustomed to the rations. Another preliminary period was allowed at the close of the first experimental period for the cows to become accustomed to the change of ration which was made after the first experimental period.

RATIONS FED.—The cut alfalfa used in the Home-Grown ration was well cured alfalfa hay that had been cut with an ensilage cutter. It would have been possible to make a better mechanical mixture if this hay had been ground, but because very few dairymen can afford to grind hay for such a purpose, it was thought best to use hay that had been cut with an ensilage cutter. The average daily rations fed, together with the nutrients contained in each ration, are:

Home-Grown Ration.

	No of Lbs.	Lbs. dry matter	Lbs. protein	Lbs. carbo-hydrates	Lbs. fat
Alfalfa Hay	10	9.36	1.17	4.09	.100
Ensilage	34.8	8.18	.487	4.94	.243
Corn and Cob Meal	5.52	4.68	.242	3.31	.160
Cut Alfalfa	4.14	3.87	.484	1.69	.041
Molasses	1.38	1.02	.019	.816	....
Soybean Meal	.684	.603	.199	.159	.099
	......	27.713	2.601	15.005	.643

Purchased Ration.

Alfalfa Hay	10	9.36	1.17	4.09	.100
Ensilage	35	9.24	.49	4.97	.245
Corn Meal	5.85	4.97	.392	3.76	.204
Beet Pulp	1.93	1.76	.079	1.25	....
Gluten Feed	.963	.874	.205	.507	.027
Wheat Bran	.963	.848	.104	.404	.024
Cotton Seed Meal	.477	.443	.179	.102	.045
	....	27.495	2.619	15.083	.645

The Home-Grown ration including cut alfalfa hay and molasses contained practically the same amount of dry matter as the Purchased ration, and was practically the same in digestible nutrients. This Home-Grown ration was mixed by diluting the molasses in about five times its weight of water and dampening the whole mixture with this solution. This made a bulky ration and one which was very palatable. All cows on the experiment with one exception, consumed the total amount of feed offered. This was on the Home-Grown ration. One cow on this ration was temporarily off feed, and during that time refused to eat all the silage offered. This made the average silage per day 34.8 pounds in the Home-Grown ration instead of 35.

In order to get an idea as to the camparative cost of feed when figured at market value and at the cost of raising, Table 2 gives the total cost of the experimental rations when figured on this basis. The values placed upon the different feeds given later in this report are based on the cost of purchasing, and the cost of raising on the College Farm.

Table 2.

Total Feed Fed to All Cows, and Cost of Feed Based on Market Values and Cost of Raising.

NAME OF FEED	HOME-GROWN RATION			PURCHASED RATION		
	Lbs. feed	Cost at market value	Cost of raising	Lbs. feed	Cost at market value	Cost of raising
Alfalfa Hay	3600	$36.00	$14.40	3600	$36.00	$14.40
Ensilage	12530	31.33	25.06	12600	31.50	25.20
Corn and Cob Meal	1989	19.90	19.90	....	....	....
Cut Alfalfa	1492	14.92	5.97	....	....	....
Molasses	498	4.99	3.99	....	....	....
Soybean meal	246	3.69	4.19	....	....	....
Corn meal	....	....	....	2102	31.54	31.54
Beet Pulp	....	....	....	693	9.02	9.02
Gluten feed	....	....	....	346	5.20	5.20
Wheat Bran	....	....	....	346	4.16	4.16
Cottonseed Meal	....	....	....	172	2.75	2.75
Totals		$110.83	$73.51		$120.17	$92.27

WEIGHTS.—The average weight per cow fed on the Home-Grown ration as compared with that per cow on the Purchased ration follows:

No. of Cow	*Home-Grown Ration* lbs.	*Purchased Ration* lbs.
1	1199	1200
2	994	1089
34	1238	1268
69	1008	1053
58	1212	1291
52	955	992
41	1166	1189
68	1107	1055
64	1148	1116
61	1373	1365
42	1143	1066
8	957	971
Total weight of Group 1 and 2	13500	13655
Average weight of Group 1 and 2	1125	1138

Each cow was weighed two days in succession every 10 days, and the average of these two weights was used as the average weight of that cow during the 10 days. Care was taken to weigh the cows at the same hour of the day in order to reduce to a minimum the error which might be due to feed and water. There was very little difference between the average weight per cow fed on the Home-Grown ration and that per cow on the Purchased ration. The greatest variation in the case of a single cow was 96 pounds, while the average variation per cow was 13 pounds.

A summary of the milk and butter-fat production on the different rations is given in Table 3. The total average production of both groups on the Home-Grown ration was 28.1 pounds of milk a day, as compared to 25.4 pounds on the Purchased ration. It will be seen that there was also a slight increase in the amount of butter-fat.

Table 3.
Summary of Milk and Butter-Fat Production.

GROUP 1	HOME-GROWN RATION			PURCHASED RATION		
	Milk Lbs.	Fat Per cent.	Fat Lbs.	Milk Lbs.	Fat Per cent.	Fat Lbs.
Cow No. 1	1095.3	3.7	40.02	888.3	3.3	30.02
Cow No. 2	1002.6	3.4	28.73	814.5	2.9	23.74
Cow No. 34	1163.9	3.0	34.97	1149.2	3.2	36.55
Cow No. 69	1007.8	3.7	38.16	872.6	4.2	37.40
Cow No. 58	562.4	3.8	22.02	279.8	4.4	12.64
Cow No. 52	791.1	3.7	29.60	726.8	4.7	34.05
Totals	5623.1	3.12	193.50	4731 2	3.68	174.30
GROUP 2						
Cow No. 41	847.2	3.4	28.91	1001.9	2.7	27.35
Cow No. 68	778.0	3.6	21.45	1035.3	3.2	32.79
Cow No. 64	884.6	3.7	32.76	1072.6	3.3	36.54
Cow No. 61	644.3	3.0	19.35	750.7	3.3	22.81
Cow No. 42	708.7	3.9	29.25	746.3	4.0	30.23
Cow No. 8	662.7	3.8	25.38	787.7	3.1	24.83
	4525.5	3.46	157.10	5394.5	3.23	174.55
Totals Group 1 and 2	10148.6	3.82	350.60	10125.7	3.44	348.85
Daily Av. per cow	28.12	3.82	.973	25.41	3.44	.969

Cost of Production.

In order to give an idea of the importance of cut alfalfa hay as a supplemental feed for concentrates, from the standpoint of economy, the cost of production is figured on the basis of market prices for feeds included in the Purchased ration, and the actual cost of raising feeds included in the Home-Grown ration that are raised on the farm. This information is given in Table 4. The cost of production is also estimated when the cost of the feeds included in the Home-Grown ration is figured at market values. The soybeans used in this experiment were small and split beans that could not be used for seed, a fact which accounts for the low market value. The values per ton given these feeds are as follows:

	Market Values	*Cost of Raising*
Alfalfa Hay	$20.00	$ 8.00
Ensilage	5.00	4.00
Corn and Cob meal	20.00	....
Cut alfalfa	20.00	8.00
Molasses	20.00	20.00
Soybean meal	30.00	34.00
Corn meal	30.00	....
Beet Pulp	26.00	....
Gluten Feed	30.00	....
Wheat Bran	24.00	....
Cottonseed meal	32.00	....

Table 4.

Yield and Costs of Producing Milk and Butter-Fat for a Period of 60 Days From Cows in the Early Part of Their Lactation Period.

RATIONS	PRODUCTION AND VALUE OF MILK					COSTS TO PRODUCE				
	Number of days	Pounds of milk	Per cent fat	Pounds of butter-fat	Value of milk	Cost of feed	Profit over feed cost	Cost of 1 qt. milk	Cost of 1 lb. fat	Returns for $1.00 expended
Home-Grown	60	10148.6	3.82	350.60	$293.22	$110.83	$182.39	$.023	$.31	$2.64
Purchased	60	10125.7	3.44	348.85	286.57	120.17	166.40	.025	.34	2.38
		HOME-GROWN RATION AT COST OF RAISING								
Home-Grown	60	10148.6	3.82	350.60	$293.22	$ 73.51	$219.71	$.015	$.209	$3.98
Purchased	60	10125.7	3.44	348.85	286.57	120.17	166.40	.025	.34	2.38

Summary.

1. The average weight per cow fed on the Home-Grown ration was 1125 pounds and that per cow on the Purchased ration was 1138 pounds, making a difference of 13 pounds in favor of the Purchased ration.

2. The total production in both Groups 1 and 2 for cows fed on the Home-Grown ration was 10148.6 pounds of milk and 350.6 pounds of butter-fat; and 10125.7 pounds of milk and 348.8 pounds of butter-fat for cows fed on the Purchased ration.

3. Figuring the cost of feeds in the Purchased ration at market value, the cost was $120.17; when figured on the same basis for the Home-Grown ration, the cost was $110.83; and the cost per quart of milk produced was $.025, and $.023 respectively.

4. When feeds in the Home-Grown ration are figured at cost of raising and feeds in the Purchased ration at market prices, the following results were reached: On the Home-Grown ration the cost of feed was $73.51; the profit over feed cost, $219.71; and the cost per quart of milk, $.015. On the Purchased ration the cost of feed was $120.17; profit over feed cost, $166.40; and the cost per quart of milk, $.025. Both rations furnished practically the same amount of nutrients.

5. When the cows were fed all the alfalfa hay they would consume, with 35 pounds of ensilage a day, it was found that 4.14 pounds of cut alfalfa fed with a grain mixture of corn and cob meal, ground soybean meal and molasses proved to be palatable, and the mixture was readily eaten.

III.

THE DAIRY HERD.

During the fiscal year 1914-15 there have been very few changes made in the dairy herd. Several heifers have freshened during the year, but owing to trouble with contagious abortion the production of these heifers has been very low. The average production per cow is slightly larger than last year and of 37 animals milking during the year, 31 have been in the herd twelve months. Several of these cows that were in the herd twelve months would have been disposed of during the year if there had been no trouble with contagious abortion. In order to maintain a certain milk flow several animals, such as number 39 and 65, had been retained in the herd in order to keep up the milk production.

Cost of Feeds.—The total amount of feed fed to the herd and the prices at which feeds are figured are as follows:

HAY AND ENSILAGE.

	Price per ton	*Lbs.*
Alfalfa Hay	$20.00	127,211.00
Oat and Pea Hay	16.00	11,580.00
Ensilage	5.00	356,819.00
		495,610.00

SOILING CROPS.

Green Soybeans	$ 6.00	7,860.00
Green Oats and Peas	4.00	47,855.00
		55,715.00

CONCENTRATES.

	Price per ton	Lbs.
Cut Alfalfa............	$26.00	2,471.50
Peanut Meal............	32.00	3,023.64
Corn and Cob meal......	20.00	30,341.22
Corn meal..............	30.00	13,106.28
Ajax Flakes............	31.00	8,971.84
Gluten	30.00	8,705.94
Bran	24.00	12,591.54
Cottonseed meal	30.00	5,920.44
Molasses	20.00	838.50
Oil meal...............	38.00	1,145.50
Soybean meal...........	30.00	498.31
Beet Pulp..............	26.00	18,973.50
Cocoanut meal..........	26.00	42.10
		106,630.31

Production, Feed Cost, and Profit.

The milk and butter-fat production, value of milk, costs, and profit over feed cost for each individual cow are given in Table 5. This record represents the production of all cows during the fiscal year 1914-15 that were kept in the herd twelve months. Other records given for a period shorter than twelve months represent the actual time that the animal was kept in the herd. These records cover a fiscal year and not a lactation period. The average cost of feed per cow for the year is $100.97 as compared with $95.24 last year. This cost of feed includes all the material eaten by the cows, figured at prices given previously, which are supposed to represent the market value in this community.

In connection with the cost of feed, it should also be remembered that no pasture was available for the animals at any time during the year. This increases the cost of feed considerably. It will be seen that about 60 per cent of the total cost of feed was spent for roughage and that the cost of grain was only $36.79 per cow. This is a comparatively low cost of grain when the fact that the cows were fed grain through the entire year is taken into consideration.

The production of the herd has been disposed of in the form of cream which was standardized to contain 40 per cent butter-fat and sold at a price ranging from $.35 to $.58 a quart. This has been equivalent to about $.05 a quart for milk and the herd is also credited with $.01 a quart for skim-milk, which was disposed of to the Swine and Poultry Departments.

Table 5.

Record of Production, Feed Cost and Profit of Dairy Herd at College Farm.

Number of Cow	Months in test	Pounds milk during testing period	Average test	Pounds butter-fat during testing period	Value of milk	Cost of roughage	Cost of grain	Total cost	Total profit	Returns for $1 00 expended for feed	Feed cost to produce 100 lbs. milk
1	12	9861.3	3.56%	350.47	$281.72	$67 01	$45.74	$112.75	$168.97	$2.49	$1.14
2	12	6877.1	3.17	218.16	192.90	62.33	36.66	98.99	93.91	1.94	1.43
3	12	7804 6	3.24	252.92	222.94	68.12	35.88	104.00	118.94	2.14	1.33
5	12	5786.7	4.47	258.87	165.26	63.41	32.92	96.33	68.93	1.71	1.66
8	12	6857.05	3.51	241.17	195.88	63 89	38.09	101.98	93.90	1.92	1.48
9	12	4426.1	4.82	213.46	126.44	56.59	28.93	85.52	40.92	1.49	1.93
11	12	6281.4	5.18	325.89	179.44	62.69	35.45	98.14	81.30	1.82	1 56
12	12	7466.0	3.84	287.30	217.24	63.78	34.32	98.10	119.14	2.21	1.31
15	9	5095.2	5.23	266.91	145.57	48.10	26.53	74.63	70.94	1 95	1.14
16	12	6261.5	5.37	336.43	178.88	63.19	34.51	97.70	81.18	1.83	1.56
17	12	8510.2	3.46	295.09	243.27	64.84	40.86	105.70	137.57	2.30	1.24
18	12	10146.3	3.38	343.51	293 73	64.55	41.81	106.36	187.37	2.76	1.04
19	10	6305.6	3.17	200.09	178.17	53.68	31.77	85.45	92.72	2.08	1.35
34	12	12688.6	3.16	394.01	362.51	67.75	46.73	114.48	248.03	3.16	.90
39	12	4603.7	4.91	226.15	131.26	62.75	27.48	90.23	41.03	1.45	1.95
41	12	7836.09	3.54	277.57	238.33	65.33	46.31	111.64	126.69	2.13	1.42
42	12	9478.1	3.99	378.68	270.76	66.43	43.81	110.24	160.52	2.45	1.16
46	12	6257.1	4.22	264.32	179.31	62.41	31.10	93.51	85.80	1.91	1.49
49	10	5659.6	5.26	298.13	162.46	52.31	30 10	82.41	80.05	1.97	1.45
50	9	3201.0	6.39	204.60	92.30	44.80	22.12	66.92	25.38	1.38	2.09
51	12	6237.7	4.56	284.58	186.72	64.41	35.53	99.94	86.78	1.86	1.60
52	12	7463.8	4.09	305.57	205.22	64.86	29 08	93.94	111.28	2.18	1.25
53	12	11479.8	4.22	485.21	328.57	66.54	45.20	111.74	216.83	2.94	.97
54	12	9984.9	3.42	341.43	285.26	64.70	40.43	105.13	180.13	2.71	1.05
56	12	7088.0	2.72	193.36	202.49	67.44	34.81	102.25	100 24	1.09	1.45
57	12	7177.8	4.19	294.94	306.04	64.25	37 95	102.20	203.84	2.99	1.39
58	12	7725.5	3.78	292.35	219.69	67.15	35.95	103.10	116.59	2.13	1.33
59	12	8171.0	4.28	349.77	233.41	64.13	32 23	96.36	137.05	2.42	1.17
61	12	9193.1	3.54	325.60	259.76	67.51	41.42	108.93	150.83	2 38	1.19
64	12	8282.8	3.34	277.41	235.06	65.46	41.36	106.82	128.24	2.20	1.28
65	12	6816.4	3.06	209.04	194.72	59.62	31.02	90.64	104.08	2.14	1.32
66	12	9504.6	3.33	316.96	281.53	60.21	33 35	93.56	187.97	3.00	1.17
67	12	7041.8	3.31	233.32	201.15	65.72	33.06	98.78	102.37	2 03	1 40
68	12	10124.5	3.50	354.86	289.43	66.59	48.50	115.09	174.34	2.51	1.13
69	12	8971.9	3.71	332.99	254.58	66.25	38.57	104.82	149.76	2.42	1.16
74	11	4223.7	4.77	201.48	120.61	54.53	27.29	81.82	38.79	1.47	1.95
23	10	4338.0	3.78	164.18	123.90	50.93	23.94	74.87	49.03	1.05	1.72
Total		275422.54	3.84	10596.78	$7,986.51	$2,304.26	$1,320.81	$3,625.07	$4,361.44	$2.20	$1.31
*Average		7671.9	3.84	295.17	$222.46	$64.18	$36.79	$100.97	$121.49	$2.20	$1.31

*Average per cow for 12 months.

The following statement shows the average production, feed cost, and profit over feed cost per cow for the year, when milk is figured at $.05 and $.06 a quart, and feeds figured at market prices.

	Milk @ 5c. a qt.	Milk @ 6c. a qt.
Average lbs. milk per cow for 12 months	7671.9	7671.9
Average lbs. butter fat per cow for 12 months	295.17	295.17
Average value of milk	$182.66	$222.46
Average cost of roughage	64.18	64.18
Average cost of grain	36.79	36.79
Average cost of feed	100.97	100.97
Average profit	81.69	121.49
Average returns for $1.00 expended for feed	1.80	2.20
Average cost to produce 100 lbs. milk	1.31	1.31
Average cost one quart milk	.027	.027

Statement of average production, cost of feed, and profit per cow with milk figured at $.05 and $.06 a quart, and when roughage is figured at the *cost of raising instead of at market prices.*

	Milk @ 5c a qt.	Milk @ 6c. a qt.
Average lbs. milk per cow for 12 months	7671.9	7671.9
Average lbs. butter-fat per cow for 12 months	295.17	295.17
Average value of milk	$182.66	$222.46
Average cost of roughage	33.36	33.36
Average cost of grain	36.79	36.79
Average cost of feed	70.15	70.15
Average profit	112.51	152.31
Average returns for $1.00 expended for feed	2.60	3.17
Average cost to produce 100 lbs. milk	.91	.91
Average cost one quart milk	.019	.019

In previous years data have been given of the production and of the cost of production in the herd, including such items as labor, bedding, etc. In order to give an idea as to the cost of milk production when such items are considered, the following information is given. In Calculation No. 1 all roughage feeds are figured at market prices, and in Calculation No. 2 at the actual cost of raising. These figures are taken from the College Farm field reports and are as follows:

Alfalfa Hay, $5.00 a ton; Oat and Pea Hay, $8.00 a ton; Ensilage, $4.00 a ton; Green Soybeans, $6.00 a ton; Green Oats and Peas, $4.00 a ton.

The following items of labor, bedding, stabling, interest and depreciation on dairy utensils, are applied to the herd, which averaged 35.9 cows for the fiscal year:

Labor (1½ men) @ $1.50 a day—365 days	$ 821.25
Bedding, 2 bales shavings @ 22c a day—365 days	160.60
Stabling @ $5 a cow	179.50
Interest and depreciation on dairy utensils	50.00
	$1,211.35

The interest and depreciation on the cows is not included in this table, as it is figured that the value of the calves will exceed the interest and depreciation. It is figured that the income from bull services outside of the herd is sufficient to pay his feed cost. The following figures represent averages:

Average cost of labor, etc., per cow for the year	$33.74
Average cost of labor, etc., per cow per day	.092
Average cost per quart of milk	.038

Total Cost of Milk Based on Market Prices of All Feeds.

Calculation No. 1.

Cost of feed per cow for the year	$100.97	
Cost, labor, bedding, stabling, etc., per cow for the year,	33.74	
Total		$134.71
Value of milk per cow @ $.05 a quart	$182.66	
Value of manure per cow for the year	15.00	
Total		$197.66
Total cost per cow for the year		134.71
" profit per cow for the year		$ 62.95
Cost per cow per day for feed	$ .276	
Cost per cow per day for labor, stabling, bedding, etc.	.092	
Total cost per cow per day	.368	
Value of milk per cow per day	.541	
Profit per cow per day	.173	
Total cost per quart of milk	.0368	

Total Cost of Milk Based on Actual Cost of Roughage.

Calculation No. 2.

Cost of feed per cow for the year	$ 70.15	
Cost of labor, bedding, stabling, etc., per cow for the year	33.74	
Total		$103.89
Value of milk per cow @ $.05 a quart	$182.66	
Value of manure per cow	15.00	
Total		$197.66
Total cost per cow for the year		103.89
" profit per cow for the year		$ 93.77
Cost per cow per day for feed	$ .192	
Cost per cow per day for labor, bedding, stabling, etc.,	.092	
Total cost per cow per day	.284	
Value of milk and manure per cow per day	.541	
Profit per cow per day	.257	
Total cost per quart of milk	.028	

IV.

FEED COST OF RAISING CALVES.

Records of the feed cost and gains in weight of heifers until freshening have been kept during the past two years, and a summary of this data has been published in the Annual Report each year. Seven heifers included among those reported this year have freshened, and the feed cost and gains in weight are given for these animals in Table 6. Space will not permit any data regarding them except the summaries in this table. An interesting comparison may be made from the rates of gains in weight for the different breeds, the average gain per day in pounds being 1.64 for Holsteins, .76 for Jerseys, .96 for Guernseys, and .83 for Ayshires. Considerable data are available from these records, as the feed has been carefully recorded and all calves weighed regularly. It is to be hoped that at some future date it may be possible to arrange this data and publish it in the form of a circular or bulletin discussing the information which is available.

In estimating the cost of feed fed to the young stock, the same price is used as that given in this report for the feed fed to the dairy herd. The cost of whole milk fed is figured at $.05 and skim-milk at $.01 a quart. Practically the same method of feeding has been practiced from year to year with the different breeds and all animals have been reared under practically the same conditions. Information regarding the costs of calves at different ages may be found by referring to tables given in previous reports which are similar to Table 6.

Table 6.

Summary of the Feed Fed, Cost of Feed, and Gains in Weight for Holstein Calves.

NAME OF CALF.	Age in months.	Whole milk.	Skim milk.	Hay.	Ensilage.	Green feed.	Grain.	Cost of milk.	Cost of feed.	Total cost.	Gain in weight, lbs.	Average gain per day, lbs.	Average cost per lb. gain.
		Lbs.	Lbs.										
Duchess 3rd	4	980	170	35	....	....	40	$6.59	$ .92	$7.51	122	1.01	$.061
College King Jewel	15	338	1371	1388	1045	1010	821.1	11.33	31.02	42.35	387	.86	.109
Duchess 2nd	15	252	1548	2333	1175	310	903.2	9.71	37.73	47.44	429	.95	.110
N. C. Duchess 2nd	17½	1082	868	2167	1688	1010	997.7	28.40	41.76	70.16	521	.99	.134
F. S. Korndyke	3	....	....	670	1050	....	303.0	....	13.49	13.49	20	0.02	.674
Princess 5th	21	360	2470	2556	2163	1600	1286.1	17.16	52.65	69.81	774	1.22	.090
Princess 6th	9½	335	1784	977	356	....	530.8	11.24	18.76	30.00	404	1.41	.074
Moran	9½	325	1784	1202	356	100	807.0	11.25	19.00	30.25	321	1.12	.094
Jewel	9	305	1784	1132	356	100	495.0	10.72	14.41	25.13	319	1.18	.078
Constance 2nd	15	338	1371	1504	1015	....	806.6	11.33	30.14	41.47	400	.88	.103
Bess 2nd	17½	1025	1140	2028	1386	1160	1088.2	26.94	38.94	65.88	750	1.42	.087
Laura 2nd	19	342	1790	2514	1895	1090	1093.2	12.48	47.01	59.49	519	.91	.114
Trixie 2nd	15	322	1275	1568	1045	910	761.2	10.87	30.08	40.95	335	.74	.122
Chloe 2nd	18	279	594	1260	815	910	661.2	6.11	24.01	30.12	337	.86	.088
Shorty	15	338	1395	1564	1045	1010	823.2	11.51	31.05	42.56	436	.96	.097
Molly 2nd	21½	360	2470	2551	2070	1420	1162.2	17.16	50.28	67.44	561	.87	.120
Sallie 2nd	11	186	377	1229	835	910	700.2	5.02	25.33	30.35	387	1.17	.077
Ethel 2nd	16	570	1284	2013	1208	310	769.9	27.66	35.12	62.78	556	1.15	.111
Maggie 2nd	23	720	2096	2675	6178	820	1925.0	22.19	72.95	95.14	979	1.41	.097
Sussex	20	....	2048	2445	5330	725	1611.0	4.92	61.89	66.81	777	1.29	.085
Totals	....	8457	27611	33811	31011	13395	7585.8	$262.59	$676.54	$939.13	....	....	....
Average per calf	13¾	422.7	1380	1658	1500	669.7	879.2	$13.12	$33.82	$46.94	679	1.64	$.100

Summary of the Feed Fed, Cost of Feed, and Gains in Weight for Jersey Calves.

NAME OF CALF.	Age in months.	Whole milk.	Skim milk.	Hay.	Ensilage.	Green feed.	Grain.	Cost of milk.	Cost of feed.	Total cost.	Gain in weight, lbs.	Average gain per day, lbs.	Average cost per lb. gain.
M. Marvel's Queen	29	156	1596	4734	7418	610	1912.1	$7.56	$94.09	$101.65	697	.80	$.145
P. College Daisy	17	800	1140	1973	1447	1010	1001.2	24.00	38.79	62.79	455	.89	.138
Donna Daisy Dunholm	19	240	1746	2265	1499	1090	1078.2	9.94	43.60	53.54	445	.78	.120
Daisy of Dunholm 3rd	2	804	....	10	....	....	10.0	19.13	.21	19.34	31	1.01	.620
L. L. of Oak Hill, 2	2	630	....	5	....	....	....	14.95	.05	15.00	22	.36	.681
Mandy Marvel 3rd	1½	341	....	....	....	....	....	10.45	....	10.45	17	.15	.614
M. Matchless Queen	30	300	21	2982	5094	1157	2002.0	12.21	90.68	102.89	631	.70	.163
Totals	....	3271	4503	11969	15458	3867	6007.5	$98.24	$267.42	$365.66	....	....	....
Average per calf	14¼	467.2	643.2	1709	2208	552.4	858.2	$14.03	$38.20	$52.23	328	.76	$.159

Table 6.—Continued.

NAME OF CALF.	Age in months.	Whole milk.	Skim milk.	Hay.	Ensilage.	Green feed.	Grain.	Cost of milk.	Cost of feed.	Total cost.	Gain in weight, lbs.	Average gain per day, lbs.	Average cost per lb. gain.
Summary of the Feed Fed, Cost of Feed, and Gains in Weight for Guernsey Calves.													
Glencoe Maiden of P. 2.	16½	634	1140	1496	948	765	961.7	$17.68	$31.68	$49.54	400	$ .80	.123
C. Boy of Haddon.....	13	....	....	2760	4100	1600	1271.2	....	66.13	66.13	450	1.15	.146
Totals	....	634	1140	4256	5048	2365	2232.9	$17.68	$97.99	$115.67	....	....	....
Average per calf..	14¾	317	570	2128	2524	1187	1116.4	$8.84	$48.99	$57.83	425	.96	.136
Summary of the Feed Fed, Cost of Feed, and Gains in Weight for Ayrshire Calves.													
Skylands Scottie	16	....	....	3829	6560	1800	1447.4	....	$70.32	$70.32	500	1.41	.140
Mary Skylands	18	972	498	1783	542	7020	1077.2	$24.28	35.70	59.98	466	.86	.128
Sue Auchenbrain 2nd ..	8½	671	694	505	348	1100	401.0	17.03	13.59	30.62	241	.94	.127
Hannah Douglas 2nd...	31½	648	2096	4630	8468	1955	2563.0	20.59	106.80	127.39	442	.46	.288
College Scottie	15½	572	1780	1274	565	1164	741.7	17.95	26.12	44.07	560	1.20	.278
Vona Skylands........	18	932	496	1827	1292	1430	1165.7	23.28	39 21	62.49	469	.85	.133
Totals	....	3795	5562	13848	17775	8469	7396.0	$103.13	$297.74	394.87	....	....	....
Average per calf..	17¾	632	927	2308	2962	1411	1232.0	$17.19	$48.62	$65.81	446	.83	.147
Summary of the Feed Fed, Cost of Feed, and Gains in Weight for Grade Short Horn Calf.													
Nancy 2nd...........	13	496	470	1247	853	910	692.3	$7.36	$30.32	$37.68	331	.84	.113
Totals	....	496	470	1247	853	910	692.3	$7.36	$30.32	$37.68	331	....	....
Average per calf..	13	496	470	1247	853	910	692.3	$7.36	$30.32	$37.68	331	.84	.113

V.

COW TESTING ASSOCIATIONS.

At the present time there are three active Cow Testing Associations in the State, and one Association which has been inactive since work was discontinued on account of foot and mouth disease. The Wallkill Valley Cow Testing Association at Sussex, N. J. has been organized during the year and at the present time it is one of the most efficient Associations in the State. The Sussex County and Salem County Associations have reorganized during the year and in these communities there is a great deal of interest in Association work. Although the Sussex County Association has completed another year's work, it is impossible to include a summary of the results in this report. The summarizing of these records requires such a large amount of time and expense that the Dairy Department has not been able to total the records for this Association.

Two temporary Associations have been organized during the year, and will be ready to begin work as soon as there is an opportunity to visit dairymen in their communities in order to get a few more cows pledged.

The Department of Dairy Husbandry feels that there is no line of work which can more effectively advance the dairy interests in the State than by the organization of Cow Testing Associations, and in order to encourage the work the Department furnishes the necessary blanks for keeping the records. The Extension Department of the Experiment Station is cooperating with the Dairy Department by furnishing funds for the purchase of these blanks.

Any information regarding the organization and plan of work may be obtained upon application to the Dairy Department of the Experiment Station.

Records and Results of the First Year's Work in the Salem County Cow Testing Association.

Tables 7 and 8 give records of the total milk production, feed fed, cost of feed, and profit per cow in each herd in the Salem County Cow Testing Association for one year, and also the average milk production, feed fed, cost of feed, and profit per cow in each herd that remained in the Association one year. A list of the Associations in the State at the present time, together with their officers and official testers are as follows:

Sussex County Cow Testing Association.
- President, Winfield S. Phillips.
- Vice-President, Arthur Danks.
- Secretary and Treasurer, Thomas Inslee.
- Official Tester, Harry E. Watt.

Salem County Cow Testing Association.
- President, E. C. Moore.
- Vice-President, Frank Ridgeway.
- Secretary and Treasurer, Asher B. Waddington.
- Official Tester, Walter Anner.

Wallkill Valley Cow Testing Association.
- President, L. J. Kelly.
- Secretary and Treasurer, Frank Raycraft.
- Official Tester, Charles L. A. Beckers.

VI.

ADVANCED REGISTRY WORK.

During the fiscal year the advanced registry work, under the supervision of the Department of Dairy Husbandry has been conducted along practically the same lines as in previous years, except that there has been considerable increase in the Holstein semi-official, Guernsey and Ayrshire work. There were 217 seven-day Holstein tests conducted in the fiscal year 1913-14 and only 108 during this fiscal year. This was due to a temporary suspension of all seven-day tests in the winter due to outbreaks of foot and mouth disease. The work was practically discontinued for a period of two months during the winter. The actual number of tests supervised during the fiscal year are as follows:

Holstein-Friesian—

77—semi-official tests	
181—seven-day tests	
1—fifteen-day test	
62—thirty-day tests	
2—sixty-day tests	
Guernsey	878—two-day tests
Jersey	91— " " "
Ayrshire	220— " " "
Dutch Belted	58— " " "
Brown Swiss	20— " " "

Records of the feed fed to cows on advanced registry tests have been carefully kept as in previous years, and the estimated production and cost of production on these tests are given in Table 9.

Cost of Production.

The costs of production given in Table 9 are estimated, using the following values as a basis for figuring the cost of feed:

Pasture, $1.00 per month; Hay, $20.00 per ton; Ensilage, $4.00 per ton; Corn Stover, $8.00 per ton; Oat Straw, $10.00 per ton; Soiling Crops, $5.00 per ton; Roots, $6.00 per ton; Grain, $30.00 per ton; Molasses, $20.00 per ton.

Table 9 gives the average milk and butter-fat production per cow for the different breeds. It is hardly fair to make a comparison of one breed to another from these data as the number of animals included is not sufficient to represent an average. However, the relation of the cost of feed to the milk produced offers an interesting study. The production from the different breeds is figured on the basis of $.04 a quart for milk and on a basis of $.30 a pound for butter-fat. The average cost of feed per cow is not abnormally high considering the fact that the animals were on advanced registry test.

Data similar to those included in this table have been accumulated for four years, and at some future date a summary of these records may be published and will offer some very interesting information regarding the relation of feed to milk produced by cows on advanced registry tests.

Table 9.

Average Production, Feed Cost, and Profit Over Feed Cost Per Cow.

BREED.	Lbs. Milk.	% Fat.	Lbs. Fat.	Value of milk @ 4c. per qt.	Value fat @ 30c. per lb.	Cost roughage.	Cost grain.	Total cost.	Profit over feed @ 4c. a qt.	Profit @ 30c. per lb. fat.
Guernsey	9511.4	4.84	460.77	$181.17	$138.23	$46.54	$66.27	$112.81	$68.36	$25.42
Jersey	6419.5	5.03	322.93	122.28	96.88	38.93	50.09	89.02	33.26	7.86
Ayrshire	9533.7	4.00	382.12	181.59	114.64	46.63	85.58	132.21	49.38	*17.57
Dutch Belted	9204.0	3.39	312.73	175.31	93.82	56.15	40.46	96.61	78.70	7.21

*Loss.

Table 10 gives the totals and averages for the seven-day and thirty-day Holstein records.

Table 10.

Totals of Seven-Day and Thirty-Day Holstein Records.

	Lbs. Milk.	% Fat.	Lbs. Fat.	Value of milk @ 4c. per qt.	Value fat @ 30c per lb.	Cost roughage.	Cost grain.	Total cost.	Profit over feed @ 4c. a qt.	Profit @ 30c. per lb. fat.
Seven day	76376.1	3.6	2753.08	$1454.78	$825.92	$217.10	$392.15	$609.25	$845.53	$216.67
Thirty-day	135183.3	3.5	4733.81	2574.92	1420.14	413.89	479.10	892.99	1681.93	527.15
AVERAGES OF SEVEN-DAY AND THIRTY-DAY HOLSTEIN RECORDS.										
Seven-day	421.9	3.6	15.21	$8.03	$4.56	$1.20	$2.16	$3.36	$4.67	$1.20
Thirty-day	2180.3	3.5	76 35	41 53	22.93	6.67	7.73	14.40	27.13	8.53

Feed Fed on Advanced Registry Tests.

The average amount of feed fed per cow for one year is given in Table 11 for each breed.

Table 11.

Average Number of Pounds of Feed Fed Per Cow for One Year.

	Pasture (days.)	Ensilage	Hay.	Soiling Crops.	Roots.	Grain.
Guernsey	116	4997	2359	1316	1935	4418
Jersey	43.7	6344	2480	....	....	3339
Ayrshire	....	7252	2480	755	1812	5705
Dutch Belted	7.	4757	3300	5362	....	2697
Brown Swiss	36.	6877	2860	840	....	6115

In order to give an idea as to the average daily ration fed each breed, Table 12 is given, including rations fed on Holstein seven-day and thirty-day tests.

Table 12.

Average Daily Rations (Pounds) Fed Per Cow for One Year.

	Pasture (days.)	Silage.	Hay.	Soiling Crops.	Roots.	Grain.
Guernsey	.317	13.6	6.46	3.6	5.3	12.1
Jersey	.11	17.3	6.79	....	....	9.1
Ayrshire	....	19.8	6.79	2.06	4.0	15.6
Dutch Belted	.019	13.6	9.04	14.7	....	7.3
Brown Swiss	.09	18.8	7.89	2.3	....	16.7
Holstein*						
Seven-day	.055	16.0	7.8	.93	17.0	20.6
Thirty-day	....	16.8	13.5	.40	14.8	17.1

*Seven-day—Oat straw .32, Corn stover .28, Molasses .016.
Thirty-day—Oat straw 1.6, Corn stover .048.

These daily rations are influenced somewhat by the number of days in pasture which is given above for each breed. It will be seen that the average number of days in pasture for the Guernseys for the year was 116, while the Ayshires on test were fed in the barn during the entire year. Pasture was figured at $1.00 a month, and at this rate is a much more economical source of feed than when commercial grains are purchased, as in the case of the Ayshires.

Information Concerning Advanced Registry Work.

This Department will be glad to furnish information to any breeder in the State regarding the conduct of advanced registry tests. Circulars are available outlining the work in detail and giving advice as to the method of procedure in starting advanced registry work. These circulars and complete information will be sent to any one in the State free of charge, upon application to the Department of Dairy Husbandry.

REPORT OF THE DEPARTMENT OF SEED ANALYSIS

Department of Seed Analysis

JOHN P. HELYAR, M.SC., *Seed Analyst.*

*ROBERT SCHMIDT, B.SC., *Assistant Seed Analyst.*

*Resigned May 1, 1915.

CONTENTS.

Report of the Department of Seed Analysis

John P. Helyar.

I.

INTRODUCTORY.

The State Seed Laboratory has continued in its efforts to give to residents helpful information concerning the quality of seeds represented by samples submitted. It is the opinion of the Analyst, however, that the samples received represent too small a proportion of the total quantity of seed used for seeding purposes. The securing of samples from dealers' stock has been continued, 427 samples having been obtained. A larger proportion than have been secured in the past are vegetable seeds. As a general rule, only low grade lots of grasses and clovers were sampled. The results of analysis of these samples will be published in bulletin form.

The occupation of quarters in the New Agricultural Building, with consequent increased equipment, has done much to facilitate the work of the Laboratory. An arrangement has been perfected whereby the Analyst will have the assistance of two graduate students, giving half of their time to the routine work of the Seed Laboratory. As their research problems bear directly on some of the many problems of this Laboratory, it is anticipated that this will be a most effective arrangement. Mr. A. C. Foster of Alabama Polytechnic Institute and Mr. H. E. Carney of Miami University have received appointment to these positions, appointments becoming effective November 1, 1915.

Classification of Unofficial Samples.

Total number received 489; for purity test only 82; for germination test only 115; for purity and germination tests 283; for special tests 10. Total number of tests made—773.

According to kind of seed: Alfalfa 87; alsike 38; crimson clover 30; red clover 84; white clover 5; sweet clover 4; spring vetch 8; winter vetch 9; grass and clover mixtures 4; timothy 45; redtop 10; orchard grass 8; Kentucky blue grass 19; bent grass 6; meadow fescue 2; lawn grass mixtures 12; oats 4; rye 6; wheat 2; spelt 1; millet 2; all vegetables 97.

Number received from each county: Atlantic 2; Bergen 20; Burlington 77; Camden 110; Cape May 0; Cumberland 27; Essex 15; Gloucester 7; Hudson 1; Hunterdon 19; Mercer 28; Middlesex 51; Monmouth 4; Morris 9; Ocean 0; Passaic 11; Salem 29; Somerset 29; Sussex 14; Union 39; Warren 3.

The larger numbers received from Burlington and Camden Counties are accounted for by the fact that the Seed Laboratory has given unlimited service to seedsmen located in these two counties. It is believed that helping the seedsmen in selecting for purchase also helps his patrons.

Number of samples received each month: 1914—November, 9; December, 19. 1915—January, 53; February, 73; March, 85; April, 30; May 25; June, 41; July, 39; August, 36; September, 44; October, 35.

The above figures indicate the period of greatest demand for service as occurring in late winter and early spring months, the balance of the year showing a fairly constant but decreased demand. It is noted that many seed laboratories have very little work in the summer and fall months inasmuch as seeding is generally confined to the late spring and early summer. The fact that most of the seeding in the southern half of the State is done in the late summer tends to equalize the distribution of the work of the Seed Laboratory.

II.

COMMENTS ON SAMPLES

While the manner of securing unofficial samples is such that the Laboratory is not warranted in publishing the analyses under the names of dealers or senders, yet these samples can be fairly considered as representative of the bulk from which they were taken. These samples are often submitted when there is suspicion as to quality and for that reason might seem to indicate that in general a relatively low grade of seed was being offered. Judging from all facts in hand, it is evident that most of the seed offered for sale in the State is of good average quality. It is also evident, however, that some of the seed is wholly undesirable and it is against this that the buyer should protect himself.

ALFALFA. Twenty per cent of the alfalfa seed examined has showed the presence of Turkestan alfalfa seed. In some cases the entire sample was of this kind, in others there was an evident mixture of this with American seed. The U. S. Department of Agriculture has reported that this alfalfa is entirely unsuited for our conditions and should not be sown. Regardless of the accuracy of this statement, the seedsman has taken very unfair advantage in many cases where American grown seed was specified. The analyst has knowledge of several cases where the dealer sold seed consisting in part of Turkestan seed when American grown seed was specified in the order. Such substituting is profitable to the dealer. Turkestan alfalfa seed can be imported at less than the cost of American grown seed. When sold at the price of American seed it means a much larger profit to the dealer. The farmer should not pay top prices for Turkestan seed mixed or unmixed with American seed.

The farmers in one of our most progressive counties, buying seed through their Farmers' Exchange, have been sowing Turkestan alfalfa this year, some believing it to be American grown seed. During the entire year only four samples of seeds were received from this county.

ALSIKE CLOVER. The purity of this seed commonly runs lower than the other clovers. Its weed content may be very high and yet pass unnoticed if not very carefully examined. None of the samples received call for any particular comment.

CRIMSON CLOVER. Germination tests of samples show surprisingly low results. The lowest recorded test is twelve per cent and several are below fifty per cent. The results indicate the presence of considerable quantities of old seed. Certainly it is poor policy to plant this kind of seed without first subjecting it to a germination test.

One man wrote as follows: "In August I sowed a field to crimson clover with very bad results. Would you kindly test some of the same seed for me?" The sample enclosed with this letter was tested with the result that twelve per cent of the seed was found to be viable, the remainder being absolutely without value, except perhaps as poultry feed.

SWEET CLOVER. Two samples of this species deserve mention although possibly of unusual condition. One contained eighteen per cent of inert matter, consisting for the most part of fragments of the clover seed. This seed had evidently been treated by some mechanical devise intended to scarify the seed coats and thus promote germination. The process damaged so many seeds that its net value is doubtful unless the broken seeds are removed. The second sample contained sixteen per cent of alfalfa seed, not an undesirable plant, but at the cost of sweet clover seed, not a profitable method of buying alfalfa seed.

WINTER VETCH. Germination was comparatively low for most samples. One sample contained ninety per cent of spring vetch.

III.

WEEDS IDENTIFIED.

Further reports have been received concerning the prevalence of Knawel or German Knot Grass *(Scleranthus annuus)*. This was mentioned in the last report of this department as causing considerable damage in newly seeded alfalfa fields. This weed develops extensively in the fall and early spring crowding out the alfalfa seedlings by its spreading and dense habit of growth.

Reports of the occurrence and spreading of horse neetle *(Solanum carolinense)* continue. This is similar in habit of growth to Canada Thistle and demands the same treatment. The seeds of this weed are of frequent occurrence in clover seed. Clover and alfalfa dodder *(Cuscuta sp.)* seem to be more prevalent this year than they have been the past three or four years.

One report was received from Moorestown of the occurrence of evening primrose *(Oenothera laciniata)* as a prevalent weed in grass land. The seeds of this weed are of more or less common occurrence in commercial seed. This plant seeds abundantly and the introduction and development of one seed may be sufficient to cover a considerable area with its progeny.

The present year has been rather unusual for the development of weed plants and the majority of these plants have been allowed to mature seed. It is anticipated that the next year will see a strong development of weeds and a demand for means of eradication. The Department is preparing a circular dealing with this subject, which is intended to answer the many questions that arise in connection with this class of plants.

Weed Seeds Occurring in Samples.

An indication of the frequency of the occurrence of common weed seeds is given in the following table compiled from the results of analysis of the unofficial samples. Some of these weed seeds occur in single samples in large numbers. In other cases only a few are found. The effect of sowing these weed seeds is not measured by the actual numbers sown in any particular lot of seed. The sowing of only a few weed seeds to the pound might not be considered a serious matter. However, the further development of these few weed seeds might have considerable effect on the area sown after two or more generation had been allowed to develop unmolested.

Table 1.

Number of Samples of Agricultural Seeds Analyzed Found to Contain Weed Seeds as Listed.

NAME OF WEED	Alfalfa.	Alsike.	Crimson Clover.	Red Clover.	White Clover.	Timothy.	Red Top.	Ky. Blue Grass.	Orchard Grass.	Grass and Clover Mixtures.	Lawn Mixtures.
Ergot grains. Claviceps purpurea (Fr.) Tal.	...	...	...	...	...	2	1	...	...	...	...
Crab grass. Digitaria sp. L.	...	...	...	1	...	...	2	...	...	...	...
Slender Paspalum. Paspalum sp. L.	2	...	...	...	...	...	...	...	...	...	...
Old Witch grass. Panicum capillare L.	...	1	...	3	...	...	...	...	...	...	...
Panicum sp.	...	...	...	...	...	...	4	2	...	...	4
Green Foxtail. Setaria viridis (L) Beauv.	28	2	...	39	...	1	...	...	...	...	...
Yellow Foxtail. Setaria glauca (L) Beauv.	3	...	...	5	...	...	...	...	1	...	...
Velvet grass. Holcus lanatus L.	...	...	...	...	...	...	...	...	5	...	2
Wild Oat Grass. Danthonia sp. L.	...	...	...	...	...	...	...	...	1	...	...
Poa sp.	...	...	...	...	...	...	1	...	...	...	...
Soft Chess. Bromus hordeaceus L.	...	...	...	...	...	...	...	...	6	...	...
Cheat. Bromus secalinus L.	...	...	...	1	...	...	...	...	...	...	...
Sheep Sorrel. Rumex acetosella L.	...	19	13	19	5	10	4	...	6	2	5
Curled Dock. Rumex Crispus L.	4	7	6	23	...	...	...	...	...	1	...
Bitter Dock. Rumex obtusifolius L.	...	1	...	...	...	...	...	...	...	...	...
White Dock. Rumex pallidus Bigel.	...	1	...	...	...	...	...	...	...	...	...
Dock sp. Rumex sp. L.	3	1	4	5	...	1	...	...	2	1	...
Smartweed. Polygonum Hydropiper L.	2	...	...	2	...	...	...	...	...	...	...
Lady's Thumb. Polygonum Persicaria L.	1	...	...	5	...	1	...	...	...	...	...
Lamb's Quarters. Chenopodium album L.	9	4	...	14	1	3	...	1	...	...	...
Pigweed sp. Chenopodium sp. L.	1	1	...	...	1	...	...	...	...	...	...
Russian Thistle. Salsola tenuifolia G. F. W. M.	17	...	...	...	...	...	...	...	...	...	...
Rough Pigweed. Amaranthus retoflexus L.	7	...	...	3	...	...	...	...	...	...	...
Knawel. Scleranthus annuus L.	...	...	2	...	...	...	...	...	...	...	...
Spurrey. Spergula arvensis L.	...	...	...	...	...	...	...	...	1	...	...
Common Chickweed. Stellaria media L.	...	9	1	...	...	...	...	1	...	...	...
Mouse-ear Chickweed. Cerastium vulgatum.	1	7	1	1	...	...	5	15	1	...	5
Corn Cockle. Agrostemma githago L.	...	...	1	...	...	...	...	...	...	...	...
Bladder Campion. Silene latifolia L.	...	...	8	...	...	...	...	...	...	...	...
Sleepy Catchfly. Silene antirrhina L.	...	...	...	...	...	...	...	1	1	...	...
Forked Catchfly. Si ene dichotoma Ehrh.	1	2	2	...	...	...	...	...	...	...	...
Night-flowering Catchfly. Silene noctiflora L.	...	18	3	2	2	...	...	...	...	...	...
Catchfly sp. Silene sp. L.	...	1	4	1	...	...	1	1	2	...	...
Buttercup sp. Ranunculus sp.	...	...	7	...	...	...	...	...	2	...	1
Frenchweed. Thlaspi arvensis L.	...	...	...	...	1	...	...	...	...	...	1
Field Cress. Lepidium campestre (L) R. Br.	...	...	1	1	...	...	...	...	1	...	...
Peppergrass. Lepidium virginicum L.	1	...	1	...	1	7	7	6	...	...	4
Shepherd's Purse. Capsella Bursa-pastorsis (L) Medic.	...	...	...	...	1	1	...	8	...	...	4
Small seeded False Flax. Camelina microcarpa Andrz.	...	5	...	...	...	...	...	...	...	...	...
False Fax. Camelina sativa (L) Crantz.	...	...	1	1	...	...	...	...	...	...	...
Wild Radish. Raphanus raphanistrum L.	2	...	...	...	...	...	...	...	...	...	...
Charlock or Wild Mustard. Brassica arvensis (L) Ktze.	...	2	12	4	...	...	...	...	...	...	...
Indian Mustard. Brassica juncea L.	1	...	...	...	...	...	...	...	...	...	...
Black Mustard. Brassica nigra (L) Koch.	...	...	...	1	...	...	...	...	...	...	...
Mustard sp. Cruciferæ sp.	3	4	8	1	1	1	...	1	...	...	...
Wormseed Mustard. Erysimun cheiranthoides L.	...	3	...	...	...	1	...	...	...	...	...
Cinquefoil. Potentilla sp.	...	1	3	1	1	12	7	1	...	...	7
Rabbit-foot Clover. Trifolium arvense L.	...	2	...	2	...	...	...	...	...	...	...
Hop Clover. Trifolium procumbens L.	...	2	...	1	...	...	...	...	2	...	...
Yellow Trefoil. Medicago lupulina L.	4	27	20	...	18	3	...	...	...	...	...
Trefoil sp. Medicago sp.	...	2	...	...	...	...	...	...	...	1	...
Kidney Vetch. Anthyllis vulnerarea L.	1	...	1	2	...	...	...	...	...	...	...
Bird's-foot Trefoil. Lotus corniculatus L.	3	...	...	12	...	...	...	...	...	...	...
Coronilla. Coronilla varia L.	...	...	...	1	...	...	...	...	...	...	...
Sulla sp. Hedysarum sp.	...	...	...	1	...	...	...	...	...	...	...
Vetch sp. Vicia sp.	1	...	4	...	...	...	...	...	...	...	...
Wood Sorrell. Oxalis acetosella L.	...	...	...	...	...	1	...	...	...	...	...
Cut-leaved Cranesbill. Geranium dissectum L.	...	...	13	5	...	...	...	...	1	...	...
Small-flowered Cranesbill. Geranium pusillum Burm. f.	...	...	4	1	...	...	...	...	1	...	...
Wild Geranium sp.	...	...	1	...	...	...	...	...	...	...	...
Storksbill sp. Erodium sp.	...	...	1	...	...	...	...	...	...	...	...

Table 1—Continued.

NAME OF WEED	Alfalfa.	Alsike.	Crimson Clover.	Red Clover.	White Clover.	Timothy.	Red Top.	Ky. Blue Grass.	Orchard Grass.	Grass and Clover Mixtures.	Lawn Mixtures.
Three-seeded Mercury. Acalypha virginica L.	...	...	...	2	...	...	...	...	...	...	...
Spotted Spurge. Euphorbia maculata L.	...	...	...	1	...	...	...	...	...	...	...
Spurge sp. Euphorbia sp.	...	...	...	1	...	...	...	...	...	...	...
Common Mallow. Malva rotundifolia L.	1	...	...	4	...	...	...	...	...	...	1
Common St. John's Wort. Hypericum perforatum L.	...	...	...	...	...	...	...	...	...	...	1
Fireweed. Epilobium angustifolium L.	...	...	...	...	...	...	1	...	...	...	1
Evening Primrose. Oenothera biennis L.	...	...	...	...	...	6	1	...	...	...	...
Umbelliferæ sp.	...	...	...	1	...	...	...	...	...	...	...
Wild Carrot. Daucus carota L.	3	...	...	25	...	...	...	...	...	...	...
Dodder. Cuscuta sp.	3	...	...	3	...	...	...	...	...	...	...
Stickseed. Lappula sp.	2	...	...	2	...	...	...	...	...	...	...
Forget-me-not. Myosotis sp.	...	...	...	...	...	1	...	1	...	...	...
Corn gromwell. Lithospermum arvense L.	...	...	1	1	...	...	...	...	...	...	...
Blue Vervain. Verbena hastata L.	...	...	...	...	...	1	2	...	...	1	...
Vervain sp. Verbena sp.	...	...	...	2	...	...	4	1	...	...	...
Catnip. Nepeta cataria L.	...	...	...	1	...	...	...	...	...	...	...
Self Heal. Prunella vulgaris L.	2	5	...	10	1	1	...	...	...	...	...
Mint sp. Mentha sp.	...	...	2	...	...	1	2	...	...	...	...
Horse Nettle. Solanum carolinense L.	...	...	1	...	...	...	...	...	...	...	...
Common Nightshade. Solanum nigrum L.	...	...	...	1	...	...	...	...	...	...	...
Veronica sp.	...	...	...	1	...	...	...	6	...	...	1
Bracted Plantain. Plantago aristata, Michx.	2	...	...	2	...	...	...	...	...	1	...
Buckhorn. Plantago lanceolata L.	19	9	2	59	2	1	2	2	6	1	1
Common Plantain. Plantago major L.	...	6	...	3	3	2	...	...	...	...	2
Rugel's Plantain. Plantago Rugelii, Decne.	...	4	...	7	1	17	8	10	...	...	3
Blue Field Madder. Sherardia arvensis L.	...	...	6	...	...	...	...	...	...	...	...
Cleavers. Galium sp.	...	...	3	1	...	...	...	...	...	...	...
Gum Weed. Grindelia squarrosa Dunal. (Pursh)	1	...	...	1	...	...	...	...	...	...	...
Ragweed. Ambrosia artemisiifolia L.	...	...	...	5	...	...	...	...	...	...	...
Black-eyed Susan. Rudbeckia hirta L.	...	...	...	...	...	4	3	1	...	...	1
Sunflower. Helianthus sp.	1	...	...	...	...	...	...	...	...	...	...
Yarrow. Achillea Millefolium L.	...	...	...	...	...	2	9	1	...	...	6
Corn Camomile. Anthemis arvensis L.	...	2	3	1	1	...	...	...	4	...	...
Mayweed or Dog's Fennel. Anthemis cotula L.	...	2	...	...	...	2	1	...	...	...	1
Ox-eye Daisy. Chrysanthemum Leucanthemum L.	...	4	...	1	...	...	...	...	1	...	...
Burdock sp. Arctium sp.	1	...	...	...	...	...	...	...	...	...	...
Canada Thistle. Cirsium arvense L.	...	3	...	1	...	...	...	...	...	...	...
Star Thistle. Centaurea calcitrapa L.	...	...	...	1	...	...	...	...	...	...	...
Russian Knapweed. Centaurea picris.	15	...	...	...	...	...	...	...	...	...	...
Chicory. Cichorium Intybus L.	8	1	...	9	...	...	...	...	...	...	...
Cat's Ear. Hypochæris sp.	...	...	...	...	...	...	...	...	...	...	1
Ox Tongue. Picris echioides L.	2	2	...	9	...	...	...	...	...	...	...
Dandelion. Taraxacum officinale, Weber.	...	...	...	2	...	1	...	1	...	...	...
Common Sow Thistle. Sonchus oleraceus L.	...	...	...	2	...	...	...	...	...	...	...
Canadian Lettuce. Lactuca canadensis L.	...	...	...	1	...	...	...	...	...	...	...
Narrow-leaved Hawksheard. Crepsis tectorum.	...	...	...	...	...	...	...	...	...	...	1

IV.

PROJECTED WORK.

It is becoming recognized more and more that seeds play an important part in the transmission of organisms which are parasitic upon plants of differing degrees of maturity. In co-operation with the Department of Plant Pathology of the Station a study is being made to gain some information concerning the fungi which are parasitic upon the seeds of alfalfa and clovers; the organisms parasitic upon young seedlings in the field; and the organisms parasitic upon older plants. It is also intended to study the relation of seeds to the transmission of these diseases.

Studies are also being made of the effect of the chemical sterilizing agents upon the vitality and viability of seeds of alfalfa and clovers.

Samples of alfalfa and clover seeds have been collected from many different sources for the above work and will serve also as material for the determination of possible differences in structure as may be shown to exist between seeds of the same kind, but grown in widely separated regions.

In an attempt to determine the effect of the rate of seeding upon the stand and yield of alfalfa a series of plots has been seeded with quantities of seed ranging from ten pounds to thirty pounds to the acre.

V.

THE PROBLEM OF THE SEED LABORATORY.

In its relation to the farmer and to his problem of securing complete satisfaction in seed purchase, the main effort of the Seed Laboratory to-day must be along lines that will develop new habits among the users of agricultural seeds. It is not necessary in most cases to emphasize the important relation of good seeds and profitable crop production. It is necessary, however, so to change the habits of the many purchasers that when they come to act in this matter they will give some thoughtful attention to the process. It will not be merely a purchase easily made to satisfy immediate needs with the only consideration a possible saving of a few cents on a bushel of seed, but a purchase with the full understanding that the commodity selected will have a profound influence on satisfactory returns in the field and on the ledger.

This new method or habit will involve a demand for knowledge concerning the quality of the seed in terms of actual per cent of purity and germination. The quantity and character of weed seeds will be questioned. With some seeds it will be deemed important to know where they were grown. These questions may in some cases be answered by the dealer. In the majority of cases the dealer can give as little of this information as the buyer himself. Appearances may be depended upon, but only in case the dealer or buyer has had extensive experience. Even then one may be deceived very easily. Some recent occurrences have demonstrated that it is possible for men who have sown clover seed for twenty or more years to be deceived by crude substitution; and it is generally recognized that buying on looks is altogether risky. There is nothing definite to come back to in case of dissatisfaction.

It must be the effort of the Seed Laboratory in its present status to indicate how it can be of service and to do all in its power to introduce that service into the elements of action which will constitute the approved method of purchase. How to do this under present conditions is a problem yet unsolved. Advice is given on all possible occasions; lectures at the farmers' institutes and other meetings reach a few and may make a little impression, but there is not the opportunity offered to maintain a continuous attack upon the majority. However, the Seed Analyst feels that something has been accomplished in giving publicity to various phases of the seed situation in the State, that possibly there is a stronger sentiment in favor of taking definite steps individually and collectively to bring about certain changes to be desired.

In consideration of the problems involved a comparison may well be made with the conditions existing with regard to fertilizers. Previous to the fertilizer control system it is presumed that as little attention was given to the actual contents and value of the fertilizer bag as has been given to seeds. Both were readily available and easily purchased. To secure samples and to submit them to a laboratory involved some trouble, and if late purchase was made such procedure was out of the question. The inauguration of the fertilizer control system placed before the the purchasers the actual analysis of the contents, which analysis is in a sense guaranteed under the provisions of the control act. The constant presence of this analysis, together with information from the Experiment Stations, has, no doubt, stimulated many to make a comparative study of the various brands, and to make selection accordingly. It is presumed that without this published analysis and inspection system, the same conditions would exist to-day that exist in the case of agricultural seeds. Undoubtedly the fact that the expenditure for fertilizers is much greater than that for seeds, and the more complex nature of the materials, have done much to hasten the development of the present conditions in the purchasing of commercial fertilizers.

The question naturally arises as to whether a similar system will materially help to bring about the same conditions with respect to agricultural seeds.. Several states have adopted such a system and results indicate that it is the most satisfactory method of securing to the buyer the information which should be at his disposal. Also the fact that the analysis is at his disposal for every lot of seed indicates to him that it must be of value in selecting purchase. As a result there is careful inspection and comparison as a preliminary action to actual purchase, which must be beneficial to the buyer.

It is the opinion of the Seed Analyst that as soon as conditions seem favorable, the present seed law should be replaced by an act requiring the labeling and state inspection of agricultural seeds with such limitations as conditions demand. The Laboratory is already provided, the funds required for operation of such an act are nearly sufficient and available under the present seed law. It remains to gather the support of the residents of the State, for such a change and sentiment favoring this has already been expressed in many quarters. The opposition of the seed trade is also to be considered, though it is believed that they stand ready to support a fair and practicable measure of this kind.

REPORT OF THE DIVISION OF EXTENSION IN AGRICULTURE AND HOME ECONOMICS

Division of Extension

ALVA AGEE, M.S., *Director.*

ALEXIS L. CLARK, *Assistant State Leader of County Demonstration.*

*JOHN H. VOORHEES, B.S., *Extension Specialist in Agronomy.*

*CHARLES M. ARTHUR, B.S., *Extension Specialist in Markets.*

†WARREN W. OLEY, B.S., *Extension Specialist in Fruit Growing.*

VICTOR G. AUBRY, B.S., *Extension Specialist in Poultry.*

MISS M. ANNA HAUSER, B.S., *Extension Specialist in Home Economics.*

MISS FANNIE F. COOPER, B.S., *Assistant in Home Economics.*

ROSCOE W. DE BAUN, B.S., *Extension Specialist in Market Gardening.*

§CARL R. WOODWARD, B.S., *Editor.*

‡PAUL B. BENNETCH, M.S., *County Demonstrator for Sussex County.*

JOHN H. HANKINSON, B.S., *County Demonstrator for Mercer County.*

W. B. DURYEE, JR., B.S., *County Demonstrator for Monmouth County.*

L. F. MERRILL, B.S., *County Demonstrator for Bergen County.*

ELLWOOD DOUGLASS, *County Demonstrator for Atlantic County.*

‡GEORGE B. THRASHER, *County Demonstrator for Cape May County.*

**IRVING L. OWEN, B.S., *County Demonstrator for Middlesex County.*

††GEORGE T. REID, *County Demonstrator for Burlington County.*

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*Resigned September 1, 1915.
†Resigned October 31, 1915 to become County Demonstrator for Cumberland County.
§Appointed September 1, 1915.
‡Appointed January 1, 1915.
**Appointed April 1, 1915.
††Appointed November 1, 1915.

CONTENTS.

Agricultural Extension

Report of Division of Extension in Agriculture and Home Economics.

I.

REPORT OF THE DIRECTOR.

ALVA AGEE.

The work of the division of extension in agriculture and home economics has made progress in the past year. The basis of organization of the division was given in the annual report one year ago. The State Agricultural College, the Experiment Station and the U. S. Department of Agriculture are given funds for the betterment of New Jersey's agricultural interests and in so far as these funds are available for extension purposes the division seeks to make them effective. Counties in the State and one railway corporation make liberal appropriations that also come under the control of the division. A spirit of cooperation in all agencies concerned has made unity possible so that the returns to the people of the State may be as large as organized effort can produce.

There are agencies in the State doing excellent work along extension lines over which the division of extension has no control. It has found these agencies desirous of cordial cooperation with the extension division which was created after they had begun work, and there is no reason to desire any degree of control in work that is being effectively done or to duplicate such work in the territory covered. Many of the best agricultural counties of New Jersey have been organized by the rural department of the State Young Men's Christitan Association, and the county secretaries have organized agricultural clubs among the boys that are doing the work which the aim of boys' and girls' clubs in other states, and these secretaries, giving all their time to close touch with the youth of their counties, are doing the work more effectively than would be possible to us with a more limited degree of supervision. We should like to see all other counties in New Jersey organized in the same way, as such organization promotes the good of the State which is the object of our own division. Direct service is rendered to these clubs upon request and the relationship is finely cooperative.

The public schools in some counties are promoting the purposes of the extension division through boys' and girls' clubs in agriculture and home economics, and county superintendents of schools realize that the division of extension at the College gladly cooperates with them in every way.

New Jersey has county boards of agriculture that have a good record of past accomplishment. In some counties the boards foster demonstration work, and where boards are inactive the division of extension seeks to strengthen them wherever possible, and is wholly at their service.

The leading agricultural agency outside of the division of extension is the State Board of Agriculture which always has been a great force for good. It is engaged in part in educational work and the relations of the division of extension with it are so close that it feels free to call for service in the promotion of its own ends at any time. This relation is such that the farmers' institutes which belong to the State Board of Agriculture have been placed this year under the direct management of the assistant State leader of county work and seven county superintendents of farm demonstration who take charge of the work for the State Board of Agriculture.

The official record of performance by the division of extension is kept less impressive by reason of activity of the staff through agencies outside of the division, but there is no waste to the State in this division of control because much of the work is done by these agencies more effectively than would be possible through the division of extension, and the cooperative spirit is such that the results to which the State has a right are obtained.

The only possible exception is the continued lack of full adjustment of the duties of the division of extension respecting farm demonstration and the duties of vocational schools of one county that have been established by the State Department of Public Instruction. It would appear that the purpose of the State school law is that young men and women should receive instruction in agriculture and home economics through class-room work during the most of the school year, and that they should have the benefit of the counsel of teachers on their farms during the summer. The possibilities for good that exist in such schools are so great that every friend of agriculture should support them, but a little time will be required to define the scope of work of such schools so that there may be no overlapping with the activities that were in the mind of Congress and the State Legislature when the Smith-Lever and farm demonstration bills were enacted. Such matters of adjustment present small difficulty and mention would not be necessary at this place except as an exact report of conditions compel recognition of the only point in which there is not the finest adjustment among all of the activities of the State for the betterment of rural conditions.

FARM DEMONSTRATION.—The work legally designated in New Jersey as "farm demonstration work," and known in most other states as "county bureau work," is finely satisfactory. It is the aim of the division to make such work its chief project. The county superintendents of farm demonstration are members of our extension staff, thereby having direct connection with the College and Experiment Station, and they are known within their counties as the representatives of the division. This brings them into the closest personal relations with the instructional and research staffs in these institutions and, therefore, these institutions determine the teachings of the demonstrators in all scientific matters. The county demonstrators welcome this relation because it strengthens them and makes their work more efficient while, at the same time, the demonstrators working in accord with their local advisory committees have as wide liberty in direction of their activities as they desire. The new organization of counties has proceeded slowly during the past year, due partly to a lack of funds and partly to some misapprehension of farm demonstration work in unorganized counties in a year when producers in New Jersey suffered severely through extraordinary gluts in market and consequent low prices. The organized counties are strong supporters of the county work, and two of the greatest agricultural counties of the State have been organized to begin November 1, 1915. A full report of county work activity will be made by Mr. A. L. Clark, assistant State leader, who in fact is charged with all the duties of a state leader.

SPECIALISTS.—The extension division makes use of a small staff of specialists who carry on farm demonstration work in unorganized counties and assist county demonstrators. This staff will be increased as funds permit as it not only meets demands from unorganized counties which have a right to service, but favors unity in the organized counties. These specialists go to the various county demonstrators upon request and as the representatives of the heads of departments at the College having their subjects in charge. Summaries of the work of the extension specialists are made a part of this report.

HOME ECONOMICS.—The work in home economics begun September 1, 1914, has been peculiarly acceptable to the State. Miss Fannie F. Cooper, a graduate of the Pennsylvania State College, was appointed assistant to the specialist in charge June 1, 1915, and has been placed in charge of girls' club work. The requests from the State for formation of clubs of women and of girls have been much more numerous than could be met, as clubs may not be safely formed without provision for careful supervision. The results of home economics work have such great economic value and such social value in interesting women and girls in rural-life, and the requests for such service are so great that provision should be made for the addition of two more specialists to the staff. A report on the work will be found in the pages that follow.

MARKETING.—A leading interest in the extension division is some improvement in market methods and less progress can be reported along this line than along any other. There is no solution to present difficulties that can be obtained within a year or any brief series of years. There has been a study of the methods of distributing white potatoes, sweet potatoes and tomatoes, and in one county safe conditions came about for the creation of a farmers' exchange which was effected by leading farmers of the county who had been brought together largely through the county bureau. In another county a very efficient committee on marketing is preparing to carry on a demonstration the coming year that may show the feasibility of distributing vast quantities of the most perishable products direct to districts consuming them rather than to permit their shipment to congested centres. The establishment of public markets in cities has been promoted. Probably the best piece of work done by the College and Station was in the distribution of peaches. This organization was effected by Prof. M. A. Blake, head of the horticultural department of the Station, and the extension division is interested only in so far as members of its staff assisted the horticultural department in every possible way.

RURAL LIFE INTERESTS.—The extension division is directly concerned with all rural life interests. The State desires that country life conditions be as attractive as possible financially and socially. Cordial relations are maintained with rural-minded preachers and teachers, with the grange, farmers' clubs, civic associations, the Y. M. C. A., and other like organizations. The demand upon time of specialists for lectures seems unduly heavy and yet the ultimate aims of extension work are promoted by such contact. A country church conference which was held during Farmers' Week last winter led to a request that longer time be devoted to another conference during the holidays in the coming winter. This conference will be held in connection with one on marketing methods and a meeting for representatives of boys' and girls' clubs.

Correspondence makes another heavy tax upon the time of the extension staff and there is a disposition in some quarters to question the efficiency of such work. While the time used in correspondence should be limited as far as possible by the use of printed matter, it is true in a state like our own where many thousands are accustomed to write direct for specific advice, that just as good demonstration results in thousands of instances from such correspondence as would result from personal visits of a demonstrator to these farms. The correspondence comes unsolicited and there is continuing evidence that the men who on their own initiative write for information are very apt to make practical use of it.

APPROPRIATIONS.—The condition of the State's finances compelled the last legislature to scale the budgets of the various State institutions severely. It was liberally disposed toward agricultural extension work but the amount appropriated by the State is inadequate, and the interests of the people suffer as a result.

Changes in Agricultural Extension Staff.

Appointments:

- November 1, 1914, Ellwood Douglass, County Superintendent of Farm Demonstration for Atlantic County.
- January 1, 1915, Roscoe W. DeBaun, Specialist in Market Gardening.
- February 1, 1915, George B. Thrasher, County Superintendent of Farm Demonstration for Cape May County.
- April 1, 1915, Irving L. Owen, County Superintendent of Farm Demonstration for Middlesex County.

June 1, 1915, Miss Fannie F. Cooper, Assistant in Boys' and Girls' Club Work.

September 1, 1915, Carl R. Woodward, Editor.

November 1, 1915, George T. Reid, County Superintendent of Farm Demonstration for Burlington County.

November 1, 1915, Warren W. Oley, County Superintendent of Farm Demonstration for Cumberland County.

Resignations:

September 1, 1915, Charles M. Arthur, Specialist in Markets.

September 1, 1915, John H. Voorhees, Specialist in Agronomy.

November 1, 1915, Warren W. Oley, Specialist in Fruit Growing.

Publications.

Bulletins:

No. 1. April, 1915, pp. 16, Director's Annual Report.

No. 2. April, 1915, pp. 12, The Home Vegetable Garden, R. W. DeBaun.

No. 3. April, 1915, pp. 8, Marketing the Sweet Potato Crop, Chas. M. Arthur.

No. 4. April, 1915, pp. 8, A Message to the Women of New Jersey, M. Anna Hauser.

No. 5. July, 1915, pp. 16, Marketing White Potatoes, Chas. M. Arthur.

No. 6. September, 1915, pp. 12, Marketing Tomatoes in New Jersey, Chas. M. Arthur.

No. 7. September, 1915, pp. 12, Milk and Eggs, M. Anna Hauser.

Circulars:

No. 40. Hog Cholera and Swine Production. Prof. F. C. Minkler.

No. 41. Varieties of Tree Fruits for New Jersey. Prof. M. A. Blake,

No. 42. Spraying and Dusting White Potatoes. Dr. T. J. Headlee.

No. 43. Meadows and Pastures. John H. Voorhees.

No. 44. Common Diseases of Apples, Pears and Quinces. Dr. M. T. Cook.

No. 45. Common Diseases of the Peach, Plum and Cherry. Dr. M. T. Cook.

No. 46. The Hessian Fly. Dr. T. J. Headlee.

No. 47. The Determination of Humidity in the Greenhouse. Prof. M. A. Blake.

No. 48. Bordeaux Mixture. Dr. M. T. Cook.

News Letters:

Vol. 2. No. 1 to Vol. 2, No. 52.

II.

REPORT OF ASSISTANT STATE LEADER IN FARM DEMONSTRATION.

ALEXIS L. CLARK.

The work of the assistant State leader within the past year has been almost entirely given over to assisting the State superintendent in carrying on cooperative farm demonstrations throughout the State. The work has been very largely of an organizing and coordinating nature. There are at the end of this fiscal year nine counties in the State which have adopted the policy of cooperative farm demonstration work, and are sharing with the State College and the U. S. Department of Agriculture the financial support of the work.

The work has become much better organized during the past year in the counties which have been carrying it on for a number of years.

No definite method of procedure can be outlined that will prove effective in all counties of the State, but it has been possible to adopt a few broad, fundamental principles which promise to do much toward standardizing the work and adding to its efficiency. Perhaps the most important development along this line has been the adoption during the past year by all of our county men of the project basis for planning and carrying on the work within the county. Under this policy the county superintendents, in conference with their advisory committees, select from three to five important agricultural problems in their county. These problems are then taken up for consideration by the county superintendent with the extension specialist or department heads at the State Agricultural College and Experiment Station. After a thorough survey of the local conditions have been made, the county superintendent writes out in detail the methods for carrying on demonstration work aimed to better these particular conditions. In this way definite lines of work can be carried out to a successful completion with less danger of time and energy waste. The necessity for such a plan is readily realized when one is confronted with the many lines of work presented to a man taking up the work in a newly organized county.

The assistant State leader has acted as a coordinating influence in bringing the county men, the extension specialists and the various College departments into closer understanding with one another. Just as the county superintendents of farm demonstration act as agents for the various College departments in giving to farmers of their communities the best and latest teachings, so the work of the teaching and investigating forces of the College and Experiment Station are necessarily influenced by the experiences of the county men who come into close contact with actual farming conditions.

We are now entering upon the second year of cooperation with the State Board of Agriculture in Farmers' Institute work. This year the assistant State leader has been appointed director of Farmers' Institutes by the State Board of Agriculture, and the county superintendents have been authorized to make all arrangements locally for the Institutes within their counties. In each county carrying on cooperative demonstration work, the county superintendent will act as the Institute conductor. In those counties which are not yet organized the assistant State leader will act in that capacity.

Several State conventions have been held at the State College where the members of the extension division have met to consider problems affecting their work. It is planned to hold at least two such conventions annually.

In order to develop further the spirit of interest and helpfulness within the division, a monthly letter entitled "Farm Demonstration Exchange" is now being sent out from the extension division to all county superintendents and members of the county advisory committees. The mailing list of this monthly letter is at present four hundred. Its purpose is to present the leading lines of work that each county man has been engaged in during the past month. Something of the work that is being done in nearby states, and other news items that have direct bearing on farm demonstration work in New Jersey also are reported.

The assistant State leader took up the projects left by Mr. John H. Voorhees, who resigned as extension specialist in agronomy September 1st. In the organized counties, the county superintendents took over almost the entire burden of this work, but in unorganized counties where no county superintendents are employed, considerable additional work was placed on the shoulders of the assistant State leader. Fourteen field meetings were arranged for and held on farms where neighborhood corn variety tests had been conducted. Mr. D. P. Witter of New York State, and members of our Station staff attended and placed special emphasis upon the lessons brought out by the tests. The average attendance at these meetings was thirty. From two to six varieties of pure bred corn were grown by seventeen interested farmers. Careful and complete notes were taken during the growing season and again after the corn was harvested. There were 205 small alfalfa demonstration plots grown in twenty counties of the State. Reports have been secured showing that at least 150 of these have been conducted according to Mr. Voorhees' directions, and are at this date giving promise of success. Six varieties of soybeans were supplied to seventeen farmers and careful records were taken of these. Meadow top-dressing experiments were carried to successful completion on six farms.

During the early summer, numerous requests were received from fair associations for an educational exhibit showing the work of the various departments of the College and Experiment Station. These requests were referred to the assistant State leader and the cooperation of the various departments of the College and Experiment Station was secured. Mr. H. V. Cory of the Class of 1915 was placed in charge of the work and the exhibit was shown at the following fairs:

Flemington Fair, Hunterdon County, August 10th to 13th.
Gloucester County Pomona Grange Fair, August 11th to 13th.
Burlington County, Pomona Grange Fair, August 17th and 18th.
Cumberland County Pomona Grange Fair, August 18th and 19th.
Passaic Township Grange Fair, Myersville, August 26th.
Vineland Carnival August 29th to September 4th.
Cape May County Fair, September 9th to 11th.
Bergen County Fair, Hohokus, September 14th to 18th.
Far Hills Fair, Somerset County, September 24th and 25th.
Camden County Fair, Gibsboro, September 24th and 25th.
Inter-State Fair, Trenton, September 27th to October 1st.
Sussex County Pomona Grange Fair, Newton, October 2nd.
Mount Holly Fair, October 5th to 8th.

Throughout the State the question of marketing has been uppermost in the minds of many producers. The assistant State leader has responded to a number of calls for addresses and discussions on the matter. In the city of New Brunswick a farmers' public market was successfully established.

All of the above mentioned lines of work have been carried on in cooperation with the county superintendents of farm demonstration in their respective counties. Each county man has of course found various peculiar problems locally, which have demanded his attention, and the following brief reports will show something of the work in each county during the past year.

SUSSEX COUNTY.—Mr. W. H. Gilbertson was placed in charge of the work by the U. S. Department of Agriculture in 1911. He resigned in January, 1915, and Mr. Paul B. Bennetch was selected as his successor.

Sussex County is noted for its dairy interests. Dairy work and fruit culture have been the two lines which Mr. Bennetch has worked along most during the past year. The work has been divided as follows:

(1). Dairy Herd Management and Cow Testing Associations. Two associations including about fifty farmers possessing over one thousand cows, have been cooperating in herd improvement work. The first association organized at the end of its fiscal year showed a larger average production than any other cow testing association in the United States. About eighty feed rations were figured for farmers. Eight pure bred sires were purchased at the suggestion of Mr. Bennetch.

(2). Forage Crops. Twenty-nine farmers sowed about two hundred and fifty acres of alfalfa during the last season, according to methods recommended by Mr. Bennetch. An alfalfa tour was made on June 24, by about sixty farmers. Five men conducted soybean variety tests. Three fertilizer mixing demonstrations were held and the fertilizer thus mixed used for top-dressing purposes. About forty men carried on top-dressing work, the results showing one thousand to three thousand pounds of hay additional to the acre.

(3). Corn Variety Tests. Corn variety tests were conducted on five farms. Three community contests were conducted and field meetings held on two of the fields.

(4). Orchard Management. Three orchards were used for demonstration purposes in pruning and spraying. Demonstration meetings were held on orchards about the county for other purposes.

The Sussex County Fruit Growers' Association was organized.

(5). Poultry raising. Several trips were made in company with the poultry specialist, and several poultrymen are anxious to carry on feeding and management demonstrations during the coming year.

Mr. Bennetch has made 942 farm visits. He has received 308 office calls; 932 letters have been sent out; 1540 circulars have been mailed; 243 persons have attended demonstration meetings; and 26 other meetings have been addressed by Mr. Bennetch.

MERCER COUNTY.—Mr. John H. Hankinson was placed in charge of the county work in Mercer County in 1912. Mr. Hankinson reports seven special lines of effort during the past year.

(1). Work with young people. A short course of ono week for boys has been given. The average session attendance has been forty-six.
A corn growing contest, acre orchard contests, and boys' and girls' club work, have been promoted.
(2). Mercer County Potato Association. The securing of better northern grown seed and trying out second crop seed is the purpose of this association.
(3). Mercer County Fruit Growers' Association. Its activities concern the securing of orchard supplies, giving out market information, securing better railroad facilities, and exhibiting at the Inter-State Fair.
(4). Establishment of a city retail curb market in Trenton.
(5). Orchard management demonstrations. Work was carried out on nine peach and apple orchards during the past year. Pruning demonstration meetings were held and much interest manifested.
Three hog management demonstrations and three poultry raising demonstrations have been carried on successfully.
(6). Cooperation with the E. B. Voorhees Agricultural Society in corn and soybean variety tests.
(7). Organization of the Mercer County Farmers' Cooperative Association.

Mr. Hankinson reports 664 farm visits, 533 office calls by farmers, 360 telephone calls, 1630 letters written, and 4304 circular letters sent out from his office.

MONMOUTH COUNTY.—Monmouth County adopted the policy of farm demonstration in 1914. Mr. W. B. Duryee, Jr., the county superintendent of farm demonstration has been carrying on the following special lines of work:

(1). Demonstrations in the use of less potash for potato growing. Thirty-five farmers acted as cooperators, and comparisons on each farm were made of fertilizers with no potash, with 5% potash, and with 10% potash. For years the great majority of potato growers in Monmouth County have been using 10% potash in their fertilizers. The yield from these comparative fertilizers showed no great decrease where less potash was used. The 5% potash mixtures proved somewhat superior to both the 10% mixture and no potash mixtures. These comparisons were made both on old potato fields and on fields where no potatoes had been grown for many years.
Mr. Duryee does not recommend that potato growers place too much dependence upon this series of comparisons, as it covers only one growing season. It does, however, briug out very forcibly the point that more thought and study should be given to this very important subject during the next few years.

Comparisons were also made between fertilizers containing 2% and 4% ammonia with and without leguminous green manures.

(2). Five corn demonstrations were carried on. The county Y. M. C. A. cooperated in boys' corn and potato growing contests. An exhibit was held of the boys' products in the fall.

Boys' dairy record demonstration. Five boys completed records of milk production, which ran from March 1st, to June 24th.

(3). Monmouth County Poultry Association. This organization was formed through the Farm Demonstration office, and meets regularly.

(4). Orchard Management Demonstrations. Six peach and apple orchards have been managed through the year according to the methods approved by the Horticultural Department of the State College.

(5). Market Committee. A State committee composed of four truck growers was appointed by the chairman of the county advisory committee to consider ways and means of bettering market conditions. This committee has held three meetings at each of which prominent authorities on the subject were present to aid in the discussion. A report will be made to the parent committee this winter which will embody certain definite recommendations.

(6). Anti-Hog Cholera Demonstrations. Five demonstrations were given in the use of hog cholera serum. The disease was practically checked.

Mr. Duryee reports 853 farm visits, 464 office calls by farmers, 493 telephone calls, 2307 letters written, 4339 circulars sent out, 54 addresses given at meetings, and 285 press notices sent out.

BERGEN COUNTY.—The Bergen County Board of Freeholders adopted the policy of cooperative farm demonstration during the summer of 1914. Mr. L. F. Merrill was appointed county superintendent of farm demonstration. Mr. Merrill's work has covered many fields, but the leading lines have been as follows:

(1). Orchard Management. Demonstration meetings were given on several orchards in pruning, spraying, and other orchard work. The increase in perfect fruit resulting from the proper care of orchards has been from thirty to one hundred per cent.

(2). Corn Growing. Mr. Merrill has been working with a number of farmers in corn improvement, the object being to adopt the variety best suited to the conditions in that county. Seed plots of Silver King were grown this year on ten different farms. One field yielded one hundred and twenty bushels of shelled corn to the acre.

(3). The Use of Lime on Truck Crops. Several kinds of vegetables which were known to need sweet soil were treated with lime. Increased yield of from twenty-five to one hundred per cent was noted.

(4). Alfalfa. Ten demonstration fields were planted and twenty farmers have seeded this crop on larger areas. An alfalfa automobile tour was arranged during the summer in which fifty farmers participated.

Other miscellaneous lines of work were top-dressing of grass lands, growing of cover crops, an agricultural short course, a county fair, and a dairymen's association.

Mr. Merrill reports 750 farm calls made, 1750 letters written, 900 telephone calls received, 1355 circular letters sent out, 324 office calls by farmers, 24 demonstration meetings held, with a total attendance of 802; 78 other meetings addressed, and 20 newspaper articles written and published in thirty local papers during the past year.

ATLANTIC COUNTY.—Atlantic County adopted the policy of farm demonstration in the fall of 1914. Mr. Ellwood Douglass was appointed county superintendent of farm demonstration. The more important lines of work carried on in the past year have been as follows:

(1). Orchard Management. Meetings were held on three farms and much interest was manifested in better care of orchards.

(2). Soil Improvement Demonstrations. Soybeans, cowpeas, sweet clover, alfalfa, and crimson clover have been recommended by the county superintendent and used extensively as cover crops and green manures.

(3). Home-Mixed Fertilizer Demonstrations. There were four such meetings held. A saving of from five to nine dollars a ton was secured in the product and without exception every farmer reported just as good, or better, results from the home-mixed product as compared with the ready-mixed.

(4). Strawberry Growing. The strawberry industry in the county is threatened by the strawberry weevil. Five thousand plants of different staminate varieties were distributed among thirty growers. In cooperation with the State entomologist excellent results were secured in controlling the weevil by spraying. Demonstrations of this method will be given the coming year.

(5). Fruit Survey. A complete survey of the Hammonton district was taken. One hundred and twenty thousand peach trees were found on about sixty farms. Nailing presses and packing tables were set up and distributed to fruit growers for demonstration purposes.

(6). Hog Cholera Inoculation. Several hundred farmers were visited and shown how to inoculate their pigs to prevent this disease.

(7). Sudan Grass Demonstration. Several farmers were induced to plant a small plot of this grass, and the results have excited considerable interest.

Mr. Douglass reports 871 farm visits, 281 office calls, 32 meetings addressed, 908 letters written, 538 circular letters sent out, and 49 newspaper articles written. Several associations of various kinds were organized.

CAPE MAY COUNTY.—Cape May County adopted the policy of farm demonstration January, 1915. Mr. George B. Thrasher was appointed county superintendent and began his work March 1, 1915. The more important lines of work which Mr. Thrasher has been carrying on are as follows:

(1) Orchard Management Demonstrations. Five orchards were secured for this purpose. A number of demonstrations were held and it is certain that the entire orchard industry of the county has been much benefited. Three farmers have also planted out new orchards under the immediate supervision of the county superintendent.

(2). Tomato Spraying. Five demonstration plots were secured, the purpose being to control the leaf blight. The sprayed plots showed an increase of one hundred per cent over the unsprayed plots, and many growers have become much interested in the work.

(3). Corn Growing Demonstrations. Work was carried on in cooperation with two farmers.

(4). Alfalfa Growing. Ten plots of one square rod each were planted, and also larger areas on a number of other farms.

(5). Poultry Flock Management. Two flocks have already been secured and it is desired to secure several more where all the work will be carried on according to the methods approved by the Poultry Department of the State College.

(6). Home Economics. Six canning demonstrations were held in the county. The attendance at these demonstrations was 207.

Mr. Thrasher reports 729 farm visits, 727 letters written, 435 circular letters sent out, 46 telephone calls, 28 calls at his office by farmers, and 36 meetings addressed.

MIDDLESEX COUNTY.—Middlesex County adopted the policy of farm demonstration in January, 1915, and Mr. Irving L. Owen was appointed county superintendent of farm demonstration April 1, 1915.

General farming, with some fruit growing, some trucking and some dairying are the main lines of agriculture in this county. Mr. Owen has received the hearty cooperation of many prominent farmers and his work has been along the following lines:

(1). Alfalfa. Approximately one hundred acres have been seeded according to recommendations. Other forage crops and green manures, such as soybeans, cowpeas, rye and vetch have been used more and their value as soil builders and cheap feeds demonstrated.

(2). Orchard Management. Two demonstration meetings were given where self-boiled lime and sulphur spray mixtures were prepared and used.

(3). Corn Growing. About thirty-five farmers entered into the corn growing contest and much interest has been aroused throughout the community in better varieties of corn.

(4). Poultry Raising. The poultry specialist has assisted in having modern methods adopted by some of the poultry raisers in the county, and three of them have agreed to carry on flock management demonstrations the coming year.

Mr. Owen, acting as chairman of the executive committee of the County Board of Agriculture, arranged the annual exhibit of the Board. A large hall in New Brunswick was completely filled with high quality farm products. A competitive grange exhibit aroused much interest.

Mr. Owen also cooperated with the assistant State leader in establishing the New Brunswick farmers' market.

Mr. Owen made 539 farm visits, and wrote 696 letters. There were 117 persons who called at the office, and 188 telephone calls. Mr. Owen attended 19 meetings and addressed 486 persons. Ninety-eight bulletins and circular letters were issued.

III.

REPORT OF THE EXTENSION SPECIALIST IN POULTRY.

V. G. AUBRY.

NOTE: The work done by the Poultry Department is given in another part of this report.

Poultry husbandry extension work as carried on this year is practically a continuation of the work as carried on by that department last year: namely, lectures to granges, farmers' meetings, winter institutes, public schools, poultry shows, and poultry association meetings; demonstrations showing various operations that are carried on in managing a poultry plant; assisting in organizing boys' and girls' poultry clubs and chick raising contests, and also other associations interested in carrying on poultry work; answering, by letter, inquiries on poultry subjects; personal visits to farms, giving advise on poultry matters; carrying on projects in cooperation with the county farm agents, to demonstrate the different and improved methods of poultry management; staging poultry educational exhibits and judging exhibits at poultry shows; and writing and distributing literature pertaining to the subject of poultry.

LECTURES. During the year, 110 lectures were given at the different meetings throughout the State, at least one lecture being given in each of the twenty-one counties in the State. Where arrangements could be made a series of lectures were given, taking up systematically, and discussing in detail the management of large poultry flocks, and smaller farm flocks.

Of the 110 lectures, 27 were illustrated with lantern slides, 28 by charts, and 10 by drawings on a blackboard. Eight of these lectures were given at Farmers' Institutes conducted by the State Board of Agriculture. The approximate attendance at these meetings was 400. There were 15 given to the children of the public schools, with an attendance of 1500. At farmers' and grange meetings, 31 of the total lectures were given with an attendance of 1200. At the poultry shows the largest attendance was recorded and although but 12 lectures were given, the approximate attendance was 2900.

More lectures were given at poultry association meetings than at any other meeting, and a marked difference was noted at these meetings in the interest shown and the nature of the questions asked as compared with the other meetings. At these lectures the audience seemed intensely interested and the questions which were asked and discussions resulting were not so elementary as those asked at the other meetings. At these meetings, especially, was it possible to arrange a series of lectures which were of much more benefit. Forty-five lectures were given with an attendance of 100 at each meeting.

The total attendance for the 110 lectures was 10,800 people.

DEMONSTRATIONS. Demonstrations were given on killing, picking, drawing, grading, and packing table poultry; candling, grading and packing market eggs; culling pullets in the fall for layers; selecting and mating breeding stock; operating incubators, and brooders; cleaning and disinfecting poultry houses and equipment; making autopsies of diseased birds; and caponizing. Twenty-one of these demonstrations were given with an attendance of 420 people. Preceding each demonstration a short lecture was given and then the various operations were performed, after which as many as could actually be arranged for were permitted to perform these operations under the supervision of the extension specialist.

It is felt that much good has been derived from these demonstrations and the interest shown was very keen, and more time will be spent on this subject the coming year.

BOYS' AND GIRLS' CLUBS.—Where asked, we aided in forming boys' and girls' clubs and this work was carried on in four counties of the State, in cooperation with the county school authorities and with the county poultry associations.

The different county poultry organizations were always glad to help in this work by offering prizes for the boy or girl raising the most chickens from a given number of eggs, for the best chickens raised and exhibited at the county poultry Shows, in a department set aside for that purpose, and for the boy or girl that they judged to be the best all around poultry-raiser.

These different breeders, also, in many cases gave the children settings of eggs or stock from valuable strains, in order that they might grow up and be interested in the best kind of poultry stock.

Over 1000 boys and girls were entered in the different poultry contests and clubs through this work.

POULTRY ASSOCIATIONS.—Much of the poultry extension work done heretofore has been to organize local poultry associations in different parts of the State, with the idea of having a systematic and uniform organization in all of the counties in the State and so enable the Department at New Brunswick to get acquainted with, and in direct touch with a class of farmers who were especially interested in poultry husbandry. This effort has been very successful for several years, and this year we were able to organize two more local associations, making a total of 42 local county poultry associations. There is at least one in each county, and the total membership of the 42 associations is over 4000.

Because of the systematic way in which these associations were formed, it was possible for this Department to unite them all this year into a state-wide association for the up-lift of poultry husbandry, and much of the best work that can be carried on in poultry extension can be carried on with this association, because of their vital interest in this subject.

Already a summer field meeting has been held and educational exhibits conducted. Some legislative work has been done by this association which has been of much benefit to the poultry industry in the State. The association has recently launched several systems of cooperative work along various lines. A substantial saving to the poultrymen has been caused and some very interesting figures should be derived therefrom for a report next year.

CORRESPONDENCE.—During the year, 2000 letters were answered on different subjects pertaining to poultry, housing, feeding, breeding, management, etc. In many cases these letters were not only beneficial to the poultrymen seeking information, but have brought about a personal acquaintance with poultrymen and this Department, which results in the best kind of extension work.

ADVISORY TRIPS AND PERSONAL VISITS.—Most of the advisory trips and personal visits were made through the county farm agents, although a considerable number were made in unorganized counties. In all 21 of these trips were made, visiting 512 farms, some of them several times. Of these 304 were visited with the county farm agents and they have proven to be the most beneficial. Much good is done through these trips in the way of correcting conditions which are wrong and already exist on these various farms, and in starting the farmers right on new developments which they wish to undertake.

PROJECT.—It has been possible this year to start but a few so-called poultry projects which are model demonstrations of improved and correct methods of management. The proper organization of these projects has taken a large amount of time and but few were conducted this year. However, a number have been started and are now in progress. These projects are on the management of layers, breeders, incubators, brooders and growing stock.

EDUCATIONAL EXHIBITS.—This Department has staged three poultry educational exhibits which were of an extensive nature and very complete. Eight poultry shows were judged.

LITERATURE.—During the year the extension specialist was the author of five circulars on poultry, besides compiling a poultry calendar which was used for the purpose of conveying to the farmer in brief form when, and to a certain extent how, he should conduct the operations of management of poultry on his farm.

Four of the circulars were printed in form of Timely Hints to Poultrymen, namely, "Killing and Picking Poultry," giving the different steps in this operation and illustrated with a diagram showing the proper way of sticking and bleeding poultry; "Boys' and Girls' Poultry Clubs," giving a set of rules by which chick raising contests can be carried on; "The Care of Laying Pullets in the Fall," giving feeds, etc.; "The Cooperative System of Buying Feed as Carried on by the New Jersey State Poultry Association," illustrated with a chart showing the various ways in which poultry feed is distributed in this State. The fifth circular is the "Management of the Farm Poultry Flock," describing in detail the several steps of managing the farm flock.

RECOMMENDATIONS.—The extension specialist recommends that more time be given to the project work as carried on by this Department in cooperation with the county farm agents, that more and permanent equipment may be had to carry on demonstrations and for poultry educational exhibits and that the work can be systematically divided in different seasons of the year.

IV.

REPORT OF THE EXTENSION SPECIALIST IN AGRONOMY.

JOHN H. VOORHEES.

Extension work to be of the highest and most efficient character must *embody the community idea. This involves the gathering together of* those of a neighborhood upon common ground for a common cause and leaves with each man who participates some thing to do which will prove profitable either in practice or financially. No work has been conducted which fulfills this purpose quite so well as a number of home-mixing demonstrations conducted in March past. Such demonstrations require such detail that it was considered wise to confine their use wholly to organized counties. In Sussex county three home-mixing demonstrations were conducted at the following places: Newton, Lafayette and Vernon. At each one a fertilizer was mixed for use in top-dressing timothy sods. Because potash is found in liberal quantities in all the soils of Sussex County, and because the price at the time was quite abnormal, it was omitted, and only nitrate of soda and acid phosphate used with ground bone as a drier. This mixture analyzed 8.6-8.7-0, and cost $29.22 a ton delivered. Over one hundred farmers attended the three meetings, and each of thirty-six farmers purchased at cost a sixty-pound lot to try out on his own farm. The follow-up has been left almost entirely to Mr. P. B. Bennetch, the county agent, who reports great interest, and states further that the work is a topic of discussion at the stores and granges, while at the same time newspaper reports have been numerous.

A similar demonstration was conducted at H. E. Howe's farm, Hohokus, N. J. At this demonstration one hundred dollars a ton was paid for muriate of potash and a 4-8-5 mixture was prepared at a total cost of thirty dollars a ton. No fertilizer was distributed among those present *at this demonstration, and it served merely to show the ease and* thoroughness of home-mixing.

A *demonstration* was held *on* the farm of John Huenke, in Atlantic County, March 11, 1915. Two mixtures were made, one as follows:

Amount.	Am.	Phos. Acid.	Potash.	Cost.
75 lbs. nitrate of soda.	14			$1.69
50 " ammonium sulphate.	12			1.75
100 " dried blood, 16%.	16			2.80
600 " acid phosphate, 14%.		84		2.85
60 " muriate of potash.			30	1.89
115 " sand as filler—cost of freight.				1.65
1000 " mixture.	42	84	30	$12.63
100 " " formula.	4.2	8.4	3.0	$1.26

The second mixture was the same, except that it contained five per cent of potash and cost $28.00 a ton. The demonstration was conducted in the same way, except that each of twenty farmers bought one hundred pounds of fertilizer to use in comparison with his purchased stock. It may be noted that these mixtures cost $25.00 and $28.00 respectively. The farmers of the same community were paying $31.50 and $34.00 respectively for ready mixed fertilizer of the same analyses. Over sixty farmers attended this demonstration and it has brought repeated requests for assistance with fertilizers as well as crop production.

Top-dressing timothy sods has been continued as usual. Besides the home-mixing demonstrations in Sussex County, which served also as top-dressing demonstrations, eight of the standard type were located in the State. It was also found advisable to include in this work a demonstration of an experimental type to compare nitrate of soda and ammonium sulphate as sources of nitrogen. The plan of this experiment is as follows:

Plot No. 1	75 lbs.	ammonium sulphate
	150 "	acid phosphate
	50 "	muriate of potash
	2000 "	ground limestone
" No. 2	75 "	ammonium sulphate
	150 "	acid phosphate
	50 "	muriate of potash
" No. 3	2000 "	ground limestone
" No. 4	Check	nothing
" No. 5	100 "	nitrate of soda
	150 "	acid phosphate
	50 "	muriate of potash
	2000 "	ground limestone
" No. 6	100 "	nitrate of soda
	150 "	acid phosphate
	50 "	muriate of potash
" No. 7	2000 "	ground limestone
" No. 8	Check	nothing

Except for location of cooperators and proper sods, this work was delegated to the demonstrators in organized counties. Results so far obtained show greater yields upon plots fertilized with the ammonium sulphate mixture. One point brought out very clearly in this work is what the author terms "firing" which occurs especially on stiff clay soils, when too much nitrogen is used in the application. This "firing" is the drying of the lower leaves causing an inferior grade of hay. When this occurs the hay should be cut ten days or two weeks earlier.

During the season of 1914 four neighborhood variety tests of corn, or seed corn demonstrations, were conducted. These demonstrations embody the community idea and because they were so very successful and so much interest manifested, fifteen similar demonstrations have been started for this season. These demonstrations require a great deal of work and unfortunately nothing can be said of the results until after the harvest season.

Corn is by far the most important crop of the State, New Jersey producing over ten million bushels, and a number of variety tests of corn secured in other sections of the State have been made. Last year Silver King, Silver Mine, Boone County White, Golden Glow, Pride of the North, Griffith's Early Dent, Darke County Mammoth, Leaming and Reid Yellow Dent besides a few native varieties were used in these tests with the result that all were eliminated except Silver King, Golden Glow, Pride of the North, Darke County Mammoth, Leaming and Reid Yellow Dent for this season's tests. Silver King and Golden Glow proved so promising in Northern New Jersey, and Darke County Mammoth in Southern New Jersey, that these have this year been planted by a number of farmers solely for seed selection, so that there might be a home-grown supply of seed for succeeding years. For convenience the author makes the following division of the State: first, 90 day corn of the Silver King or Golden Glow varieties, in that section north of a line drawn from Belvidere to Newark; second, 100 to 110 day corn of the Leaming, Wing 120 day, or native White Cap Yellow Dent varieties from the line of the first section to a line drawn from Pennington to South Amboy; third, 110 to 130 day corn, Leaming on heavy soils, Darke County Mammoth, or Reid Yellow Dent on loamy and light soils, from the line of the third section to a line drawn from Woodbury to Mt Holly, and thence to Asbury Park; and fourth, 130 day corn, Boone County White on heavy soils, native strains of Leaming, Reid Yellow Dent, or Repp Dent on the loam soils, from the line of the third section south, Cumberland and Cape May counties, but excepting the light soils along the Atlantic coast and east of the Central Railroad. This country is still undeveloped and nothing has been done. Offhand, Sussex, a variety grown on similar soils in Delaware, would give good results in this section. The individual who takes up this work should be in a position to give detailed information after harvest in the fall when the results of this work will be available.

Work with soybeans heretofore has been delegated almost entirely to the individual farmer. It has served its purpose, however, in showing that Mammoth Yellow, Medium Green, Haberlandt, Swan, Wilson, and Ito San, named in the order of the length of time required to mature seed, are adapted to use in New Jersey. South of Trenton, all of these varieties will mature seed, except Mammoth Yellow, and even it will mature seed in Salem, Cumberland and Cape May counties in favorable seasons. In this territory Swan, and Haberlandt have proved excellent varieties for seed, forage or hay. Mammoth Yellow appears best suited for green manure, hay or forage, because it makes the largest growth. North of Trenton, Wilson and Ito San will mature seed and in some isolated communities where the season is long, Haberlandt and Swan will also. Medium Green, Haberlandt and Swan do well in this territory for green manure, hay or forage. The soybean might serve a very useful purpose as a green manure crop. There hardly appears to be a place for this crop for grain or hay, unless it can be grown to fill in, because it matures at the same time in the fall as corn, and is not as profitable as alfalfa for hay. However, in order to learn more of a few of the various varieties for different purposes, seventeen cooperative tests located by the writer and a few others located by the demonstrators with seed furnished by the department are now being conducted. In each case two or more of the following varieties are being grown by the cooperators: Mammoth Yellow, Medium Green, Haberlandt, Peking, Wilson and Ito San. It was desired to include Swan in the tests, but it was found impossible to secure seed of this variety.

Alfalfa is without doubt the most profitable general farm crop produced in the State, that is in an average of five or more years, not excepting potatoes. This year very extensive plans have been worked out with the result that the author located 139 cooperators, and the seven demonstrators 66 cooperators, to conduct small demonstrations with this crop. The plan bas for its purpose the introduction of alfalfa upon farms not at present producing it, the distribution of literature concerning the crop, and a means of supplying inoculated soil for subsequent use in planting larger areas on the farms. To each of the cooperators was sent one five-pound bag of inoculated soil; one four-and-a-half-pound bag of fertilizer, containing one-half pound of nitrate of soda, three pounds of acid phosphate, and one pound of muriate of potash; one fifty-pound bag of ground limestone and a three-ounce packet of best quality American grown alfalfa seed. Directions for preparing and planting one square rod, or one one-hundred-and-sixtieth of an acre, was forwarded to each. In organized counties the demonstrators handled everytning after receipt of the materials. Because the materials for these demonstrations have just been forwarded, and it is not yet time to plant, little can be said of the success of the plan, except that great interest has been shown by many of the cooperators located by the author.

It seems unnecessary to mention the work with cover and green manure crops. During the past two seasons, seeds adapted for this purpose were forwarded to a number of farmers in various sections, and so far as fall follow-up work was concerned the resnlts were encouraging.

Records on file in the office show the following summary:

I have addressed 43 meetings having a total attendance of 3600. This includes Farmers' Institutes, open-air demonstrations, and work to encourage hoys and girls in agricultural contests. I have visited 333 farms and written 1470 letters. Occasionally a day was spent inspecting cranberry bogs. Other work with cranberries which requires about thirty or forty days during the year is reported elsewhere.

July 31, 1915.

V.

REPORT OF EXTENSION SPECIALIST IN FRUIT GROWING.

WARREN W. OLEY.

The work of the past year has consisted mainly of orchard demonstration work comprising practical orchard management projects and supplemented with special demonstrations in pruning trees, spraying fruit trees, including the preparation of spray materials and the testing of various makes of nozzles, and in packing and marketing fruit. Considerable time also has been spent visiting orchards at the request of owners and advising them in regard to the care of the orchard when advice was sought. Also time has been spent on farmers' institute work and at other farmers' gatherings where requests were made for talks on some fruit subjects.

Two fruit growers' associations have been formed with our assistance during the past year, one at Sussex, N. J., and one at Lebanon, N. J. Also, an association was formed at Vineland for the purpose of disposing of the enormous peach crop.

We have introduced six new or promising varieties of strawberries in Atlantic County and one new variety in Bergen County, with the idea of comparing them in yield and susceptibility to insect attacks. This work has been done in cooperation with the county demonstrators.

We have worked on a press to save time in nailing lids on peach crates and have placed sixteen of these around the peach districts. These have been paid for by the growers, except five that are used purely for demonstration work. Three of these are in the hands of county demonstrators.

A condensed report of the work for the year is as follows: number of meetings held, 120; total attendance, 4336; farms visited, 463; letters written, 899. Of these meetings, eighteen were institutes with a total number of 1162 present, twenty-two were other lectures with an attendance of 1065 and eighty-one advertised demonstrations with an attendance of 1999.

Part of these demonstrations were held in cooperation with county demonstrators and include Mr. Cowgill's work which consisted of ten demonstrations with 65 present and 55 farms visited on request. Mr. Cowgill also completed a survey of the fruit section of Hammonton, in cooperation with Mr. Douglass, the Atlantic County farm demonstrator. He covered a territory with a six-mile radius from Hammonton. Seventy farms were included.

Demonstration Orchards. Thirty orchards have been selected and with the cooperation of the owners, treated as demonstration orchards. The idea has been to demonstrate how best to manage and operate peach and apple orchards in the locality. In these orchards as far as possible all advertised demonstrations have been held. Twenty-five of these orchards are located in counties having demonstrators. At these advertised meetings we have shown how to prune and spray our trees and fruit and at harvest time we have given packing demonstrations and endeavored to assist in marketing problems.

The fruit specialist has proposed a project along this line of orchard management to the county demonstrators for work for the coming year.

Vineland Shippers' Association.—In the summer of 1914 work was started by Mr. Farley, at that time extension specialist in fruit growing, in cooperative marketing of peaches from the Vineland district. Three carloads of peaches were shipped to Boston.

At an early spring meeting of the Vineland Peach Growers' Association, it was decided to continue this cooperative work, and in order to compete with other growers it was decided to endeavor to grow better fruit. A shippers' association of thirteen men was formed. In order to assist in growing high class fruit, we have visited all orchards of the association and overseen their spraying and general care. On the advice of the State Horticulturist, we drew up an agreement for the association which was accepted, and which made provision covering the quality of fruit to be shipped and for a standard method of packing and grading as well as rules to govern the management of the association.

The association marketed ninety-nine carloads of peaches in New York and Boston and other New England markets, and according to the report of the secretary has been successful and satisfactory. This cooperative shipping not only saves largely on freight charges, but it lowers cost of handling and allows for a choice of markets.

Peach Packing Demonstration.—Owing to the demand for peach packers during the peach season and because of the scarcity of good packers in some localities, packing schools have been held for a day or in some cases two days at a place and instruction given to any one attending in the correct method of packing peaches and in ways by which speed can be obtained. It has been the desire of the growers to get some uniform system of packing down to such a point as to make the cost of placing the fruit on the market as low as possible.

Various methods of conducting these schools have been tried but the one giving most satisfaction was held on August 5th and 6th at Vineland and seems worthy of a description.

The Vineland Peach Growers' Association asked that a packing school be held in their vicinity in time to train packers for the packing season. Mr. R. C. May, the secretary, caused a notice to be printed in the local papers stating that any persons desiring instruction in packing, either those owning orchards or persons willing to work as packers, should report to him and that a school would be held by the Experiment Station specialist on August 5th and 6th. Mr. May assigned hours to these applicants in order that they should not all appear at one time. On these two days, sixty-four persons presented themselves and received instruction. As far as could be determined, no persons left the place before they could pack peaches of different size and all that they needed to obtain speed was practice.

The school was held at the Experiment Station orchard on the training school grounds. The method used was as follows:

A packing table of the type recognized by the Experiment Station was placed out of doors where there would be room for everybody to look on even though not receiving instruction. As the people came at their appointed time, a demonstration and a talk on packing and proper methods were given. Previous to this, four sizes of peaches were graded out and placed on the table. The sizes were 6¼" in circumference, packing 2-2-4 tiers and 12 to a tier or 288 to a crate; 7" in circumference, packing 2-2-3 tiers and 10 to a tier or 180 to a crate; 7½" in circumference, packing 2-1-3 tiers and 9 to a tier or 162 to a crate; 8"—using both the 8-7-8 and the 7-8-7 pack. A few 8¼" peaches were shown to demonstrate a 6-6-6 pack.

Each individual was started with one size peach and shown how to pack that size and given an opportunity to pack a crate. After this he was passed to the next size and the process repeated while another person began at the first size. Two instructors were kept busy most of the time.

Demonstrations and schools similar to this have been held at Hammonton, Atlantic County; Pennington, Mercer County; Wyckoff, Bergen County; Woodcliffe Lake, Bergen County; Vineland, Cumberland County; Newton, Sussex Connty; and Sussex, Sussex County.

Peach Crate Lid Press.—There has been a demand for some simple machine to lessen the labor of putting the covers on crates of peaches. Apple box presses have been on the market for some time. Mr. Scheiferstein of the Horticultural Department and Mr. Cowgill of the Extension Division have devised a press, similar in some ways to an apple box press used on the Pacific Coast but suited to the peach carrier. These presses have proven very successful and have greatly lessened the cost of putting out peaches in carriers. Sixteen of these presses have been made by Mr. Cowgill, assisted in a few cases by a carpenter. Eleven of these have been paid for by peach growers and five have been used for demonstration purposes. Three of these have been placed with county demonstrators. These presses are made at a material cost of $3.74 a press with a labor value estimated at one day for one man per press.

VI.

REPORT OF THE EXTENSION SPECIALIST IN MARKETS.

CHARLES M. ARTHUR.

The awakening in recent years, on the part of both producer and consumer, to the necessity of better methods for the distribution of food products, whereby greater economy may be secured and the route from producer to consumer shortened and simplified, has been only too apparent.

It is a recognized fact that any efforts looking toward either a complete or partial solution of the problem of marketing farm produce cannot be spectacular, nor can they be expected to produce anything like immediate results. Those who have entered into such work or have given the question careful thought and study, agree that its solution must necessarily be a matter of years. New Jersey, with its numerous markets on every hand, offers a fertile field for the investigator of the distribution problem.

From the inception of the work in market methods at this Station the object has been to discover some logical program of procedure, some vulnerable point of attack. No economic problem is capable of effective solution unless the fundamental, underlying and basic facts concerning it are first known. It was the realization of this truth that brought about the method of procedure which we have pursued during the past year.

The plan adopted has been to select individual farm products raised in the State, and to discover in connection with these products information along the following lines: growing centers; acreage and value of the crop in the State; time and method of harvesting; grading and packing methods and type of package used in marketing; methods of storing, if the crop is a storage crop; varieties and the time they come on the market; markets and methods of marketing; yearly average prices for several years; and any other information which would seem to be valuable.

In collecting these data, information has been solicited from growers, commission men, officials of exchanges and any others who may have had anything to offer. Three bulletins, one covering the marketing of sweet potatoes, another covering the marketing of white potatoes, and the third the marketing of tomatoes have been issued. It is hoped that the information thus secured will be augmented with more of a like nature, in the future. What has been attempted so far is little more than a systematic study of marketing methods and conditions as applied to specific products, and might be termed the preliminary work.

Part of our time has been devoted to the issuing of a News Letter each week, containing items of interest from members of the staff of the Experiment Station, bearing on different phases of the work being prosecuted. This letter has been sent to Philadelphia and New York City papers, to agricultural publications and to some three hundred or more county papers throughout the State.

A careful check kept for a period of several months on the amount of the material from the News Letter used by the county and city papers and the agricultural publications, is of interest. It shows that many of the papers are making use of the items from week to week, some using the News Letter in its entirety and others making a selection from time to time. City newspapers use some of the material in their garden, poultry or general agricultural pages. Careful observation, also, shows that agricultural publications are using this matter freely and giving the Station credit.

Special illustrated articles to the number of about twenty-five have also been sent, during the year, to some of the city papers and agricultural journals. These articles have been based upon various lines of Station activities. Items of a shorter and more special character have been prepared and distributed from time to time to different city and county papers. Special attention, also, has been given to the advertisement of such special sessions as Farmers' Week, Short Courses in Agriculture and other events of a like nature.

In connection with the editorial work information bearing on overhead irrigation as applied to New Jersey conditions was secured and put into circular form. This circular is now available for distribution.

VII.

REPORT OF EXTENSION SPECIALIST IN MARKET GARDENING.

ROSCOE W. DEBAUN.

Extension work in market gardening was begun January 1st of this year. The vegetable growing industry in the State far exceeds any other line of agriculture, therefore, the needs of the vegetable growers should be carefully considered so that the most efficient service can be rendered to them. There were no established projects or demonstrations going, and the work had to be built up entirely new.

A vegetable variety survey was conducted by sending out circular letters to some of the successful market gardeners and truck farmers of the State. The results indicate very clearly the popularity of the best varieties and may be found in this issue under the report of the Horticulturist of the Station (pp. 60-61).

A circular on "The Home Vegetable Garden" was written, giving brief discussion of the location, size, plan, preparation and management of the home garden. It also contains a list of all vegetables giving the best variety of each for home use, amount of seed needed, time, depth and distances for planting and probable time for harvesting. A short discussion follows taking up interesting points on each of the vegetables.

The use of lime has been advocated throughout the State where soil was too sour for those crops which respond to applications of lime. Small plots in large fields of beets, cantaloupes, celery, cucumbers, lettuce, onions and spinach were limed on more than fifty farms. Very beneficial results were observed in nearly every limed plot. Lime is advocated for use only on these crops where it is expected that the extra returns will more than make up the cost of the application.

An effort has been made to advise the farmers of the many uses of nitrate of soda not only to grow the crop but to increase yield, promote quick growth and to stimulate certain vines when maturing their crop so that the vigor and vitality of the foliage may be maintained in spite of blight.

More than two thousand cauliflower plants were mailed out in lots of 25 to 50 people wishing to attempt the culture of this crop. Wherever the plants received careful attention, good results were obtained. An excellent crop was produced in only a few cases, but the indications are that the crop would prove to be a profitable one in this State.

With the assistance of Mr. Thrasher, farm demonstrator of Cape May County, it was demonstrated in plots in five large tomato fields that bordeaux mixture will control the tomato blights and about double the yields of tomatoes.

With the assistance of Mr. Merrill, farm demonstrator for Bergen County, and Mr. Owen, farm demonstrator for Middlesex County, eight plots in sweet corn fields were staked off for suckering demonstrations. The results obtained are of value to the sweet corn growers of the State and may be studied under the report of the Horticulturist (pp. 61-63).

The growing of horseradish is an important industry in this State. Many growers especially in Burlington County requested information on its culture. Subsequently, an original idea in its culture was advocated by the writer whereby larger and better roots would be produced. Test plots were arranged for on five different farms; the results of this test may also be noted under the report of the Horticulturist (pp. 63-64).

Assistance was personally given in the planning of school gardens that simple tests might be arranged to demonstrate some of the fundamentals in vegetable culture, fertilizing and seed selection. In one school district five farmers contributed their choice home-grown tomato seed for comparison of production with their neighbors'. The entire community was interested in the results and it is worthy of note that the yields in every case more than doubled the production of tomatoes grown on plants from purchased seed.

During the year advice has been given on many of the various points pertaining to vegetable growing. The author answered 897 personal letters asking for information; 357 farms were visited; lectures were delivered at 31 meetings to a total actual attendance of 2640.

The vegetable growers of the State and the Extension Specialist in Market Gardening begin to better realize the broad opportunity for efficient service in promoting the vegetable industry within the State. The work of the specialist may be summed up as follows:

1. To send or bring to each grower who desires it, the latest information about the avoidance or control of insect pests and diseases on vegetable crops; to consult about soil improvement by liming, cover crop and fertilization; to give advice on growing of plants or vegetables under glass; to furnish correct information about the adaptability of soils, varieties, planting and cultural methods, seed selection and crop disposal or storage; in fact, either to be able to answer questions about all these subjects or to know where to get the latest and best information and take or send it to the grower in a practical and efficient form.

2. To conduct actual demonstrations on farms throughout the State in the lines of work mentioned above.

3. To determine the most serious and economically important unsolved problems of our vegetable growers and to obtain consideration and investigation of these problems by experts so that a remedy may be determined and the information sent to the growers.

It is the aim of the writer to work with and for the growers so that excellent uniform vegetables may be produced at the least cost, at the right season, properly packed and marketed to obtain the highest net returns. During the coming year many of the demonstrations indicated above will be continued while new work will be taken up on a few other projects, such as an attempt to avoid sweet potato diseases by seed selection and plant bed management, vegetable forcing under glass, seed selection, uses of bordeaux and the use of cheap yet very efficient farm machinery.

VIII.

REPORT OF THE EXTENSION SPECIALIST IN HOME ECONOMICS.

MISS M. ANNA HAUSER.

A division of extension in agriculture and home economics was organized in the New Jersey State Agricultural College at New Brunswick, July 1, 1914. Work in home economics was begun September 1, 1914, in the belief that such extension service would be helpful to the farm home just as the extension work in agriculture has been helpful for years to the farmer and his son. Some of the results hoped for are: greater efficiency in the management of homes and the care of the family, with less personal sacrifice on the part of wives and mothers; an increased interest in the welfare of the community in general; a closer bond between mothers and daughters, teachers and parents, and the establishment of a relationship between the women of the State and the agricultural college similar to that which exists between the farmers of the State and the college.

The home economics representatives wish to express here their appreciation of the spirit of hearty cooperation that has been found in the College, Experiment Station and other members of the extension staff.

Of necessity the work this year has been quite varied, first because of the demands for practical demonstrations and instruction from different persons and organizations throughout the State, and second in order to popularize the endeavors along this line so that sufficient financial and moral support may be secured to carry on the work on a basis large enough to meet the demands. Although the work has been varied and a large part of time has been given to work with granges, farmers' clubs, women's clubs, housewives' leagues, mothers' clubs, parents' and teachers' associations and county boards of agriculture, organized work has been started along two definite lines, namely: the organization in rural communities of canning clubs for the boys and girls, and home economics associations for the women.

Why have canning clubs? The following are a few of the reasons:

1. To arouse interest in canning of fruits and vegetables so that a balanced ration may be had during the winter as well as during the summer.
2. To teach labor and time saving in home canning.
3. To eliminate waste and save surplus.
4. To reduce the high cost of living.
5. To encourage greater production.
6. To dignify home work.
7. To develop earning power and encourage saving toward a higher education.
8. To train for efficiency.

Early in the year the demand for the organization of canning clubs became so great that Miss Fannie F. Cooper, a graduate of the Pennsylvania State College, was appointed, June 1, 1915, to do work along this line, and will eventually take charge of the club work entirely. During the summer both Miss Cooper and the writer put most of their endeavor into this work and 36 clubs were organized with a membership of 575 girls and boys. One hundred and twenty-two canning demonstrations were given, 81 of which were for the benefit of the club girls and boys, their mothers and other women of the communities. The remaining 41 demonstrations were given to meet the demand of organized and unorganized groups of women in communities where there were no canning clubs. Forty-eight of the canning demonstrations were held in schoolhouses and it is estimated that 2900 children were reached in this way.

During the winter these same clubs are taking up work along other lines under the supervision and direction of Miss Cooper. The following courses are being offered: bread-making, cooking of meats, cooking of milk and eggs, cooking of vegetables and cereals, cake making, darning and mending, garment-making, crocheting and basket-making. Each club is urged to select the course which best meets their greatest immediate needs.

The purpose of organization of home economics associations among the women are briefly the following:

1. To raise the standard of the farm homes of the State.
2. To arouse greater interest in efficient and economic home management.
3. To promote better health and more efficient work through a properly fed body, proper clothing and housing.
4. To arouse interest in community welfare.

Organization along this line has been somewhat retarded by the large amount of time given to the canning club work and because of the necessity to meet the varied demands that come to this department from all sections of the State. However, six home economics associations have been organized with a membership of 190 women. Thirty-eight demonstrations and lectures were given for the benefit of these organizations. The great interest shown on the part of the women and the results obtained lead us to believe that the time is ripe for the organization of fifty more such groups throughout the State as soon as the money and help are available to carry on the necessary follow-up work resultant from such organization. Since the boys' and girls' club work is well started, it is hoped that more time can be given to this line of endeavor during the coming year.

Although the home economics work is to be chiefly demonstration, it has been necessary to supplement demonstration with lectures. Besides meeting a large number of people through lectures given at 26 farmers' institutes throughout the State, 67 talks or lectures were given at grange meetings, county board of agriculture meetings, schools and meetings of church and community groups.

The total number of meetings held during the year is 254 and the total number of people addressed is 14,710. There were 122 canning demonstrations, 39 demonstrations of cooking along other lines and 93 talks or lectures. There were 27 meetings with previously organized clubs of women and 4 talks and 11 demonstrations at meetings held in homes. Twenty-four talks and demonstrations were given in connection with grange programs. Besides the demonstrations there were 16 meetings held in the interest of canning club work. County boards of agriculture were served seven times either by talks or demonstrations. There were 6 demonstrations at State and county fairs and four times service was given by judging domestic science and domestic art exhibits.

Another feature of the extension work in home economics during the year was the writing of 8 newspaper articles and 2 bulletins. The first bulletin, "A Message to the Women of New Jersey," outlines the extension work in home economics; the second is entitled "Milk and Eggs." A great many people were served by having questions answered through correspondence. The total number of letters written is 1290 and the number of circular letters sent out is 1206.

All through the year the demand from various sources for extension service in home economics was greater than the present workers in the field could fill. There were as many as twelve unfilled requests from organized clubs for winter courses of a series of demonstrations and lectures along the line of domestic science as well as a great many unfilled requests from various sources for talks or demonstrations at single meetings.

REPORT OF THE DEPARTMENT OF AGRONOMY

Department of Agronomy

*Frank App, B.S., *Agronomist.*

†Irving L. Owen, B.Sc., *Associate in Farm Crops.*

‡Charles S. Van Nuis, *Associate in Farm Crops.*

*Appointed November 1, 1915.
†Resigned April 1, 1915.
‡Appointed April 1, 1915.

CONTENTS.

Report of the Department of Agronomy

FRANK APP.

I.

EXPERIMENTS WITH FARM CROPS.

The Agonomist did not begin official duties for the Station until November 1, 1915, since during the previous year official relations were with Rutgers College alone. However, part time was devoted to the organization of Station work. This report includes in a brief manner the development of the work to the present time. The past year's work was begun on a very moderate scale because of meagre funds. A grass garden was set out which included 56 different grasses and forage crops. Among these of special interest was Sudan Grass. This was seeded June 15th and Japan Millet seeded adjacent for a check. On August 21st, or 67 days later, both plots were cut and their green weights recorded with the following results:

Sudan Grass (acre yield)	10.2 T.
Japan Millet (acre yield)	8.7 T.

The Sudan Grass was 5 ft. high and coming out in panicle while the Japan Millet was 4 ft. high in head, but seed not developed. The Sudan Grass was fed to the cows to determine its palatibility. The greater portion was eaten but some was refused, indicating that it was not especially relished. The second crop was small and not over one-third the weight of the first. The true value of Sudan Grass as a forage crop for New Jersey, can be ascertained only after more extensive trials. One factor relating to time of seeding was clearly established. A small plot was seeded May 15th, but due to the cold, wet spring, did not become vigorous until late in June. The later seeding of June 15th was far more vigorous from the beginning. Sudan Grass, like the millets, is a warm weather annual and should not be seeded until the soil is warm, and not earlier than the planting of corn. Furthermore, it does not appear that Sudan Grass would be far superior to the millets as a forage crop for New Jersey from New Brunswick north, with the present high price of Sudan Grass seed. Where two full cuttings can be obtained in South Jersey it should prove a more valuable forage crop than millets for the dairyman, since two cuttings should give an ample production increase over the millets.

Variety tests of wheat, oats and corn were begun, but owing to a faulty drain, satisfactory results were not obtained with the wheat.

The heavy storm damaged the oats to such an extent that the separate weights were not obtained for the individual plots.

The corn varieties were planted on a three-year-old alfalfa sod. Acid phosphate was added at the rate of 400 lbs. to the acre. After careful fitting, the field was planted May 8, 1915. It germinated well and later the hills were thinned to a stand of three. The weights of ear corn, which was husked November 22d and 23d, were as follows:

Table I.
Yields of Corn in Variety Test.

PLOT.	Actual yield—plot.	Actual yield—bu. per acre.	Corrected yield—bu. per acre.	Stover—Tons.		
				Actual yield	Actual yield.	Corrected yield—tons per acre.
1. Check.	117	48	....	172	43	....
2. Dark Co. M.	77	32	28.5	167	2.41	22.0
3. Silver Mine, Trenton.	92	38	35.5	167	2.41	2.19
4. Silver King.	87	36	35.2	85	1.22	1.11
5. Ohio 75, Ohio.	92	38	38.9	114	1.64	1.48
6. Check.	94	39	....	176	2.53	....
7. Golden Glow.	94	39	41.6	75	1.08	1.00
8. Rocky Mt. Dent, Sussex.	116	48	51.3	150	2.16	2.09
9. Reid's Yel. Dent, Gloucester Co.	103	42	45.4	150	2.16	2.17
10 Boone Co. White Lebanon	83	34	36.5	157	2.26	2.37
11. Check.	95	32	....	145	2.09	....
12. Clarage.	79	33	33.5	125	1.80	1.88
13. Minn. 13.	99	41	40.3	65	.94	.95
14. Pride of North.	78	32	30.7	122	1.76	1.73
15. Hall's G. N. Sussex.	86	35	32.8	82	1.18	1.12
16. Check.	113	46	....	171	2.46	....
17. Decov, Mercer.	108	44	40.2	172	2.47	2.31
18. Rogers, Mercer.	72	30	26.9	90	1.30	1.22
19. Burroughs, Mercer.	105	43	39 6	144	2.07	1.98
20. Imp. Calico, N. Y.	104	43	39.5	162	2.33	2.25
21. Check.	109	45	....	162	2.33	....
22. Boon Co., Iowa.	95	39	38.2	147	2.12	2.14
23. Mon. Co. Yel.	94	39	39.7	122	1.76	1.84
24. Learning, Bur. Co.	150	62	67.	234	3.37	3.66
25. Reid Y. D. Mon. Co.	90	37	42.5	128	1.84	2.08
26. Check.	83	34	....	135	1.94	....
27. Hunterdon Co., 100 Day White Dent.	93	38	45.3	107	1.54	1.73
28. Longfellow, N. Y.	77	32	36.4	63	91	.97
29. Longfellow, Sussex Co.	104	43	47.8	85	1.22	1.25
30. White Dent, Sussex Co.	115	47	51.3	89	1.28	1.26
31. Check.	96	39	....	167	2.41	....
32. Reid's Y. D. Lebanon.	106	43	45.3	149	2.15	2.12
33. Reid's Y. D., Burl. Co.	94	39	39.6	137	1.97	2.00
34. 100 Day, Sussex.	93	38	38.6	110	1.58	1.66
35. Silver Mine, Iowa.	72	29	29.5	81	1.21	1.27
36. Check.	103	42	....	139	2.01	....
37. Seed Corn, N. Y.	110	45	44.3	112	1.61	1.83

To draw conclusions from one year's work with varieties would be unwarranted, but these results do show the possible increase due to selecting the proper variety. The highest yield was obtained from a strain previously grown in Burlington County, producing a yield of 67 bushels to the acre, while the lowest was from Rogers, a strain previously grown in Mercer County, which produced 26.9 bushels to the acre. In short, the best variety yielded almost two and a half times as much as the poorest, on the same soil, with the same fertilizer and care. Seventeen of the varieties were grown from seed obtained from growers in the State. There is a wider variation in the production of these varieties than in those imported from other states. This emphasized the need of more careful tests and selection on the part of the individual corn grower, for it is evident that there was a vast difference in their production of value of different varieties when grown on the Experiment Station farm this year. The reader may argue that this difference might not exist when the corn is grown under conditions similar to those under which the seed was raised. It is quite possible that it might change their relative value, but this same wide difference was emphasized this year in the cooperative tests conducted by the Extension Department. Here corn was obtained from fifteen or twenty farmers in the same neighborhood on adjoining farms with the same type of soil and climate. The varieties were all planted on one farm for comparison as to producing value. In all cases a great difference was obtained between the lowest and the highest yields. This work substantiates the results of the Station, that the individual corn grower should try a number of varieties on his farm and select the one that produces best results after careful trial. In these trials it would be well to obtain varieties from the farmers in his own locality as well as improved strains from other reliable sources. The yield of grain may not be the only deciding influence in selecting a variety since the stover is from one-fourth to one-third the value of the whole plant for feeding purposes. Hence, when used for ensilage a heavy yielding variety of both grain and stover is preferable. In these trials the heaviest yielding variety for grain is likewise the highest in stover, yielding 3.85 times as much stover as Minnesota 13, the lowest in stover yield. Silver Mine grown in New Jersey out-yielded Silver Mine from Iowa by 9 bushels. Longfellow from Sussex County out-yielded Longfellow from New York State by 11.4 bushels. This is probably due to the fact that seed obtained outside the state was not acclimated. It usually requires three or more years for seed obtained from a distance to make its best production. In trying out varieties from a distance this factor must be considered before a variety is decided upon definitely. The first step in the improvement of the corn crop is to determine the best variety from the individual needs on the farm where it is to be grown. This should be decided before improvement by seed selection or pedigreed seed is attempted. From these results, which are substantiated by those from the Extension Department in their cooperative experiments, we must consider the question of proper varieties of corn for New Jersey one which needs far more attention than has been given it in past years. By good seed of the proper variety yield is increased with little additional expense, except the added labor of harvesting the larger crop. It is the great source of profitable and economical increase. Further, improvement is at the command of all the growers, inasmuch as the added capital for carrying out such work is almost nil.

II.

FARM MANAGEMENT SURVEY.

During the months of June, July and August, 1915, a farm managemen survey was made of Monmouth and Sussex Counties. Monmouth County represents general, truck, potato, dairy, fruit, and poultry farming, while Sussex is largely a dairy center. Some of the most intensive, as well as the extensive, systems of agriculture prevail in these two counties. Due to the fertile soils so well adapted to the potato industry, Monmouth leads all the counties in the State in the value of agriculture products. Many of these potato farms have only sufficient stock to supply horse labor for the farm, and butter, milk, eggs and some meat for family use. The fertility of these farms has been maintained by a heavy application of fertilizers and green manures. Many of these farms are specialized potato farms, practising no definite rotation and raising little but potatoes.

In obtaining data for the survey, the following men who are students or graduates of the College, assisted: A. G. Waller, R. M. Hubbard, R. C. Cook, D. A. Coleman, E. C. Stillwell, L. N. Lewis, H. B. Holcomb, and F. C. Johnson. The farms were visited personally by each man for the purpose of obtaining the desired information. All records were recopied at night and checked next day by the man in charge of the group. By using bicycles, the men were able to average five records a day for the time actually in the field. A total of 1730 records was obtained. Of these 1730, there were 1189 from Monmouth County and 541 from Sussex. At the present time these data are being tabulated and these results are only preliminary to more complete results later.

The farms were divided according to their receipts, placing those that obtained 50 per cent or more of their total receipts from potatoes as potato farms, 50 per cent or more from fruit as fruit farms, 50 per cent or more from truck as truck farms, 50 per cent or more from milk as dairy farms, 50 per cent or more from poultry as poultry farms, and if a farm was found, no product of which made up 50 per cent or more of the receipts, it was classed as a general farm.

The labor income for the whole county has not been determined but for some of the farm classes, divided as above, it is as follows:

Table II.

LAND TENURE.	Number of farms.	Average labor income.	Number with minus labor income.	Percentage with minus labor income
Owner	194	$917	39	20
Part owner	19	801	5	26
Share	132	739	10	8
Labor Share	7	726	1	14
Cash Rent	16	938	2	12
Cash and Share	2	411	....	....
	370	$853	57	15

It is noticeable that the owners are making a higher labor income than the share renters, but not as high as the cash renters. This is opposite to the results obtained from some regions where farming was more general and especially from the grain farm centers. This should be the proper relation from the capital standpoint, but from the standpoint of the rural economist it may have a more significant meaning. However, if the owners' labor income was not greater than the tenants' and land values are stable, tenant farmers would be more encouraged to remain so.

The owner has still another advantage which does not show in the labor income. In New Jersey the land values are rapidly advancing. This advantage is not shared by the tenant. Therefore, the owner is not only getting a greater cash return fro his efforts, hut he has an additional increase from the gradual advance of land values. For any region where this condition is true, it is preferable to become an owner just as soon as possible. Again, the fact that the owners' labor income is only $176 greater than that of the share renters does not mean that the owners have only $176 more to live on for the year than the tenants. But the labor income consists of the receipts of the farm, less the expenses with 5 per cent interest, on the capital invested, deducted. Since the owners have far more capital invested than the tenants, they have, in actual cash returns, their labor income plus 5 per cent interest on their total capital invested. Potato farming for the year 1914 was profitable in Monmouth County, but with a specialized product such a survey should be made for four or five years in succession in order to draw the best lessons. Products such as potatoes, truck and fruit, fluctuate much in different years so that one year's work may show abnormal results. The average price of potatoes in 1914 as given by the Monmouth County Farmers' Exchange was $1.42 per barrel. The yield was good so that it was considered a good year by the growers. Should a survey be made for 1915 less encouraging results would be shown by many farmers, since the price of potatoes was low, and cost of fertilizers higher than the previous year, due to the unusual conditions existing at this time. However,.the year of 1914 was considered a fairly normal year by the County. Whether these results would be materially changed by repeated survey work is doubtful, since the price received for potatoes was not unusually high. Again, the expense for fertilizer and seed was normal. Therefore, these results should not be far from normal for the potato farms in Monmouth County.

By comparing the price of potatoes for the last three years in Monmouth County, taking the average price paid by the Farmers' Exchange, we find it to be as follows:

1912........	$1.32½	per barrel
1913........	1.58	" "
1914........	1.42	" "
Average of 3 yrs.	$1.43	

According to this, the price for 1914 was approximately normal for the last few years in the county.

Table III.

Relation of Capital to Labor Income on 194 Owners' Farms.

Capital	Number of Farms	Labor Income
$ 4000 or less	5	Loss $ 65
4001 to 5000	5	Gain 118
5001 to 7000	11	320
7001 to 10,000	21	374
10,001 to 15,000	46	607
15,001 to 20,000	43	856
20,001 to 30,000	43	1774
30,001 and over	20	1250

It appears from these data that unless a farmer has $10,000 or more capital at his command, he had better farm as a tenant rather than an owner, for with less than $10,000 capital, his chances of making a good labor income are small. In other words, an investment under $10,000 is too small to be used efficiently in this type of a farm business.

Table IV.

Return for Each $1,000 Capital Invested on 194 Owners' Farms.

Capital	Number of Farms	Return for each $1,000 Invested
$ 4000 or less	5	Loss $17
4001 to 5000	5	Gain 26
5001 to 7000	11	53
7001 to 10,000	21	44
10,001 to 15,000	46	48
15,001 to 20,000	43	49
20,001 to 30,000	43	71
30,001 and over	20	35
Average return	194	Avg. 52

The return for each $1,000 invested is likewise greater per $1,000 with the class farmers who have between $20,000 and $30,000. In other words, it means that the farmer's greatest efficiency is reached with $20,000 to $30,000 worth of capital. Not only is his average labor income highest, but his returns per $1,000 investment are greater.

Table V.

Variation in Labor Income on 194 Farms of Potato Growers.

Labor Income Received	Number of Farms	Percentage Total
Less than $1	36	18.
1—400	36	18.5
401—700	26	13.5
701—1000	23	11.5
1001—1500	30	15.
1501—2000	13	7.5
2001—2500	9	5.5
2501+	21	10.5

One farmer out of every five had a minus labor income or paid for the privilege of operating his farm instead of receiving pay for his efforts. About one-third of all the farm owners received less than their hired men for the year's work. One-fourth of all the men received from $400 to $1,000 returns, while over one-third received over $1,000 labor income. One out of every ten made a return of over $2,500, The potato region of Monmouth County required a large amount of capital to conduct a profitable farming business. The average investment on 194 of these potato farms is $17,624 which is nearly the same as the investment per farm in Indiana as shown by a survey made by the United States Department of Agriculture, and published in 1914. This is purely an agricultural region and values have not been influenced by the establishment of wealthy estates. From these results it appears difficult for a man to acquire sufficient capital to purchase an efficiently equipped farm. Moreover, much of these farmers' wealth has been derived from the rise of land values within the last few years. This means that with present conditions, it is more difficult to change from tenant to farm owner. From the standpoint of efficiency and prosperity in the community, it appears as though the ideal investment is from $20,000 to $30,000. Almost one-third of these men make a labor income of over $2,500. This indicated very strikingly that men who have $20,000 to $30,000 capital have an excellent opportunity to make a good return for their capital invested. When these men make an average labor income of $1,774 and 29.5 per cent of the total number make a labor income of over $2,500, farms of this class offer an attractive opportunity. A whole region equipped with such efficiency as this, needs no rural uplift movement. Such a region would have no rural problem. Not one farm with less than $10,000 made as much as $1,500 labor income, and only two out of forty-two made between $1,000 to $1,500. Hence, a man had one chance out of twenty-one to make over $1,000 for the year. It appears quite evident that unless a man has $10,000 or more available capital, he had better invest in some other region than the potato area of Monmouth County. He would have the other option of farming as a tenant, which should place him in a position to make a larger investment later.

The following table shows the relative chances of an owner of making a given labor income with a given amount of capital:

Table VI.

Relation of Capital to Labor Income on 194 Potato Farms.

Operating capital.	Number of farms.	Less than $1	$1-400	$401 -700	$701 -1,000	$1,001 -1,500	$101 -2,000	$2,001 -2,500	$2,501+
$3,000 and over	20	3	3	2	2	3	2	1	4
$2,000-30,000.	43	6	4	4	2	9	1	4	13
$1,500-20,000.	43	7	3	8	6	11	3	3	2
$1,000-15,000..	46	9	14	5	4	4	7	1	2
$700-10,000 ...	21	3	7	4	5	2	....	....	....
$500-7,000	11	3	2	3	2	1	....	....	....
$400-5,000.....	5	2	2	....	1	....	....	....	....
$300-4,000.....	5	3	1	1	....	....	....	....	....

Percentage of Farms Making Given Income With Capital Invested.

Operating capital.	Number of farms	Less than $1	$1-400	$401 -700	$701 -1,000	$1,001 -1,500	$1,501 -2,000	$2,001 -2,500	$2,501+
$3,000 and over.	20	15	15	10	10	15	10	5	20
$2,000-30,000..	43	13.9	9.8	9.3	4.6	21	2.3	9.3	30.3
$1,500-20,000..	43	16.2	6.9	18.6	13.9	25.5	6.9	6.9	4.6
$1,000-15,000..	46	19.5	31.7	10.6	8.6	8.6	15.2	2.1	4.1
$700-10,000....	21	14.2	33.3	19.1	23.4	9.6	....	....	....
$500-7,000.....	11	27.2	18.1	27.2	18.1	9.1	....	....	....
$400-7,000.....	5	40	40	1	20	....	....	....	....
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					

It is quite striking that it is essential to obtain sufficient capital so as not to stint farm operation. The men who have only $3,000 or $4,000 have small opportunity to make as much as the hired man. Of the five farmers, who had a capital of $3,000 to $4,000, one made as high as $551. Of the five who had from $4,000 to $5,000, one made $762 by selling his crop in Asbury Park, while the other four all made less than the hired man. Of those with a capital between $7,000 and $10,000, none get as much as $1,500 labor income. It certainly does not appear wise to invest less than $10,000 in the potato region, preferably the capital should be $20,000. According to these results a man who has a $10,000 investment had better in some manner obtain a larger sized business. This he might do by renting more land, or buying additional land. If this is impracticable, he had better sell out and buy a larger farm elsewhere. In any case, a man could pay the borrowed capital on a large investment far more easily than on a small one. This is a matter of much importance for one who is considering the purchase of a farm in such a region.

Tenant Farms.

In addition to the 194 owners' potato farms, there were 150 tenant farms of which 16 were cash tenants, 2 cash and share, and 132 share tenants. In addition to these 150, there were 7 tenants who furnished labor only, or a small portion of the operating capital. These last seven have not been included in the study of capital since it was a minor item for them in their system of tenantry. Of the total number of potato farms 52 per cent are owners' farms, 42 per cent tenants' and 6 per cent part owners' and tenants'. This is a large proportion of tenant farms and more than is ordinarily found in most communities. In surveys made to date, it is commonly found that a prosperous region will have a greater proportion of tenants than one less prosperous. Such a locality encourages a young man with small capital to farm as a tenant until he has sufficient capital accumulated to become an owner. Many of the owners began as tenants. The following results show the relative opportunity of a tenant to become an owner through capital acquired as a tenant farmer.

Table VII.

Relation of Capital to Tenants' Labor Income on 150 Potato Farms.

CAPITAL.	Number of farms.	Labor income.
$1,000 and less	4	$470
$1,001-2,000	18	447
2,001-3,000	38	567
3,001-4,000	43	886
4,001-5,000	34	852
5,001-7,000	18	1,437
Average, $3,353	150	$781

The capital for tenant farmers brings greater return per individual with each increase. This appears not to have reached the highest limit as in the case of the owners. However, the rate of increase begins to diminish after $3,000 to $4,000 capital has been reached. The total

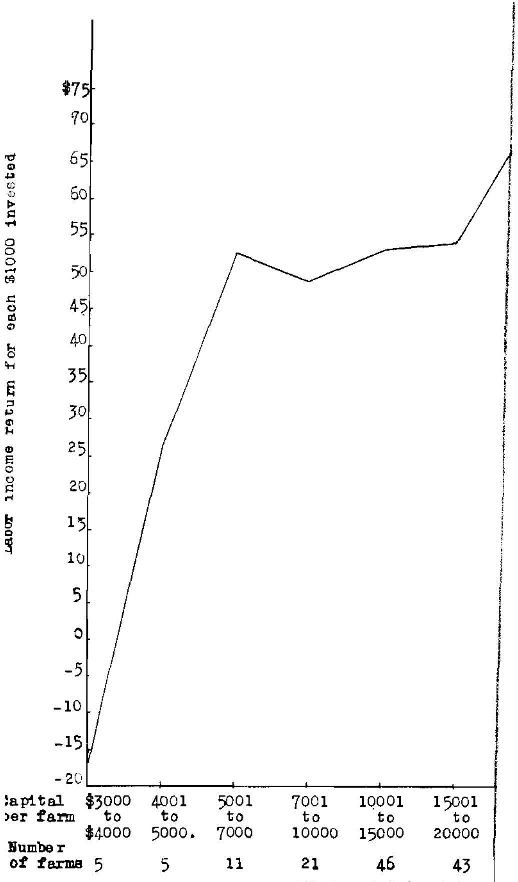

Fig. 1.—Diagram showing return per $1,000 of capital invested on operated by owners in Monmouth County, N. J.

investment for these tenants and their landlords amounts to about the same as that of the owners in the $20,000 to $30,000 class.

Table VIII.
Return for Each $1,000 Invested by the Tenants on 150 Tenant Farms.

Capital.	Number of farms.	Return for each $1,000 invested.
Less than $1,000	4	$619
$1,000–2,000	18	262
2,001–3,000	38	230
3,001–4,000	43	260
4,001–5,000	34	189
5,001–7,000	13	240
	150	$230

The return per $1,000 invested is high compared to that of the owners, but it necessarily must be so, when so little is invested by the tenant. Since the tenant gets half the receipts, but invests far less than half the total farm capital he would have a greater return per $1,000 invested than the owner. Probably a better standard of return to compare that of tenant to that of landlord, would be the return per man work unit. With more time this will be determined, but at present the labor on these farms has not been studied.

Table IX.
Variation of Labor Incomes Obtained From 157 Tenant Farms in the Potato Region.

Labor Income.	Number of farms.	Percentage of total number.
Less than $1	12	8
$ 1– 400	39	26
401– 700	33	22
701–1,000	21	14
1,001–1,500	21	14
1,501–2,000	11	7
2,001–2,500	10	7
2,501+	3	2

Of the tenants, one-third make less than $400 labor income or receive less or about as much as the hired men; one-third make between $400 and $1,000, while one-third make from $1,000 to $2,500. This is a good return for the small amount of money invested by the tenants and it does appear as though the tenant had a fair opportunity of acquiring land of his own in time. But it must not be understood that the tenant who has a labor income of $1,000 has as much to live upon as the owner who has $1,000 labor income. The owner has more interest from his capital than the tenant, which leaves him more for living and personal expenses. The extremes for the tenant are not as great as for the owner, his maximum loss is not as great as that of the owner and he seldom makes as high a return as the best of the owners. In short he is more limited in his possibilities until he becomes an owner. This is to be expected since the tenants do not assume as great a risk as the owners.

The following table shows the distribution of 150 tenant farms in the potato region with a given amount of capital.

Table X.

Distribution of Labor Income Obtained From Given Capital on 150 Tenant Farms in Potato Region.

Number of Farmers.

Tenants' capital.	Number of farms.	Labor Income.							
		Less than $1	$1–400	$401 –700	$701 –1,000	$1,001 –1,500	$1,501 –2,000	$2,001 –2,500	$2,500+
$1,000 or less	4	..	2	1	1	....	....	....	....
1,001–2,000	18	2	6	4	4	1	1	....	....
2,001–3,000	38	2	11	15	3	4	3	....	....
3,001–4,000	43	4	11	5	5	8	4	6	....
4,001–5,000	34	3	6	7	6	7	2	2	1
5,001–7,000	13	1	3	1	2	1	1	2	2

Percentage of Farmers.

Tenants' capital	Number of farms.	Labor Income.							
		Less than $1	$1–400	$401 –700	$701 –1,000	$1,001 –1,500	$1,501 –2,000	$2,001 –2,500	$2,500+
$1,000 or less	4	....	50	25	25	....	....	....	....
1,001–2,000	18	11.1	33.3	22.2	22.2	5.5	5.5	....	....
2,001–3,000	38	5.2	28.9	39.4	7.8	10.5	7.8	....	....
3,001–4,000	43	9.3	25.5	11.5	11.5	18.6	9.3	13.9	....
4,001–5,000	34	8.8	17.6	20.6	17.6	20.6	5.8	5.8	2.9
5,001–7,000	13	7.7	23.1	7.7	15.3	7.7	7.7	15.3	15.3

This shows the same relation of distribution of labor incomes to a given amount of capital as that of the owners. As long as the tenant does not have sufficient capital to operate a fair-sized business he had better rent as a labor tenant or work as a hired man. From these data it appears that a tenant should have not less than $2,000 before he can hope to do much better than the hired man. Five to seven thousand dollars is far more desirable and appears to give a tenant a good opportunity of making a good labor income for his year's work.

Return to Landlord on Farms Occupied by Tenants or Percentage Received by Landlord on His Investment.

Systems of Tenure.	*Return to Landlord.*
Cash	3.3 per cent
Share	7.6 per cent
Part owner share	7.7 per cent

The return to the landlord for his capital invested is 3.3 per cent for those who rent for cash; 7.6 per cent for share and 7.7 per cent to men who rent additional land. It appears as though land is a satisfactory investment in this county where potatoes are grown, though these returns do not show the rise of real estate values which accrue as additional returns to the landlord.

Table XI.

Distribution of Landlords Who Receive a Certain Per Cent on Their Investment on 140 Share-rented Potato Farms.

Per cent. received by landlord on capital invested.	Number of farms.	Percentage of total.
2 % or less	4	3
2.1–4	7	5
4.1–6	32	23
6.1–8	31	22
8.1–10	24	17
10.1–12	13	9
12.1–14	13	9
14.1–16	8	6
16–1. +	8	6

Table XII.

Distribution of Landlords Who Receive a Certain Per cent on Their Investment on 16 Cash-rented Potato Farms.

Per cent. received by landlord on capital invested.	Number of farms.	Percentage of total.
2 % or less	4	25
2.1–4	7	44
4.1–6	2	12.5
6.1–8	1	6
8.1–10	2	12.5
10.1–12	....	....
12.1–14	....	....

One-third of the landlords on the share-rented farms get less than 6 per cent on their investment in return receipts above expenses for the year, one-third get between 6 and 10 per cent, while the remaining third get over 10 per cent. This is a wide range and it suggests that greater care could be exercised in renting farms both by tenants and landlords. With the landlords who rent for cash this range does not exist, neither are the average returns as great. Here four-fifths have returns below 6 per cent while none exceed 10 per cent. The number of cash rented farms is too small from which to draw definite conclusions, but these 16 farms show that cash renting is not as profitable for the landlord as share renting.

While Monmouth County is considered the most wealthy, agriculturally, in New Jersey, apparently it is not over-capitalized if we draw from the returns of receipts over expenses for 1914 on the potato farms. Both tenants and landlords are prosperous on the average, but the returns are not phenomenal. The tenants on an average have larger farms and more capital invested, if the tenants' and landlords' capital are taken together as a unit investment per farm. The tenants lose less and make less per farm than the owners, but this is to be expected for they have less to lose. The average farm capital is shown on the following table to illustrate the investment per farm with the labor income for the capital invested.

Table XIII.

Capital on 150 Tenant Farms Showing the Relation of Operators' and Landlords' Capital to Labor Income Return in the Potato Region.

Number of farms.	Percentage of total number.	Average labor income.	Capital of Operator.		Capital of Landlord.		Average of operator's capital and average of landlord's capital
							Farm.
			Total.	Average per farm.	Total.	Average per farm.	Average per farm.
4	2.6	$470	$3,138	$785	$23,700	$5,925	$6,710
18	12.1	447	29,243	1,624	170,971	9,498	11,122
38	25.3	567	98,151	2,583	545,433	14,353	16,936
43	28.7	886	146,917	3,416	898,775	20,901	24,317
34	22.7	853	151,02[illegible]	4,442	722,500	21,250	25,692
13	8.6	1,437	74,351	5,719	295,940	22,764	28,483
Totals. . .150	*100.0*	....	$502,828	$3,352	$2,657,319	$17,715	$21,067

A very noticeable break in the tenants' labor income is observed in the class of $4,442 compared to that of the $3,416 class. Those tenants with a $1,026 increase in capital make $33 less labor income. By comparing the capital furnished by the landlord on these farms we find an increase farm value of $349 only. From this it appears that these tenants who got an investment of $4,442, do not farm a larger farm than the preceding class. Or their increased operating capital is not met by a corresponding increase on the part of the landlords. This may account for the decrease rather than an increase in their labor income above that of the $3,416 class. The next class with an average investment of $5,719 make an increase of $584 above the $4,442 men. But their corresponding landlords have an increase of $1,514, or a total farm increase of $2,791. This then brings the tenant a marked return for the landlord helps to furnish this increased capital.

Depreciation.

The depreciation on farm machinery is an important item, and one quite perplexing to the farmer. There is no arbitrary rate that can satisfactorily be used in all cases, but for this work the writer has ascertained depreciation on the different types of farms by the following method. All the expenses for repairing and new machinery are added for all the farms of one type. This sum is divided by the investment in machinery ascertained by the inventory; the result represents the rate of depreciation of machinery on the given type of farms. For research work this is quite satisfactory but might not be so in extension work where but few farms are obtained. Nevertheless, it can be used as a guide and serves to keep the extension man to a conservative figure. It does not allow for any possible repairing done by the farmer himself but this is usually a small factor. In this work, but few men were found who did any repairing whatever.

The depreciation on potato farms was found to be 11 per cent; general farms 11 per cent; truck farms 10 per cent, and in dairy farms 10 per cent. This shows but little difference in depreciation for these different types of farming in Monmouth County, hardly sufficient to be of much significance. More work on depreciation will be presented later.

REPORT OF THE DEPARTMENT OF SOIL CHEMISTRY AND BACTERIOLOGY

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CONTENTS.

Report of the Department of Soil Chemistry and Bacteriology

Jacob G. Lipman
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I.

THE AVAILABILITY OF NITROGENOUS MATERIALS.

The nitrogen problem as related to crop production is an exceedingly important one for a number of reasons, chief among which may be mentioned the high cost of nitrogen-containing materials and also the fact that a deficiency of available nitrogen is so often the prime limiting factor in crop production. The problem may be attacked from the standpoint of the source of nitrogenous material, or the method of obtaining it, and finally from the standpoint of the relative availability of the different materials obtained.

The second part of the problem is the one with which the user of nitrogenous fertilizers is directly concerned, and is the one with which this paper deals.

Notwithstanding the fact that much work has already been done along this line there are still many points upon which further light must be thrown. Especially is this true with reference to farm manures, green manure crops and crop residues.

Series I-A.

Comparison of Commercial Nitrogenous Substances.

Twenty pounds of clean white sand were placed in glazed earthenware pots and to each pot the following were added: 4 gm. acid phosphate, 2 gm. potassium sulphate, 5 gm. calcium carbonate, 0.5 gm. magnesium sulphate, and 0.25 gm. ferric sulphate. The special treatment with nitrogenous fertilizers, together with the results secured are shown in Table I. After the fertilizers were applied the pots were allowed to stand for about four months, the sand being kept moist during this time. This gave opportunity for the decomposition of the organic materials and no doubt resulted in a somewhat higher recovery of nitrogen from these materials than otherwise might have been the case. At the end of the two weeks the pots were seeded to barley which grew to maturity and was harvested and prepared for analysis in the usual way. Unfortunately the plants on the check pots made but little growth and there was practically no crop to harvest, hence there is no check for comparison. It is possible, however, to compare the total amount of nitrogen recovered under the different treatments, and in this way get some idea of the relative availability of tho materials.

Table I.

The Recovery of Nitrogen From Different Materials.
Barley.

No.	SPECIAL TREATMENT	Nitrogen applied mg.	Dry matter gm.		Per cent. nitrogen.	Total nitrogen mg.	
			Per pot.	Average		Per pot.	Average.
1			0				
2	Nothing	0	0	....	....	....	....
3			0				
4			17.6		1.796	316.10	
5	4 gm. $NaNO_3$	616	18.5	18.27	1.743	322.46	327.05
6			18.7		1.832	342.58	
7			19.5		1.236	241.02	
8	2.92 gm. $(NH_4)_2SO_4$	616	18.9	18.80	1.449	273.86	242.07
9			18.0		1.174	211.32	
10			17.5		1.192	208.60	
11	5.77 gm. Tankage	616	17.7	17.47	1.156	204.61	207.57
12			17.2		1.218	209.50	
13			15.2		1.227	186.50	
14	9.62 gm. C. S. Meal	616	18.0	16.23	1.112	200.16	183.31
15			15.5		1.032	159.96	

The yield of dry matter with nitrate of soda and ammonium sulphate is very nearly the same though the ammonium sulphate stands slightly ahead. The percentage of nitrogen in the dry matter is however decidedly higher with nitrate of soda thus giving this material the advantage in the amount of nitrogen recovered.

The results with tankage and cottonseed meal are lower, both in the yield of dry matter and in percentage of nitrogen, than with nitrate of soda or sulphate of ammonia.

These results confirm the results obtained in a number of experiments previously reported in that they show the amount of nitrogen recovered from nitrate of soda, sulphate of ammonia and organic materials to be in the order in which these materials are here named.

Series I-B.

Comparison of Commercial Nitrogenous Materials.*

This experiment was carried out in glazed earthenware pots holding 10 pounds of a sandy loam soil. All pots received the following:—5 gm. calcium carbonate, 2 gm. acid phosphate, and 1 gm. potassium sulphate. In applying the different nitrogenous materials an amount was taken equivalent to 2 gm. of nitrate of soda. The pots were seeded to barley which grew to maturity and was then harvested, dried, weighed and prepared for analysis in the usual way. The special nitrogenous treatment given and the results obtained are recorded in Table II.

*The experimental work was carried out by Mr. R. O. Cook, holder of the Ammonium Sulphate Fellowship in Rutgers College.

Table II.

The Recovery of Nitrogen From Different Materials.
Barley.

No.	SPECIAL TREATMENT.	Dry matter gm. Per Pot	Dry matter gm. Average	Gain dry matter gm.	Per-cent nitrogen.	Nitrogen mg. Per Pot.	Nitrogen mg. Average.	Increase over check mg.	Percent nitrogen recovered.
1		8.8			1.047	92.1			
2	Check	8.5	8.37		1.052	89.4	87.9	......	......
3		7.8			1.055	82.3			
4		16.9			1.221	208.4			
5	2. gm. $NaNO_3$ 15.93% N.	15.7	16.60	8.23	1.236	194.1	199.4	111.5	35.0
6		17.2			1.150	197.8			
7		16.0			1.113	178.1			
8	1.547 gm. Am. Sulphate 20.6% N............	14.0	13.80	5.43	1.214	170.0	169.1	81.2	25.5
9		11.4			1.397	159.2			
10		8.1			1.690	136.9			
11	.950 gm. Am. Nitrate 33.53% N...........	11.9	10.60	2.23	1.381	164.3	150.3	62.4	19.6
12		11.7			1.280	149.8			
13		15.6			1.164	181.6			
14	2.770 gm. Dried Blood 11.5% N............	*7.4	16.30	7.93	......	......	179.9	92.0	28.8
15		17.0			1.048	178.2			
16		9.4			1.630	153.2			
17	2.426 gm. Ca'cium Cyanam d 13.13% N..	12.5	10.27	2.00	1.760	220.0	186.4	98.5	30.9
18		8.9			2.090	186.0			

*Omitted from average

The highest yield of dry matter and highest percentage of nitrogen recovered were with nitrate of soda. In yield of dry matter, dried blood stands second and sulphate of ammonia third, but in percentage of nitrogen recovered calcium cyanamid stands second, dried blood third and sulphate of ammonia fourth. The low yield of dry matter and high percentage of nitrogen with calcium cyanamid, possibly indicate a slight *injury from this material.* The *high percentage of nitrogen especially,* an average of 1.83,-as against 1.202 for nitrate of soda and 1.241 for sulphate of ammonia would seem to indicate an abnormal growth. No explanation is at hand for the low yield with ammonium nitrate. There seems no reason why it should not give just as high yields as ammonium sulphate and a higher yield than dried blood. The fairly high yield on the check pots is no doubt responsible for the general low recovery of nitrogen.

Series II.

The Availability of Ammonium Sulphate When Used in Varying Amounts and With and Without Lime.*

The experiment was carried out in glazed earthenware pots holding 20 pounds of a sandy loam soil having a lime requirement of 800 pounds of quick lime (CaO) an acre.

Each pot received 4 gm. of acid phosphate and 2 gm. of potassium sulphate. The pots were seeded to barley which was harvested at maturity and prepared for analysis in the usual way. Table III indicates the special treatment, the yield of dry matter and the percentage of nitrogen recovered under the varying conditions.

*The experimental work was carried out by Mr. R. C. Cook, holder of the Ammonium Sulphate Fellowship in Rutgers College.

Table III.

The Recovery of Nitrogen From Ammonium Sulphate With and Without Lime. Crop Above Ground.

Barley.

Number	SPECIAL TREATMENT		Dry matter gm. Per pot	Dry matter gm. Average	Increase dry matter due to $(NH_4)_2SO_4$	Per cent nitrogen	Total nitrogen mg. Per pot	Total nitrogen mg. Average	Increase over check mg.	Per cent nitrogen recovered
1		Unlimed	16.9			.708	119.6			
2	Check		20.6	18.75		.695	143.2	131.4		
3			27.7			.708	196.1			
4	.5 gm. Sul. of Am.		28.2	27.95	9.20	.723	203.8	200.0	68.6	86.3
5			38.5			.771	297.0			
6	1 " " "		37.0	37.75	19.00	.786	290.8	293.9	162.5	78.5
7			46.2			.875	404.2			
8	2 " " "		44.0	45.10	26.35	.860	378.5	391.4	260.0	62.8
9			50.4			1.070	539.0			
10	3 " " "		48.4	49.40	30.65	1.060	512.7	525.9	394.5	63.5
11			47.6			1.385	659.0			
12	4 " " "		47.0	47.30	28.55	1.385	650.5	654.8	523.4	63.2
13		10 gms.... CaCO3	17.2			.764	131.5			
14	Check		19.4	18.30		.764	148.3	139.9		
15			30.8			.714	220.0			
16	.5 gm. Sul. of Am.		30.7	30.75	12.45	.714	219.4	219.7	79.8	77.1
17			38.2			.800	305.6			
18	1 " " "		33.9	36.05	17.75	.800	271.2	288.4	148.5	71.7
19			49.8			.876	436.4			
20	2 " " "		50.3	50.05	31.75	.866	436.6	436.5	296.6	71.6
21			53.2			1.080	574.2			
22	3 " " "		50.7	51.95	33.65	1.210	613.5	593.9	454.0	73.1
23			51.0			1.342	684.4			
24	4 " " "		50.0	50.50	32.20	1.350	675.0	679.7	539.8	65.2

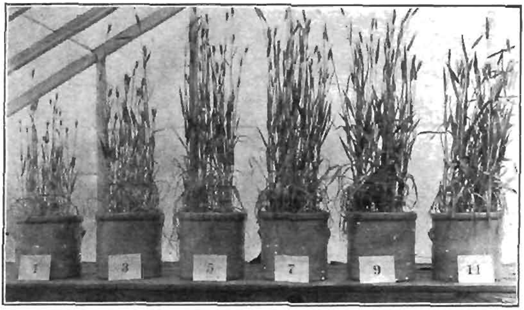
The gain in yield of dry matter due to the sulphate of ammonia increases gradually up to and including the three-gram quantity, and this applies to both the limed and the unlimed sections. With the four-gram portion there is a slight depression in both sections, indicating that with the three-gram portion, the maximum yield for the quantity of soil used, is obtained.

The average gain with the 10 gm. of calcium carbonate is somewhat greater than the gain without the calcium carbonate.

It is of interest to note the increase in the percentage of nitrogen in the dry matter with the increased application of ammonium sulphate. In this respect the limed and unlimed sections are very much alike, and this applies to the roots as well as the portion above ground as may be seen by reference to the table, though the increase in the roots is not so pronounced as in the tops.

There is a tendency towards a higher recovery of nitrogen with the smaller applications, though there are exceptions to this, as for example, in the limed section, a recovery of 73.5 per cent with three grams and 71.6 per cent with one gram. On the other hand in the unlimed section one gram gave a recovery of 77.7 per cent and three grams a recovery of 64.0 per cent. The average recoveries with calcium carbonate are somewhat higher than the average without calcium carbonate.

PLATE I.



Check 0.5 gm. 1 gm. 2 gm. 3 gm. 4 gm.

FIG. 1.—Ammonium sulphate without lime—Barley.

Check 0.5 gm. 1 gm. 2 gm. 3 gm. 4 gm.

FIG. 2.—Ammonium sulphate with lime—Barley.

On harvesting the first crop the soil was removed from the pots, sieved, and the roots from the pots bearing the odd numbers dried, weighed and nitrogen determinations made. These results are shown in Table IV. From this it will be noted, as already pointed out, that the dry weights increase as the applications of ammonium sulphate were increased. As might be expected the percentage of nitrogen in the roots is not so high as in the part above ground, but here again there is a tendency towards a slightly higher nitrogen content as the applications were increased. At the time of making the nitrogen determinations on the roots from the pots bearing the odd numbers, the roots from pots bearing the even numbers were returned to their respective pots, but without further fertilizers, and a second or residual crop grown to determine to what extent the nitrogen of these roots would become available. The residual crop which was buckwheat was grown to maturity, harvested, dry weights recorded and nitrogen determinations made as usual.

Table IV.

The Recovery of Nitrogen From Ammonium Sulphate With and Without Lime.—Roots.

Barley.

Number	SPECIAL TREATMENT.		Dry matter gm.	Gain dry matter gm.	Per cent nitrogen	Nitrogen mg.	Increase over check mg.	Per cent nitrogen recovered roots	Total recovery
1	Check	....	3.2	......	.685	21.9	......	......	......
3	.5 gm. Sulphate of Am...	....	6.2	3.0	.699	43.3	21.4	20.7	87.0
5	1.0 " " " " ..	....	7.8	4.6	.728	57.5	35.6	17.2	95.7
7	2.0 " " " " ..	Unlimed	8.8	5.6	.772	67.9	46.0	11.1	73.9
9	3.0 " " " " ..	....	11.5	8.3	.810	93.2	71.3	11.6	75.0
11	4.0 " " " " ..	....	12.0	8.8	.990	118.9	97.0	11.7	74.9
13	Check	....	3.0	......	.765	22.9	......	......	......
15	.5 gm. Sulphate of Am...	....	6.0	3.0	.730	43.8	20.9	20.2	97.3
17	1.0 " " " " ..	....	8.5	5.5	.610	51.9	29.0	14.0	85.7
19	2.0 " " " " ..	10 gm.	13.5	10.5	.757	102.3	79.4	19.2	90.8
21	3.0 " " " " ..	$CaCO_3$...	15.5	12.5	.775	120.2	97.3	15.7	88.8
23	4.0 " " " " ..	....	18.5	15.5	.787	145.6	122.7	14.8	80.0

No essential difference was found either in weight of dry matter or of total nitrogen recovered, between the pots bearing the even and those bearing the odd numbers. That is, there was no recovery of nitrogen from the roots that were returned to the pots bearing the even numbers. There was a small amount of nitrogen recovered from all pots, varying from one to four and one-half per cent, but this nitrogen evidently came from the soil organic matter or from some residual ammonium sulphate and not from the returned roots, otherwise more nitrogen would have been recovered from the even numbered pots than from the odd numbered ones. Evidently the time was too short for the decomposition of these roots to go far enough to yield available plant food even in the presence of an abundant supply of carbonate of lime.

There was however more nitrogen recovered from the limed than from the unlimed section, which shows the influence of the lime on the decomposition of the organic matter—older material than the roots—and on the nitrification of the ammonium sulphate. The yield of dry matter was small throughout, but there was the same tendency, noted in the first crop, towards an increased yield with increase of the ammonium sulphate applied.

The figures for this crop are not reported for the reason that they do not materially change the results secured with the first crop.

Taking the entire series the recoveries are distinctly higher than have usually been obtained with sulphate of ammonia. This is no doubt due in part to a utilization by the crop of a part of the nitrogen of the soil organic matter, this having been made available as a result of the stirring and consequent thorough aeration of the soil at the time of preparation. The high yield of dry matter on the check pots bears out such an explanation and while it is true that the subtracting of the yields from the checks is supposed to make a correction for this, as a matter of fact it does not fully make such correction for the reason that the readily available soil nitrogen stimulates the plant to a more complete utilization of the ammonium sulphate as it gradually goes through the process of being converted into nitrates, and on the other hand the stimulating effect of the ammonium sulphate causes the plant to use more of the nitrogen of the soil organic matter than is used by the plants in the check pots.

The accompanying photograph gives a fair indication of the relative growth under the different treatments.

Series III-A.

Green Manures Compared With Commercial Materials.

The experiment was carried out in glazed earthenware pots holding 20 pounds of white sand, and the general treatment with minerals was the same as in Series I-A. For green manures three legumes and three non-legumes were selected. These were collected the 22nd of May and nitrogen determinations were made at once in order that the proper quantity of each might be weighed out. Three grams of nitrate of soda (15.4 per cent of nitrogen), equivalent to 462 mg. of nitrogen were taken as the standard nitrogen treatment and sufficient quantities of the other materials to give an equivalent in nitrogen. The chopped up green crops and the fertilizer materials were mixed with the soil and the mixture was allowed to stand for two weeks before planting to barley so that conditions might be somewhat similar to those given by the plowing under of a green manure crop. The general plan of the experiment is set forth in Table V. The table likewise gives the weights of dry matter, and percentages of nitrogen recovered.

Table V.

Recovery of Nitrogen From Fertilizers and Green Manures.

Barley.

Number	SPECIAL TREATMANT	Nitrogen applied mg.	Dry matter gm. Per pot	Dry matter gm. Average	Per cent nitrogen	Total nitrogen mg. Per pot	Total nitrogen mg. Average	Increase over check, mg.	Per cent nitrogen recovered
1	....	......	1.9		.969	18	......	......	......
2	Check.	......	2.0	1.95	.850	17	18	......	......
3	3.00 gms. nitrate of		30.5		.988	301			
4	soda (15.4%).	462	35.3	32.90	.988	349	325	307	66.5
5	2.193 gms. Sulphate of Ammo-		26.0		1.018	265			
6	nia (21.07%).	462	24.0	25.00	1.108	266	266	248	53.7
7	3.972 gms. Dried Blood		22.5		.998	225			
8	(11.63% N.).	462	23.0	22.75	.988	227	226	208	45.0
9	6.417 gms. Tankage		15.0		.940	141			
10	(7.2% N.).........	462	14.5	14.75	.979	142	142	124	26.8
11	69.86 gms. Green Alfalfa......		19.0		.988	188			
12		462	18.0	18.50	.949	171	180	162	35.1
13			20.7		.969	201			
14	73.48 gms. Green Vetch	462	19.7	20.20	.949	187	194	176	38.1
15			21.3		.910	194			
16	85.55 gms. Green Can. Fld. Peas	462	21.2	21.25	.949	201	198	180	39.0
17			3.4		.969	33			
18	155.92 gms. Green Rye	462	4.4	3.90	.999	44	39	21	4.5
19			13.5		.930	126			
20	106.52 gms. Green Timothy....	462	9.2	11.35	.949	87	107	89	19.3
21			5.0		1.117	56			
22	147.27 gms. Green Wheat ...	462	2.4	3.70	.979	24	40	22	4.8

Before the plants were many weeks old it was apparent that the plants in the pots to which nitrate was applied were going ahead of the others. It was likewise apparent that those in the pots that received the green legumes would surpass those that received the non-legumes. Referring to the table it will be noted that the largest yield was obtained with nitrate of soda, and that this is followed in order by sulphate of ammonia, dried blood, and tankage. The yields with alfalfa, vetch, and Canada field peas do not differ greatly and stand between the tankage and dried blood. Of the non-legumes, timothy stands ahead, but all are low, the yields with green wheat and rye being only a little more than the check. The percentages of nitrogen in the dry matter are fairly constant the lowest being 0.85 per cent, and the highest 1.117 per cent.

The highest recovery of nitrogen is 66 per cent with nitrate of soda. The ammonium sulphate, dried blood, and tankage follow in the order named. These results are quite in accord with the results reported in previous years.

The highest recovery with the green legumes is 39 per cent, with Canada field peas and the lowest 35.1 per cent with alfalfa. The highest recovery with the non-legumes is 19.3 per cent with timothy while both the others fall below 5 per cent.

It is significant that there should be so much difference in the availability of the nitrogen in the legnmes and the non-legumes. With reference to the latter it may be pointed out that they are low grade materials that is, a large quantity must be used in order to obtain the desired amount of nitrogen, and in this case attention may be called to the fact that the least recovery was with rye of which there was the largest amount required. It would appear that the rather hard, almost woody structure of these materials enable them to resist decay. Timothy is not so hard as the rye or wheat and it will be observed that it has given a recovery nearly three times as great as the other materials.

It is possible too, that the large amount of carbohydrate material has actually had a detrimental effect. We have shown in previous reports that excessive applications of carbohydrates may depress the yield very materially and frequently attention has been called to the fact that heavy applications of coarse manure have the same effect.

The pots to which the wheat and rye were applied received just as much nitrogen as any of the others but it is quite evident from the figures in the table, that the plants got only a small fraction of this nitrogen Either it must have been lost, or it remained in the soil unutilized. The latter seems the more probable, since the only opportunity for loss was by volatilization as nitrogen or as ammonia, and there seems little probability that so great a loss could take place in this way with the wheat and rye, and not with the legumes.

The results emphasize again the desirability of the legumes as a green manure crop rather than the non-legumes, for not only do the legumes furnish more nitrogen but that which they do furnish is far more available.

This work is being continued to determine to what extent the residual nitrogen may become available for a second crop.

The accompanying photograph, Plate A. Fig. 2, shows the appearance of the plants about the 10th of August and constitutes a very good check upon the weights as reported.

Series III-B.

Green Manures Compared With Commercial Materials.

The plan of this experiment is identical with that of the experiment reported under Series III-A. However, 20 pounds of rather poor sandy loam soil were used instead of the 20 pounds of sand, and the green materials were cut later—June 17th—about the time they were in bloom. As in Series III-A. sufficient quantities of these were taken to give nitrogen equivalent to 3 gm. of nitrate of soda (15.4 per cent nitrogen). Also as in Series III-A. the green materials and fertilizers were mixed with the soil two weeks before the time of planting the barley. The plan of the experiment together with the weights of dry matter and percentages of nitrogen recovered are shown in Table VI. Here again the nitrate of soda gave the largest yield of dry matter, followed by the legumes, which differ from one another only slightly. The ammonium sulphate stands between the tankage and the dried blood. It is noteworthy that the yields of dry matter with the rye and wheat are actually less than the yields on the check pots, which indicates a direct injury due to the presence of these materials.

PLATE II.

147.27 gm. Green Wheat | 106.52 gm. Green Timothy | 155.92 gm. Green Rye | 85.55 gm. Canada Field Peas | 73.48 gm. Green Vetch | 69.96 gm. Green Alfalfa | 6.42 gm. Tankage | 3.97 gm. Dried Blood | 2.19 gm. $(NH_4)_2SO_4$ | 3 gm. $NaNO_3$, | Check

FIG. 3.—Nitrogenous Fertilizers and Green Manures Compared. Barley Grown in Sand.

Table VI.

Recovery of Nitrogen From Fertilizers and Green Manures.

Barley.

Number	SPECIAL TREATMENT	Nitrogen applied mg.	Dry Matter gms. Per pot	Dry Matter gms. Average	Per cent nitrogen	Total nitrogen mg. Per pot	Total nitrogen mg. Average	Increase over check, mg.	Per cent nitrogen recovered
1			11.0		.979	108			
2	Check		9.0	10.00	1.187	107	108		
3			18.0		1.622	292			
4	3.00 gm. Nitrate of Soda.	462	20.2	19.10	1.602	324	308	200	43.29
5			16.0		1.730	277			
6	2.193 gm. Sulph. of Ammonia..	462	12.0	14.00	1.839	221	249	141	30.52
7			11.5		1.750	201			
8	3.972 gm. Dried Blood	462	15.0	13.25	1.552	2[illegible]4	218	110	23.81
9	(11.63% N.)		15.3		1.484	227			
10	6.417 gm. Tankage (7.2% N.) .	462	14.0	14.70	1.484	208	218	110	23.81
11			13.2		1.414	187			
12	60.63 gm. Green Alfalfa in blm.	462	17.0	15.10	1.375	234	211	103	22.27
13			15.3		1.444	221			
14	66.81 gm. Green Vetch in blm.	462	15.5	15.40	1.325	205	213	105	22.73
15			11.0		1.958	215			
16	90.67 gm. Green Canada Field	462	19.0	15.00	1.464	278	247	139	30.09
17	*Peas in bloom.* ...		4.8		1.602	77			
18	157.70 gm. Green Rye in head	462	2.8	3 80	1.780	50	64	......	......
19			14.0		1.266	177			
20	122.70 gm. Green Timothy in	462	13.5	13.75	1.375	186	182	74	16.02
21	bloom		6.0		1.562	94			
22	129.70 gm. Green Wheat in . head.	462	9.0	7.50	1.424	128	111	3	.65

There is a much wider variation in the percentage of nitrogen in the dry matter than there was in Series III-A, the lowest in this case being .979 per cent and the highest 1.958 per cent. The highest average was 1.784 per cent with ammonium sulphate and the next highest 1.711 per cent with Canada field peas.

The percentage of nitrogen recovered is lower in all cases than in Series III-A, though here again nitrate of soda stands first with ammonium sulphate second. The recovery with Canada field peas is almost equal to the recovery from ammonium sulphate while the recovery from the blood, tankage, alfalfa and vetch are somewhat lower, but run very close together. There was no recovery from rye and less than one per cent from the wheat. Evidently these materials had a depressing effect upon the yield, due possibly to the excessive amount of carbohydrate material. The recovery from the timothy is slightly less than one-sixth of a possible 100, as compared with a recovery of nearly one-third out of a possible 100 for the Canada field peas.

The accompanying photograph, Plate II, Fig. 3, shows the appearance of the plants at a rather early stage of growth but confirms the analytical data here presented.

II.

LIME AS A FACTOR IN THE UTILIZATION OF NITROGEN.

Series I.

Complaint is sometimes made that the plowing under of green materials or even dry organic matter seems to reduce the crop yield rather than increase it.

Assuming that this decreased yield might be due in part to the formation of organic acids which would retard decomposition, and therefore the formation of available plant food, it was determined to conduct an experiment using carbonate of lime as a corrective for this condition.

The soil was a sandy loam of medium quality. Two-gallon glazed earthenware pots, which held 17 pounds of soil, were used. No commercial fertilizers were used. Rye was used as the source of organic matter. This was cut in December when young, chopped up and mixed with the soil. For *dry* organic matter the same material was used after it had been dried. The pots were seeded to barley and when this had matured it was harvested, dried and samples prepared for analysis in the usual way.

Table VII shows the special treatment together with the weights of dry matter, and of nitrogen obtained. From the data here presented it will be noted that neither the organic matter nor the carbonate of lime have appreciably increased the weight of dry matter. It is quite apparent, however, that with these materials there has been a decided increase in the percentage of nitrogen in the dry matter. Thus the total yield of nitrogen is greater in all pots where these materials were used than in pots 1 and 2 which received no treatment. This is shown in the column headed "Increase of Nitrogen Over no Treatment." It will he noted that with the green rye the carbonate of lime gave distinct increases, the largest increase being with the heaviest application of the carbonate. In the case of dry rye the 10 and 20 gram portions of calcium carbonate resulted in an increase of nitrogen. With 30 gm. of carbonate there was unfortunately poor agreement between the checks, both as regards dry matter and nitrogen content, and these pots show a loss. The experiment indicates quite clearly that the carbonate of lime does aid in the decomposition of the organic matter and thus in furnisbing the plant with available nitrogen.

Table VII.

The Effect of Lime on the Decomposition of Organic Matter.

Barley.

Number.	SPECIAL TREATMENT	Dry matter gm Per pot	Dry matter gm Average	Per cent nitrogen	Total nitrogen mg. Per pot	Total nitrogen mg. Average	Increase of nitrogen over no treatment mg.	Increase of nitrogen over check, mg.
1		29.1		1.089	316.90			
2	Nothing	29.6	29.35	1.079	319.38	318.14	....	....
3		32.6		1.264	412.06			
4	100 gm. Green Rye (Check) ..	28.2	30.40	1.594	449.51	430.79	112.65	....
5		19.0		2.333	443.27			
6	100 gm. Green Rye; 10 gm. Lime	24.5	21.75	1.789	438.31	440.79	122.65	10.00
7		28.8		1.663	479.94			
8	100 gm. Green Rye; 20 gm. Lime	29.4	29.10	1.614	474.52	477.23	159.09	46.44
9		24.9		1.915	476.84			
10	100 gm. Green Rye; 30 gm. Lime	32.3	28.60	2.285	738.06	607.45	289.31	176.66
11		33.5		1.458	488.43			
12	25 gm. Dry Rye; (Check).......	23.9	28.70	1.915	457.69	473.06	154.92	....
13		27.3		1.828	499.04			
14	25 gm. Dry Rye; 10 gm. Lime .	33.1	30.20	1.633	540.52	519.78	201.64	46.72
15		29.8		1.789	533.12			
16	25 gm. Dry Rye; 20 gm. Lime .	31.9	30.85	1.526	486.79	509.96	191.82	36.90
17		19.7		2.158	425.13			
18	25 gm. Dry Rye; 30 gm. Lime .	31.7	25.70	1.410	446.97	436.05	117.91	....

With an abundant supply of organic matter and carbonate of lime a crop is obtained which is richer in protein and therefore higher in feeding value, than one grown with a deficiency of these materials even though the former be no more in quantity than the latter.

Series II.

This experiment emphasizes the importance of carbonate of lime in making available the nitrogen of the soil organic matter and also in making conditions favorable for the accumulation of atmospheric nitrogen by means of leguminous crops. The soil used was taken from an unlimed plot where sulphate of ammonia had been used for several years, and was *distinctly acid in reaction.*

No fertilizing materials other than those indicated in the plan were used. Table VIII shows the arrangement of the series together with the weights of dry matter and nitrogen recovered.

Table VIII.

Lime as an Aid in the Utilization of Nitrogen.

Number	SPECIAL TREATMENT	Crop	Dry matter gm. Per pot	Dry matter gm. Average	Per cent nitrogen.	Total nitrogen mg. Per pot.	Total nitrogen mg. Average.	Increase of nitrogen over check mg.
1			6.4		3.101	198.46		
2	Nothing		3.5	4.95	2.946	103.11	150.79	....
3			5.4		2.343	126.52		
4	2 gm. $NaNO_3$.	Vetch	6.9	6.15	2.557	176.43	151.46	.67
5			9.4		3.461	325.33		
6	10 gm. $CaCO_3$..............		8.8	9.10	3.393	298.58	311.96	161.17
7			2.2		1.254	27.59		
8	Nothing		2.0	2.10	1.186	23.72	25.66	....
9			7.4		1.838	136.01		
10	2 gm. $NaNO_3$...............	Barley	8.9	8.15	1.449	128.96	132.49	106.83
11			8.8		.778	68.46		
12	10 gm. $CaCO_3$.....		9.3	9.05	.865	80.45	74 46	48.80
13			8.1		1.896	153.58		
14	Nothing		10.1	9.10	2 207	222 91	188 25	.. ....
15		Canada	15.1		2.392	361.19		
16	2 gm. $NaNO_3$...............	Field	13.3	14.20	2.324	309.09	335.14	146.89
17		Peas.	19.7		2.800	5 1.60		
18	10 gm. $CaCO_3$		20.9	20.3	2.596	5 2.56	547.08	358.83

It will be observed that with each crop the nitrate of soda and carbonate of lime gave higher yields of dry matter than the check. Likewise in each case the carbonate of lime gave higher yields than nitrate of soda. In the case of vetch and Canada field peas the percentage of nitrogen in the dry matter is greater with the calcium carbonate than with the nitrate of soda. With the barley the highest percentage of nitrogen was obtained with the nitrate of soda.

It thus appears that the percentage of nitrogen in the dry matter of the non-legume is somewhat increased by an application of available nitrogen, and that the percentage of nitrogen in the dry matter of a legume may be higher with a liberal supply of calcium carbonate than with a liberal supply of a soluble nitrogenous compound. This is brought out clearly in the figures in the column headed "Increase in Nitrogen over Check." Too much emphasis cannot be laid upon this as indicating the method which farmers should adopt in maintaining and building up the nitrogen supply of the soil. In the case of leguminous crops the gain in nitrogen in the first crop would no doubt, in most cases, more than pay for the lime used.

Series III.

Series III was carried out in exactly the same manner as Series II, but the soil in this case was taken from a limed sulphate of ammonia plot. However, as the lime had been applied about four years previous to the taking of the sample the soil had again become distinctly acid, though the degree of acidity was not so great as that of the soil used in Series II.

The special treatment given and the results secured are shown in Table IX.

Table IX.

Lime as an Aid in the Utilization of Nitrogen.

Number	SPECIAL TREATMENT	Crop.	Dry matter gm. Per plot.	Dry matter gm. Average.	Per cent nitrogen.	Total nitrogen mg. Per plot.	Total nitrogen mg. Average.	Increase over check.
1			2.8		2.586	72.41		
2	Nothing		2.2	2.50	2.722	59.88	66.15	....
3			8.2		3.179	260.68		
4	2 gm. $NaNO_3$	Vetch	7.8	8.00	2.897	223,97	243.33	177.18
5			8.7		3.578	311 39		
6	10 gm $CaCO_3$		8.7	8.70	3.626	315.46	313.43	247.28
7			1.9		1.147	21.79		
8	Nothing		2.0	1.95	1.400	28.00	24.90	....
9			13.8	......	1.001	138.14		
10	2 gm. $NaNO_3$	Barley	18.2	16.00	.943	171.62	154.88	129.98
11			7.0		1.069	74.83		
12	10 gm $CaCO_3$		6.7	6.85	.982	65.69	70.31	55.41
13			7.7		2.139	164.70		
14	Nothing	Canada	12.8	10.25	2.295	293.76	229.23	....
15		Field	18.6		2.888	537.17		
16	2 gm. $NaNO_3$	Peas	17.7	18.15	2.858	505.87	521.52	202.29
17			17.7		2.606	461.26		
18	10 gm. $CaCO_3$		15.0	16.35	2.149	322.35	391.81	162.58

In each instance carbonate of lime resulted in an increased yield though only with the vetch did it give a greater yield than nitrate of soda. The percentage of nitrogen in the dry matter is likewise higher where the carbonate of lime was used than it is in the check pots. In the case of the vetch it is distinctly higher than with nitrate of soda. With the vetch the increase in total nitrogen over the check, is decidedly greater than the increase with the nitrate of soda; with the barley there is an increase over the check, but this is not equal to the increase with the nitrate of soda.

Evidently the carbonate has had the effect of making available some of the nitrogen of the soil organic matter, but the amount thus made available is less than the amount furnished by the 2 gm. of nitrate of soda.

With the Canada field peas, the carbonate of lime has likewise given an increase over the check, but again it is not equal to the increase made with nitrate of soda.

It is quite evident that with such soils an application of carbonate of lime has an effect similar to that given by an application of a soluble nitrogenous compound. It makes the conditions for the nitrification of the soil organic matter more favorable, and what is perhaps of more importance, it greatly increases the amount of nitrogen fixed by symbiotic bacteria, if leguminous crops are grown.

Series IV.

The soil used in this experiment was a very acid muck taken from the Hackensack Meadows. It was quite certain that lime in some form would be required for most crops. But it seemed worth while also to try commercial fertilizers both alone and in combination with the lime. A given weight of the muck, which had been treated as indicated in the accompanying table, was placed in one-gallon glazed earthenware pots and cabbage seed planted in each, cabbage being a crop that does well in neutral or slightly alkaline soil. The results are set forth in Table X.

Table X.

The Effect of Lime on the Decomposition of Soil Organic Matter.

		FIRST CROP—CABBAGE						RESIDUAL CROP—CORN				
		Dry matter gm.			Total nitrogen mg.			Dry matter gm.			Total nitrogen mg.	
Number	SPECIAL TREATMENT	Per pot	Average	Per cent nitrogen	Per Pot	Average	Increase over check, mg	Per pot	Average	Per cent nitrogen	Per pot	Average
1		5.2		2.611	136			26.5		1.187	315	
2	Check	5.0	5.10	3.926	196	166	....	26.9	26.70	1.018	274	295
3		5.0		3.989	199			22.5		1.187	267	
4	2 gm. $NaNO_3$	4.0	4.50	2.640	106	153	....	21.4	21.95	1.137	243	255
5		14.2		1.730	246			16.5		0.890	147	
6	4 gm. Acid Phosphate	* .5	14.20	3.066	* 15	246	80	29.6	23.05	0.910	269	208
7		5.0		2.928	146			24.5		0.930	228	
8	2 gm. KCl	*1.9	5.00	3.677	* 70	146	....	27.7	26.10	1.028	285	257
9		*5.4		3.677	*199			28.4		0.712	202	
10	5 gm. Limestone	14.2	14.20	1.543	219	219	53	19.5	23.95	0.761	149	176
11		19.5		1.414	276			21.5		0.722	155	
12	10 gm. Limestone	15.4	17.45	1.434	221	249	83	19.0	20.25	0.712	135	145
13		24.0		1.256	301			28.2		0.652	184	
14	25 gm. Limestone	25.5	24.75	1.058	270	286	120	24.9	26.55	0.741	185	185
15		31.7		1.740	551			23.0		0.702	162	
16	50 gm. Limestone	31.4	31.55	1.454	457	504	338	27.0	25.00	0.741	200	181
19		23.1		1.385	320			20.2		0.810	164	
18	10 gm. Limestone; 4 gm. A. P.; 2 gm. KCl.	21.7	22.40	1.325	287	304	138	21.5	20.85	0.613	132	148
19		23.7		1.424	337			28.6		0.613	175	
20	25 gm. Limestone; 4 gm. A. P.; 2 gm. KCl	12.8	18.25	1.483	190	264	98	46.2	37.40	0.534	247	211
21		30.5		1.236	377			19.5		0.692	135	
22	10 gm Limestone; 4 gm. A.P.; 2 gm. KCl; 2 gm. $NaNO_3$	28.5	29.50	1.315	375	376	210	26.0	22.75	0.702	183	159
23		37.9		1.236	469			22.5		0.603	136	
24	25 gm. Limestone; 4 gm. A.P.; 2 gm. KCl; 2 gm. $NaNO_3$	32.5	35.20	1.375	447	458	292	24.5	23.50	0.692	170	153

*Omitted from average

The highest yield was from pots 23 and 24 with ground limestone and a complete fertilizer. A yield almost as great however was obtained from pots 5 and 6 where 50 gm. of ground limestone only were used. The third highest yield was obtained from pots 21 and 22 where 10 gm. of ground limestone and a complete fertilizer were used. From pots 13 and 14, with 25 gm. of ground limestone, the yield is slightly greater than from pots 17, 18, 19 and 20 where limestone was used with acid phosphate and muriate of potash. These differences are clearly brought out in the accompanying photographs.

From data here presented it would appear that the non-productiveness of this soil should be attributed partly to a deficiency of available nitrogen and partly to direct acidity or to the presence of some other toxic conditions which were counteracted by the use of ground limestone, since with nitrate of soda alone, with minerals alone, and also with an insufficient application of ground limestone the yield was low. On the other hand with a heavy application of ground limestone the second largest yield was obtained, and the largest increase in nitrogen, over the check.

This soil was unusually high in total nitrogen and it is quite evident from the above that much of this became available when the soil was sufficiently neutralized, thus giving an effect even better than that obtained with nitrate of soda, and likewise better than that with an application of minerals and nitrate of soda, without an adequate supply of lime.

After harvesting the cabbage from the experiment described above the soil in these pots was thoroughly stirred and allowed to stand for several days and then planted to corn—four grains to the pot—without further fertilizer or lime treatment. The results obtained from this experiment are shown as part of Table X.

It will at once be noted that the yields were much more uniform than in the experiment with cabbage. Furthermore some of the largest yields of corn were found where the yield of cabbage was small. At least three reasons may be assigned for these differences. The stirring of the soil would permit the oxidation of a certain amount of the toxic substance; where the first crop was large more of the available plant food was taken out than where it was small, that is, there was less left for the second crop; and, finally, corn will endure a higher degree of acidity than cabbage, without injury.

It may be pointed out that the percentage of nitrogen is likewise higher in the corn taken from pots that gave a low yield of cabbage than it is in those that gave a higher yield. For example, pots 1—8 in comparison with 9—24. This is further evidence that plant food in pots 1—8, which was not available for the cabbage, became available for the corn. This statement is borne out by the amount of nitrogen recovered in the crop as shown in the last column of the table.

Without question there are thousands of acres of such soil in the State that can be made highly productive without the expenditure of a dollar's worth of commercial fertilizer. To make them productive they would

PLATE III.

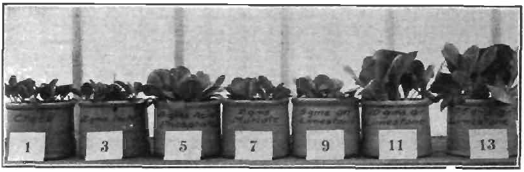


FIG. 5.—Cabbage on muck soil.

FIG. 6.—Cabbage on muck soil.

FIG. 7.—Beets on muck soil.

Photos by C. P. Browning

require, however, good drainage, thorough cultivation and a liberal application of lime, marl or ground limestone. In some cases a liberal application might mean five or six tons of ground limestone to the acre, but this would probably prove less expensive than the use of high grade fertilizers on poor upland soils.

Series V.*

The soil used in Series V was a silt loam from the lowlands along the Delaware River. It was decidedly acid having a lime requirement of about five or six thousand pounds per acre and was high in organic matter. The experiment was conducted in two-gallon glazed earthenware pots, 13 pounds of the soil being used per pot. No general fertilizer treatment was given. The pots were planted to barley which was grown to maturity and harvested and prepared for analysis in the usual way. The special treatment together with the weights of dry matter and nitrogen obtained are shown in Table XI. It will be noted that nitrate of soda alone gave only a small increase in dry matter; minerals with nitrate gave a somewhat larger increase, but unfortunately the checks do not agree as they should. With 5 gm. of lime the average weight was a little below the check. However, with 10 and 25 gm. portions of lime there were pronounced increases. A somewhat greater increase was made with 10 gm. of lime and a complete fertilizer.

Table XI.
The Effect of Lime on an Acid Soil.

Number.	SPECIAL TREATMENT.	Dry matter gm. Per pot.	Dry matter gm. Average.	Per cent nitrogen.	Total nitrogen mg. Per pot.	Total nitrogen mg. Average.	Increase over check.
1		21.5		1.425	306.4		
2	Check	32.0	26.75	1.331	425.9	366.2	......
3		28.0		1.781	498.7		
4	2 gm. $NaNO_3$	35.0	31.50	1.575	551.3	525.0	158.8
5		33.0		1.275	420.8		
6	4 gm. acid phosphate; 2 gm. KCl	32.0	32.50	1.406	449.9	435.4	69.2
7		23.0		1.725	396.8		
8	4 gm. acid phosphate; 2 gm. KCl; 2 gm. $NaNO_3$	44.0	33.50	1.537	676.2	536.5	170.3
9		29.0		1.256	364.2		
10	5 gm. Quick lime	23.5	26.25	1.620	380.7	372.5	6.3
11		35.7		1.335	476.6		
12	10 gm. Quick lime	38.5	37.10	1.293	497.8	487.2	121.0
13		40.0		1.706	682.4		
14	25 gm. Quick lime	35.5	37.75	1.837	652.1	667.3	301.1
15		50.0		1.594	797.0		
16	10 gm. Quick lime; 4 gm. acid phos.; 2 gm. KC, and 2 gm. $NaNO_3$	50.5	50.25	1.500	757.5	777.3	411.1

The highest percentage of nitrogen in the dry matter is shown with 25 gm. of lime but without commercial fertilizers, and the next highest is with 2 gm. of nitrate of soda.

*The experimental work for Series V and VI was carried out by Mr. A. G. Waller, class of 1915, Rutgers College.

The highest yield of nitrogen was with 10 gm. of lime and a complete fertilizer and the second highest with 25 gm. of lime only.

The analysis of this soil shows that it was rather high in mineral fertilizing materials and in total nitrogen and the results here obtained would seem to indicate that with a liberal application of lime there is not much need of commercial fertilizers.

Series VI.

In Series VI the soil was the same as that used in Series V. However in this experiment cabbage and radishes were grown and only nitrate of soda and carbonate of lime were used. The quantities of these used and the green weights obtained are shown in Table XII. From this table it will be noted that in the case of the cabbage nitrate of soda alone gave but slight increase, but this with carbonate of lime gave a remarkable increase. Likewise carbonate of lime alone gave a large increase, this increase being greater with 30 gm. than with 15 gm. of the carbonate.

Table XII.

The Effect of Lime on an Acid Soil.

Number.	SPECIAL TREATMENT.	CABBAGE. Green matter gm.		RADISHES. TOPS. Green matter gm.		RADISHES. ROOTS. Green matter gm.		RADISHES. TOTAL. Green matter gm.	
		Per pot.	Average.	Per pot.	Average.	Per pot.	Average.	Per pot.	Average.
1		2.6		* .5		* .5		*1.0	
2	Check	3.2	2.90	12.5	12.5	2.0	2.0	14.5	14.5
3		3.4		10.0		1.0		11.0	
4	2 gm. $NaNO_3$	2.7	3.05	12.0	11.0	2.0	1.5	14.0	12.5
5		126.5		135.0		120.0		255.0	
6	2 gm. $NaNO_3$; 15 gm. $CaCO_3$	157.0	141.75	128.0	131.5	92.0	106.0	220.0	237.5
7		111.5		69.0		96.0		165.0	
8	15 gm. $CaCO_3$	110.2	110.85	68.5	68.75	88.5	92.25	157.0	161.0
9		132.0		91.5		158.5		250.0	
10	30 gm. $CaCO_3$	152.0	142.00	75.0	83.25	120.0	139.25	195.0	222.5

*Omitted from average.

With the radishes similar results were obtained. There was no increase with nitrate of soda alone but with nitrate and 15 gm. of carbonate of lime there was again a remarkable increase. Also with carbonate of lime alone there was a very great increase. The effect of the carbonate of lime is especially noticeable in the yield of roots, which in this case is the important part of the crop. The average weight of the roots with 30 gm. of carbonate of lime is 139.2 gm. as against 1½ gm. with nitrate of soda alone, and 106 with nitrate of soda and 15 gm. of carbonate of lime.

From this it is very clear that applications of nitrate of soda only, on this soil, for the crops grown, would result in an absolute loss.

The results would indicate the presence of a toxic substance producing positive injury and that this substance may be destroyed by the use of carbonate of lime. The injury may come from the direct acidity or it may be due to the presence of some compound of iron as for example, fer-

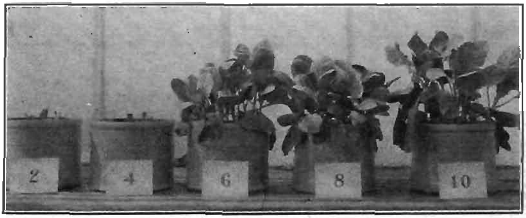
Plan of Experiment.

Series	Arrangement of Cylinders			Soil.	Treatment.
A	1	2	3	Shale soil	1, 2. Nothing. 3, 4. 10 gm. nitrate soda 5, 6. 13.24 gm. dried blood
	4	5	6		
B	1	7	5	10% sand..	"
	4	5	6		
C	1	2	3	20% "	"
	4	5	6		
D	1	2	3	30% "	"
	4	5	6		
E	1	2	3	40% "	"
	4	5	6		
F	1	2	3	50% "	"
	4	5	6		
G	1	2	3	70% "	"
	4	5	6		
H	1	2	3	80% "	"
	4	5	6		
I	1	2	3	90% "	"
	4	5	6		
J	1	2	3	100% "	"
	4	5	6		

PLATE IV.

Check	2 gm. $NaNO_3$	2 gm. $NaNO_3$ 15 gm. $CaCO_3$	15 gm. $CaCO_3$	30 gm. $CaCO_3$

FIG. 8.—Radishes—Original soil highly acid.



Check	2 gm. $NaNO_3$	2 gm. $NaNO_3$ 15 gm. $CaCO_3$	15 gm. $CaCO_3$	30 gm. $CaCO_3$

FIG. 9.—Cabbage—Original soil highly acid.

rous sulphate. Whatever the toxic substance, it was not destroyed by nitrate of soda, nor could the nitrate be utilized by the plant in the presence of the toxic substance. With the injurious substances destroyed by the use of carbonate of lime, there was enough available plant food in the soil for a good crop. The differences here emphasized in the case of both cabbage and radishes, are clearly brought out in the accompanying photographs.

NITROGEN UTILIZATION IN FIELD AND CYLINDER EXPERIMENTS.

The Influence of the Mechanical Composition of the Soil on the Availability of Nitrate of Soda and Dried Blood.

This is a continuation of work that was begun in the spring of 1911, and the results for 1911, 1912, 1913 and 1914 have already been published.* For convenience, a diagram showing the plan of the experiment, together with a brief description, as presented in previous reports, are herewith submitted.

"The soil used was the typical red shale that had not been under cultivation. This was screened to remove stones, and was then mixed with sand in varying proportions as indicated in the accompanying diagram. The soil was then placed in cylinders of the type that has been in use at this Station for a number of years,† and to each cylinder there were added 38 gm. of precipitated chalk, 20 gm. acid phosphate, 5 gm. potassium chloride, 5 gm. potassium sulphate and 2 gm. magnesium carbonate. As originally planned the five-year rotation included corn, oats, wheat and timothy. Later it was decided to substitute barley for oats, consequently the 1912 crop was barley with buckwheat as a residual crop. Each group of six cylinders is set off in three pairs, and each of the three pairs of a group receives a different fertilizer treatment, which treatment, however, is common to all groups. Thus the first and second cylinders of any group receive no fertilizer, the third and fourth receive 10 gm. of nitrate of soda and the fifth and sixth dried blood equivalent to 10 gm. of nitrate of soda."

First Crop 1914—Barley.

As in previous years the cylinders remained bare during the winter of 1914-1915, and were prepared and seeded to barley the 22nd of April. Each cylinder received 20 gm. of acid phosphate, 5 gm. potassium sulphate, 5 gm. calcium chloide, 38 gm. calcium carbonate (ground limestone) and 2 gm. magnesium carbonate.

The special treatment was the same as in previous years, that is, for each series, cylinders 1 and 2 constitute the check (no nitrogen) 3 and 4 receive 10 gm. of nitrate of soda and 5 and 6 an equivalent amount of nitrogen in the form of dried blood.

*Reports of Soil Chemist and Bacteriologist, New Jersey Agricultural College Experiment Station, 1911, 1912, 1913, and 1914.

†Bul. 221, N. J. Expt. Sta.

The barley was somewhat earlier than usual, and a good crop was harvested July 19th. The samples were dried, weighed and prepared for analysis, in the usual way. The dry weights, percentage of nitrogen and nitrogen recovered are indicated in Table XIII.

Table XIII.
Barley 1915.

Series.		NITROGEN APPLIED GRAMS.	Dry matter grams: Per cylinder.	Dry matter grams: Average.	Per cent nitrogen	Nitrogen grams: Per cylinder.	Nitrogen grams: Average.	Nitrogen increase over check grams	Per cent nitrogen recovered	Relative availability
A. . .	1		41.2		1.031	.425				
	2	Nothing.	44.2	42.70	1.050	.464	.445	. . . . . .	. . . .	. . . .
	3		98.4		1.041	1.023				
	4	1.54.	120.9	109.7	1.181	1.428	1.226	.781	50.71	100.00
	5		110.3		1.163	1.282				
	6	1.54.	106.2	108.3	1.078	1.146	1.214	.769	49.93	98.46
B. . .	1		45.5		1.134	.515				
	2	Nothing.	46.5	46.0	1.125	.523	.519	. . . . . .	. . . .	. . . .
	3		104.1		1.172	1.220				
	4	1.54.	109.4	106.7	1.172	1.282	1.251	.732	47.59	100.00
	5		99.5		1.238	1.232				
	6	1.54.	93.5	96.5	1.219	1.140	1.186	.667	43.31	91.21
C. . .	1		36.5		1.069	.390				
	2	Nothing.	38.0	37.3	1.088	.413	.402	. . . . . .	. . . .	. . . .
	3		105.9		1.350	1.429				
	4	1.54.	117.9	111.9	1.144	1.349	1.389	.987	64.09	100.00
	5		98.7		1.144	1.119				
	6	1.54.	101.4	100.1	1.172	1.188	1.154	.752	48.83	76.19
D. . .	1		30.4		1.163	.353				
	2	Nothing.	32.5	31.5	1.106	.359	.356	. . . . . .	. . . .	. . . .
	3		117.7		1.106	1.302				
	4	1.54.	116.0	116.9	1.050	1.218	1.260	.904	58.70	100.00
	5		94.0		1.134	1.066				
	6	1.54.	97.4	95.7	1.125	1.096	1.081	.725	47.07	80.19
E. . .	1		33.9		1.031	.350				
	2	Nothing.	35.7	34.8	.994	.355	.353	. . . . . .	. . . .	. . . .
	3		100.2		1.163	1.165				
	4	1.54.	114.5	107.4	1.125	1.288	1.227	.874	56.75	100.00
	5		78.5		1.097	.861				
	6	1.54.	94.5	86.5	1.097	1.037	.949	.596	38.70	68.19
F. . .	1		35.0		.994	.348				
	2	Nothing.	35.0	35.0	1.041	.364	.356	. . . . . .	. . . .	. . . .
	3		114.4		1.013	1.158				
	4	1.54.	112.4	113.4	1.050	1.180	1.169	.813	52.79	100.00
	5		92.2		1.097	1.011				
	6	1.54.	96.5	94.4	1.041	1.004	1.008	.652	42.33	80.18
G. . .	1		24.5		1.144	.280				
	2	Nothing.	24.0	24.3	.984	.236	.258	. . . . . .	. . . .	. . . .
	3		116.0		.947	1.099				
	4	1.54.	107.5	111.8	1.125	1.209	1.154	.896	58.18	100.00
	5		89.5		1.059	.948				
	6	1.54.	89.0	89.3	1.050	.935	.942	.684	44.43	76.36
H. . .	1		17.7		1.059	.187				
	2	Nothing.	15.5	16.6	1.153	.179	.183	. . . . . .	. . . .	. . . .
	3		100.0		1.153	1.153				
	4	1.54.	111.0	105.5	.862	.957	1.055	.873	56.68	100.00
	5		81.0		1.013	.821				
	6	1.54.	81.7	81.4	1.022	.835	.828	.645	41.88	73.89
I. . .	1		10.7		1.633	.124				
	2	Nothing.	13.8	12.3	1.191	.164	.144	. . . . . .	. . . .	. . . .
	3		93.0		1.078	1.003				
	4	1.54.	104.0	98.5	1.032	1.073	1.038	.894	58.05	100.00
	5		81.5		1.013	.826				
	6	1.54.	74.7	78.1	1.144	.855	.841	.697	45.26	77.97
J. . .	1		7.7		1.247	.096				
	2	Nothing.	7.0	7.4	1.200	.084	.090	. . . . . .	. . . .	. . . .
	3		78.2		1.153	.902				
	4	1.54.	55.4	66.8	1.219	.675	.789	.699	45.39	100.00
	5		47.4		1.247	.591				
	6	1.54.	45.5	46.5	1.200	.546	.569	.479	31.10	68.52
		Averages. . . .	. . . .	28.79	1.0964	. . . .	.3106	. . . . . .	. . . .	. . . .
			. . . .	104.86	1.1068	. . . .	1.1558	.8453	54.898	. . . .
			. . . .	87.68	1.1167	. . . .	.9772	.6666	43.284	. . . .

With slight exception the duplicate weights agree unusually well. In all series the yield with nitrate of soda stands first, the dried blood second and the check third, the averages being 104.86 gm., 87.68 gm., and 28.79 gm. The highest average yield is found with nitrate of soda in series D, and the lowest on the check cylinder in series J. With the exception of series J, where the pure sand is used, the yields with nitrate of soda do not differ greatly. Likewise excepting series I and J, the yields with dried blood are fairly constant, the averages ranging from 108.3 gm. to 81.4 gm., the general tendency being downward as the amount of sand is increased. The yields are well maintained up to and including series F, which is 70 per cent sand. With higher percentages of sand the loss through leaching must be considerable, so that the yields are decidedly reduced. The relation between the yields from the three pairs in each series is well brought out by the curves in Plate V.

The percentage of nitrogen in the dry matter is quit uniform throughout the series, the average for all checks being 1.098 per cent, for the nitrate of soda 1.107 per cent, and for the dried blood 1.117 per cent.

The highest percentage of nitrogen recovered—64.09 per cent—was with nitrate of soda on series C and the second highest with the same material on series D. The highest recovery with dried blood was 49.93 per cent, on series A, and the second highest 48.83 per cent on series C. It may be pointed out that the recoveries in the different series from both nitrate of soda and dried blood do not differ so widely as in previous years. The rather low recoveries from nitrate of soda in series A and B may be the result of a poor mechanical condition of the soil due to the continued use of this salt. The recoveries are considerably higher in series C to I—an average of 57.9 per cent—where the proportion of sand is larger, and where, therefore, there is not so much chance of establishing a poor mechanical condition of the soil. The average recovery with nitrate of soda for all series was 54.89 per cent, and the average from dried blood was 43.28 per cent. The corresponding figures for 1914 were 60.52 per cent from nitrate of soda and 43.92 per cent from dried blood.

It is significant that with one exception, the recoveries are all less than 60 per cent. That is, of 100 pounds of nitrogen applied, less than 60 pounds are recovered in the crop. This loss which is much larger than it should be, has not as yet been accounted for, though there is a strong probability that it is largely accounted for in drainage water.

If the average availability of nitrate of soda is placed at 100 then the availability for dried blood, that is the relative availability, will stand at 79.11. On the same basis the relative availability for dried blood in 1914 was 72.07.

Residual Crop, 1915—Kaffir Corn.

Following the barley the soil in the cylinders was spaded and prepared for the next crop without further addition of fertilizers, and on July 24th the cylinders were seeded to Red Kaffir Corn. This did not come up well in a number of the cylinders and it was necessary to replant

PLATE V.

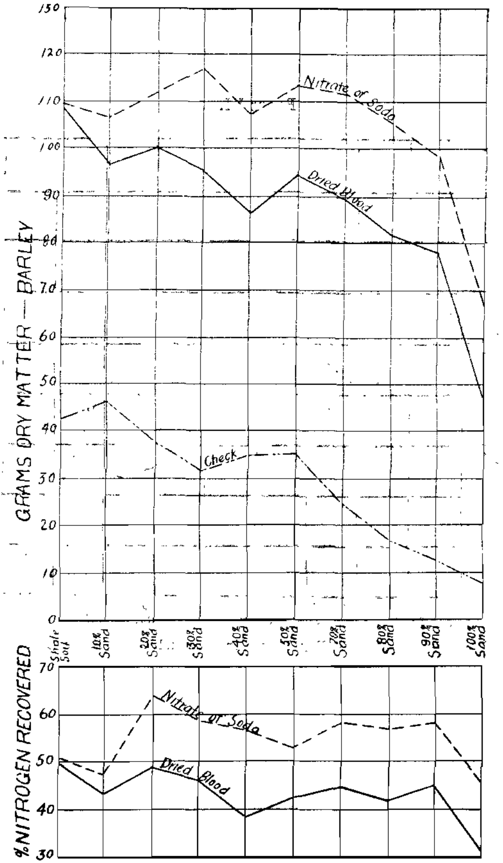


PLATE V.—Weight of Dry Matter and Per Cent. of Nitrogen in First Crop, Barley.

PLATE VI.

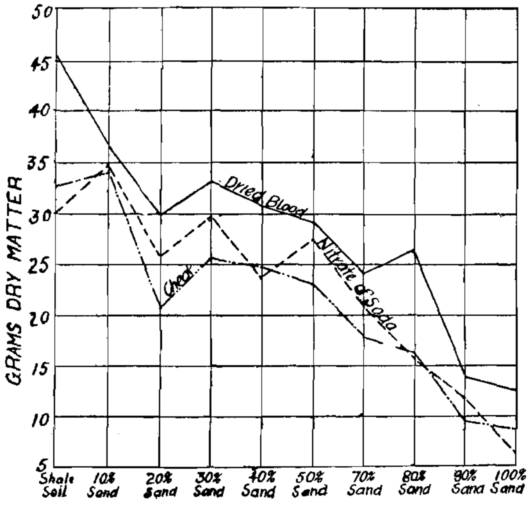


PLATE VI.—Weight of Dry Matter in Residual Crop—Kaffir Corn.

to a considerable extent, but a good stand was finally obtained and this grew until late in October, when it was harvested and prepared for analysis as in the case of the barley.

The yields of dry matter from the residual crop are distinctly less than from the first crop, though there are not such wide differences due to the different treatments. The results for this crop together with the combined results for the two crops are shown in Table XIV.

Table XIV.
Residual Crop of Kaffir Corn and Summary for Both Crops.

		NITROGEN APPLIED, GRAMS	DRY MATTER GRAMS		Per cent. nitrogen	NITROGEN GRAMS		Nitrogen increase over check, grams	Per cent. nitrogen recovered	SUMMARY FOR BOTH CROPS.				
			Per cylinder	Average		Per cylinder	Average			Nitrogen increase over check, grams	Per cent. nitrogen recovered	Relative availability	Total nitrogen, gm.	Total dry matter, gm.
A	1		35.0		1.299	.455								
	2	Nothing	30.5	32.75	1.407	.429	.442						.887	75.45
	3		34.5		1.466	.506								
	4	1.54	25.5	30.00	1.535	.391	.449	.007	.45	.788	51.16	100.00	1.675	139.70
	5		48.5		1.299	.630								
	6	1.54	42.8	45.65	1.348	.577	.604	.162	10.52	.931	60.45	107.70	1.818	153.95
B	1		37.0		1.830	.677								
	2	Nothing	31.5	34.25	1.407	.443	.560						1.079	80.25
	3		32.7		1.437	.470								
	4	1.54	37.0	34.85	1.525	.564	.517			.732	47.59	100.00	1.768	141.55
	5		34.2		1.663	.569								
	6	1.54	39.0	36.60	1.456	.568	.569	.009	.58	.676	43.89	92.20	1.755	133.10
C	1		20.0		1.810	.362								
	2	Nothing	21.2	20.60	1.604	.340	.351						.753	57.90
	3		23.7		1.751	.415								
	4	1.54	27.7	25.70	1.545	.428	.422	.071	4.61	1.058	68.70	100.00	1.811	137.60
	5		25.2		1.683	.424								
	6	1.54	34.7	29.95	1.397	.485	.455	.104	6.76	.856	55.59	81.00	1.609	130.05
D	1		29.5		1.397	.412								
	2	Nothing	21.5	25.50	1.683	.362	.387						.743	57.00
	3		26.7		1.594	.426								
	4	1.54	32.6	29.65	1.555	.507	.467	.080	5.19	.984	63.89	100.00	1.727	146.55
	5		32.5		1.545	.502								
	6	1.54	33.8	33.15	1.466	.495	.498	.111	7.21	.836	54.28	84.95	1.579	128.85
E	1		26.2		1.594	.418								
	2	Nothing	23.3	24.75	1.643	.383	.401						.754	59.55
	3		19.2		1.771	.340								
	4	1.54	28.2	23.70	1.614	.455	.398			.874	56.75	100.00	1.625	131.10
	5		29.4		1.771	.521								
	6	1.54	32.2	30.80	1.604	.516	.519	.118	7.66	.714	46.36	81.70	1.468	117.30

F	1		[illegible]		[illegible]	[illegible]								
	2	Nothing	22.0	23.25	1.732	.381	.398						.754	58.25
	3		26.5		1.614	.428								
	4	1.54	28.5	27.50	1.604	.457	.443	.045	2.92	.858	55.71	100.00	1.612	140.90
	5		28.3		1.751	.496								
	6	1.54	30.0	29.15	1.604	.481	.489	.091	5.91	.743	48.24	86.60	1.497	123.55
G	1		20.0		1.535	.307								
	2	Nothing	15.7	17.85	1.634	.257	.282						.540	42.15
	3		17.5		1.820	.319								
	4	1.54	24.0	20.75	1.506	.361	.340	.058	3.77	.954	61.95	100.00	1.494	132.55
	5		23.0		1.594	.367								
	6	1.54	25.3	24.15	1.594	.403	.385	.103	6.69	.787	51.12	82.53	1.327	113.45
H	1		16.6		1.732	.287								
	2	Nothing	16.0	16.30	1.584	.254	.271						.454	32.90
	3		14.0		2.154	.302								
	4	1.54	17.2	15.60	1.692	.291	.297	.026	1.69	.899	58.37	100.00	1.352	121.10
	5		27.0		1.624	.438								
	6	1.54	25.8	26.40	1.535	.396	.417	.146	9.48	.791	51.36	88.00	1.245	107.80
I	1		8.4		1.712	.144								
	2	Nothing	10.5	9.45	1.692	.178	.161						.305	21.75
	3		13.0		1.663	.216								
	4	1.54	10.5	11.75	1.791	.188	.202	.041	2.66	.935	60.71	100.00	1.240	110.25
	5		14.2		1.702	.242								
	6	1.54	13.5	13.85	1.673	.226	.234	.073	4.74	.770	50.00	82.36	1.075	91.95
J	1		6.8		1.939	.132								
	2	Nothing	10.2	8.50	1.683	.172	.152						.242	15.90
	3		5.8		2.047	.119								
	4	1.54	6.7	6.25	2.028	.136	.128			.699	45.39	100.00	.917	73.05
	5		13.2		1.594	.210								
	6	1.54	11.7	12.45	1.751	.205	.208	.056	3.64	.535	34.74	76.51	.777	58.95
		Averages									57.02	100		
				21.320	1.630		.3405				49.60	86.36		
				22.575	1.686		.3663	.0328	2.129					
				28.215	1.583		.4378	.0973	6.319					

The average yield with the nitrate of soda is somewhat less than the average with dried blood and but little more than the yield on the check cylinders. From this it is clear, as has been emphasized in previous reports, that there is very little residual effect from the nitrate, while there is a small residual effect from the dried blood. The relatively high yield on the check cylinders is, no doubt, to be accounted for on the ground that the first crop on these cylinders did not draw heavily upon the nitrogen of the soil organic matter, and after the barley was harvested there was still time for a considerable proportion of this to become available for the second crop. On the other hand the first crop on the nitrate cylinders not only exhausted the nitrate of soda, but the plants thus stimulated sent their roots deeper and farther, and therefore used more of the nitrogen of the soil organic matter, than did the plants in the check cylinders. The relative yields with the different treatments are nicely brought out by the curves in Plate VI. From these curves it will be noted that there is a general downward tendency as the percentage of sand increases.

The percentages of nitrogen in the dry matter of the Kaffir corn are higher and likewise there are wider variations than in the case of the barley. The averages, however, differ hut little, and are as follows: checks 1.63 per cent, nitrate of soda 1.69 per cent, and dried blood 1.58 per cent.

In three of the series, B, E, and J, the residual crop failed entirely to recover any nitrogen from nitrate of soda. In the other series the recovory was small, though it amounted to 5.19 per cent in series D. In series B the recovery from dried blood was less than one per cent though in the other series there was a fair recovery, the highest—10.52—being in series A. The average recovery with nitrate of soda is 2.13 per cent, and with dried blood 6.32 per cent.

When the data for both crops are studied it is found that for series A the total weight of dry matter and the percentage of nitrogen recovered from dried blood, are greater than the corresponding figures for nitrate of soda. In all other series nitrate of soda stands ahead of dried blood both with respect to weight of dry matter and percentage of nitrogen recovered. The highest recovery from nitrate of soda was 68.70 per cent on series C and the highest from dried blood 60.45 per cent on series A. The average recovery for all series was 57.02 per cent for nitrate of soda and 49.6 per cent for dried blood.

Placing the relative availability of nitrate of soda for all series at 100, the average availability for dried blood is 86.36.

As pointed out in previous reports, the returns from dried blood are almost invariably less than the returns from nitrate of soda, even when the work is continued over a period of years. When this is so, it hardly seems fair that the farmer should pay as much for nitrogen in the form of dried blood as for nitrate nitrogen. The yields of dry matter and percentage of nitrogen recovered are emphasized in the curves shown in Plate VII.

PLATE VII.

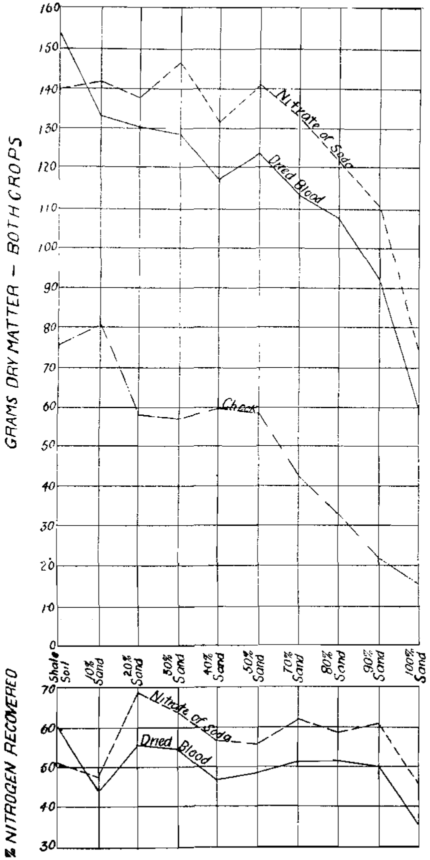


PLATE VII.—Weight of Dry Matter and Per Cent. of Nitrogen Recovered in Both Crops.

The Theoretical and Actual Recoveries from the Shale Soil.

As in previous years a comparison of the amount of nitrogen which should he recovered from the organic matter of the shale soil where sand was introduced (as calculated from the recovery from pure shale), with the net amount actually recovered is of interest.

Under "Total Nitrogen in Both Crops" it is seen that there was recovered from the check cylinders 0.887 gm. From the corresponding cylinders with pure sand there was a recovery of 0.242 gm. made up of traces which may have been in the sand, that which was contained in the seed, and any that may have been fixed by non-symbiotic hacteria. The difference hetween these amounts—0.645—represents the actual net recovery from the shale soil cylinders.

Since the check cylinders of series B were 90 per cent shale instead of pure shale the theoretical recovery from this should be 90 per cent of 0.645 which is 0.581. The actual amount of nitrogen recovered in the combined crops from the check cylinders of series B was 1.079 gm. and subtracting from this .242 gm. (combined recovery from check cylinders in pure sand), we have .837 gm., which represents the net recovery from the shale soil of series B. In a similar way we may calculate the theoretical and actual recoveries from the humus of the shale soil for the combined crops with various dilutions. These results are shown in Table XV.

Table XV.

Nitrogen Recovered From Shale Soil in the Combined Crop.

COMPOSITION OF THE SOIL	Theoretical amount of nitrogen recovered, gm.	Actual amount of nitrogen recovered, gm.
100 % Shale Soil	.645	.645
90 % " "	.581	.837
80 % " "	.516	.511
70 % " "	.451	.501
60 % " "	.387	.512
50 % " "	.323	.512
30 % " "	.194	.298
20 % " "	.129	.212
10 % " "	.065	.063
100 % Sand	....	....

From the above table we note that with two exceptions, namely 80 and 10 per cent of shale soil, the actual recoveries surpass the theoretical amounts as calculated from the recovery from the shale soil alone. It may be pointed out that the amount thus actually recovered is decidedly increased with the higher percentages of sand, excepting, however, the recovery with 10 per cent of sand.

As pointed out in previous reports this clearly indicates an improved condition of the soil with the introduction of sand, due to better aeration, and therefore more complete utilization of the soil organic matter.

Summary.

1. This is a continuation of the work begun in 1911 on the availability of nitrate of soda and dried blood when applied to shale soil, and mixtures of sand and shale soil.

2. For the first crop, the cylinders to which nitrate of soda and dried blood were applied invariably gave higher yields of dry matter than the check cylinders. Likewise nitrate of soda invariably gave a higher yield of dry matter and a higher recovery of nitrogen than dried blood.

3. The percentage of nitrogen in the dry matter ran quite uniformly for the different treatments and throughout the different series.

4. The average recovery of nitrogen from nitrate of soda for all series, first crop, was 54.89 per cent, and the average for dried blood 43.28 per cent. The highest recovery from nitrate was 64.09 per cent from cylinders containing 20 per cent of sand, and the highest from dried blood was 49.93 per cent from cylinders containing pure shale soil.

5. Taking 100 as representing the availability of nitrate nitrogen, on the same basis the availability of dried blood nitrogen was 79.11.

6. With the second or residual crop, the average yield of dry matter with dried blood was somewhat greater than the average with nitrate of soda or the average on the check cylinders. The average on the check cylinders was almost as great as that from the nitrate cylinders. This is apparently due to the fact that the nitrate was largely utilized by the first crop, which was thus stimulated to a more thorough ntilization of the nitrogen of the soil organic matter. As a result the residual crop on the check cylinders probably had at its disposal as much, and perhaps more available nitrogen, than was present in the nitrate cylinders.

7. In three out of the ten series there was no recovery of nitrogen from the nitrate cylinders, and in most cases the recoveries from the other seven were low. There was some recovery from dried blood for all series, the average being 6.32 per cent.

8. In spite of the fact that the dried blood shows a higher recovery in the residual crop than nitrate of soda, when the combined recoveries are considered it is found that the nitrate stands first in all series except A. The average combined recovery for nitrate was 57.02 per cent and for dried blood 49.6 per cent.

9. Again taking 100 as representing the availability of nitrate nitrogen for the combined crops, the availability of dried blood is represented by 86.36.

10. From the results here recorded and likewise from previous results it is quite clear that nitrate of soda need not be expected to have a very great residual effect. On the other hand dried blood may be counted on for a small residual effect both in heavy and light soils, though the initial effect of the nitrate is sufficiently above that of the

dried blood to place the former in first place, in most cases, when the combined crops are taken into consideration.

11. With these facts before him it seems that the farmer cannot afford to pay more for nitrogen in organic materials than in nitrate of soda.

12. Mixing sand with heavy soil permits a better aeration and drainage and results in a more complete utilization of the nitrogen of *the soil organic matter.*

THE INFLUENCE OF BACTERIA IN MANURE ON THE DECOMPOSITION OF GREEN MANURE. (LEGUME AND NON-LEGUME).

An account of the first five years of this work was given in the report for 1912, and an account of the work for 1913 and 1914 in the reports for those years. The object of the experiment is to study the bacterial influence of cow manure on the decomposition of green manures. The quantities of manure are purposely kept small in order that the influence of the fertilizing constituents in the manure may be reduced to a minimum. The experiment also contemplates a comparison of legumes with non-legumes in continuous corn growing. For convenience a brief statement of the plan is included here.

Plan of the Experiment.

"The experiment is conducted on one-twentieth acre plots, on land that is largely a gravelly loam, varying from sandy to clayey phases, although apparently the differences are not great. The soil is not what would be called a fertile soil, and is without doubt deficient in nitrogen, this being the chief limiting factor. At the beginning of the experiment ground limestone, at the rate of one ton per acre, was applied to all the plots by means of a fertilizer drill, and each plot also received fifteen pounds of acid phosphate, five pounds of potassium chloride, and ten pounds of dried fish. The special treatment is as follows:

Plot 49, corn followed by crimson clover as green manure, no cow manure.
Plot 50, corn followed by crimson clover as green manure, + 50 lbs. manure.
Plot 51, corn followed by crimson clover as green manure + 100 lbs. manure.
Plot 52, corn followed by crimson clover as green manure + 200 lbs. manure.
Plot 53, corn followed by rye as green manure, no cow manure.
Plot 54, corn followed by rye as green manure, + 50 lbs. cow manure.
Plot 55, corn followed by rye as green manure, + 100 lbs. cow manure.
Plot 56, corn followed by rye as green manure, + 200 lbs. cow manure.

The manure is preferably that which has been well rotted, and is broadcasted over the green manure before plowing under."

Crop of 1915.

On August 4th cover crops were seeded on these plots as follows: Plots 49-52 three pounds of vetch, one and one-half pounds of crimson clover and two pounds of Ito San soybeans per plot; and plots 53-56 four pounds of rye per plot. The soybeans were added to the legume plots with the thought that they would make considerable growth before frost, thus adding nitrogen and organic matter.

On account of the unusually dry fall these crops made very poor growth. The soybeans were a complete failure, and the crimson clover and vetch made very little growth throughout the fall. Notes made on December 4th state that the cover crops had not grown to amount to anything. Plot 53 was the poorest. On April 1, 1915, there was scarcely enough crimson clover and vetch to be seen. Later the scattered patches of vetch grew fairly well, and the rye, though poor, grew to a height of about 15 inches. On May 3d the plots were disked and the manure applied in accordance with the original plan. A few days later the plots were plowed, fertilizers applied (15 pounds of acid phosphate and 5 pounds of muriate of potash per plot) and the ground disked and harrowed, thus putting it in good condition for planting. On May 12th all plots were planted to Reed's Yellow dent corn in rows 40" x 40". There was good germination, though the crows did some damage later. The corn received the usual cultivation and hoeing, but was considerably damaged by storms on August 1st and 3d. At this time it was so badly blown down that it became necessary to cultivate by hand when the cover crop was planted.

On October 11th the corn was harvested and shocked in the field. A few weeks later it was husked and samples amounting to 1/20 of the whole weight were collected and prepared for analysis. The weights and other analytical data are shown in Table XVI. The results are calculated to the acre basis and the grain reported in bushels, while the stover and nitrogen are reported in pounds.

The yield of grain is only a little more than one-half what it was in 1914. In one or two cases it is less than half of the 1914 yield. The yield of stover is also less than in 1914. The poor growth made by the cover crops and the damage done by storms in August are partly accountable for the low yields.

Without question a deficiency of nitrogen has become a limiting factor on these plots. The legume section has at its disposal more nitrogen than the non-legume section, but even here there is not enough for a maximum crop.

The Influence of the Manure.

From an examination of the table it is at once apparent that the manured plots yielded more in both grain and stover than the check plots, and this is true of both sections. One exception, however, should be noted: the yield of grain on plot 52 is slightly less than the yield on the check plot.

Table XVI.
Continuous Corn With Cover Crop—1915.
(Calculated to Acre Basis.)

Number	SPECIAL TREA MENT	GRAIN Dry matter, bu.	GRAIN Per cent. nitrogen	GRAIN Nitrogen, lbs.	STALKS Dry matter, lbs.	STALKS Per cent nitrogen	STALKS Nitrogen, lbs.	COBS Dry matter, lbs.	COBS Per cent nitrogen	COBS Nitrogen lbs.	Total nitrogen, lbs.	INCREASE OVER CHECK Dry matter grain, bu.	INCREASE OVER CHECK Dry matter s over, lbs.	INCREASE OVER CHECK Nitrogen, lbs.
	Legume Section													
49	No manure	18.57	1.321	13.73	2240	.582	13.04	200	.515	1.03	27.80	......	......	......
50	50 lb:. ʾow manure	22.85	1.263	16 16	2720	.651	17.70	240	.437	1.05	34.91	4.28	520	7 11
51	100 lbs. cow manure	20 00	1.312	14.69	2680	.825	22 20	200	.592	1.18	38.07	1.43	440	10.27
52	200 lbs. cow manuro	17.50	1.380	13.52	2760	.777	21.44	180	.505	.91	35.87	......	500	8.07
	Non-Legume Section													
53	No manure	10 00	1.370	7.67	2340	.660	15.44	120	.894	1.07	24.18	......	......	......
54	50 lbs. cow manure	16.08	1.331	11.98	2360	.738	17.42	160	.554	.89	30 29	6.08	60	6.11
55	100 lbs. cow manure	16.79	1.321	12 42	2920	.534	15 58	160	.398	.64	28.64	6.79	620	4.40
56	200 lbs. cow manure	15 00	1.244	10.45	2120	.777	16 47	140	.408	57	27.49	5.00	......	3.31

As pointed out in previous reports the increased yield can hardly be attributed to the fertilizing constituents in the manure for the reason that in some cases at least the largest yields were on the plots that received the smallest applications of manure, as for example the yield of 22.85 bushels per acre on plot 50 which received 50 pounds of manure, as against 20 bushels per acre in plot 51 which received 100 pounds of manure.

There was without exception more nitrogen recovered in the dry matter from the manured plots than from the check plots, but here again the largest yield was not necessarily from the plot that received the most manure. It thus appears that the manure does have an influence aside from any effect which may be attributed to fertilizing constituents which it contains. While there is not positive proof that this beneficial effect is due to the more thorough decomposition of organic matter by bacteria introduced in the manure, such a conclusion seems fairly warranted.

The Legume and Non-Legume Sections Compared.

Without exception the yield of grain and nitrogen were greater on the legume section than on the non-legume section. In the non-legume section plots 53 and 55 yielded more dry stalks than the corresponding plots (49 and 51) on the legume section. The average increase of grain resulting from the use of manure was for the non-legume section nearly 6 bushels, and for the legume section 2.85 bushels. The greater gain on the non-legume section may no doubt be explained on the ground of the wider difference between the yield on the check plot and the yields on the plots that received manure. In the case of the legume section the check plot profits by the addition of the nitrogen secured through the legume and as a consequence this plot does not differ so widely from the other plots in the section. Stated in other words the somewhat readily available nitrogen secured by means of the legume tends to obscure the effects to be expected from the bacterial decomposition of soil organic matter.

Since the rye of the non-legume section adds no nitrogen, and since such organic matter decomposes more slowly than the organic matter of legumes, the influence of the bacteria supplied in the manure makes the contrast between the manured plots and the check plot greater than the contrast between the corresponding plots of the legume section.

THE CONTINUOUS GROWING OF WHEAT AND RYE—1915

The plan of this experiment was fully described in the Annual Report for 1912.* The results for the first five years were given there in detail and further accounts appear in the Annual Reports for 1913 and 1914. For convenience, the general plan may be briefly restated.

Plan of Experiment.

The experiment is being conducted on four one-twentieth acre plots designated as numbers 68, 69, 70, and 71. The soil is a gravelly loam fairly uniform in quality. Previous to starting this experiment the land

*Report Soil Chemist and Bacteriologist, N. J. Agr. College Expt. Sta. 1912, p. 361.

had been used for general farming, but had not been heavily manured and had not been limed for more than twenty years. When the experiment was begun, all plots were limed at the rate of 2,000 pounds of ground limestone per acre. The plots also receive annually an application of minerals (acid phosphate and muriate of potash) at the rate of 400 pounds of acid phosphate and 200 pounds of muriate of potash per acre. No nitrogenous fertilizers are used. Tests made of samples of soils collected from these plots in the spring of 1913 show a lime requirement of four to six hundred pounds of lime (CaO) per two million pounds of soil. In the fall of 1913, before seeding to wheat and rye, they received limestone at the rate of 4,000 pounds per acre.

The arrangement of plots, with the treatment given, is as follows:

Plot 68, Rye alone..Minerals
Plot 69, Wheat alone..Minerals
Plot 70, Rye followed each year with cowpeas (or soybeans) as green manure ....Minerals
Plot 71, Wheat followed each year with cowpeas (or soybeans as green manure ....Minerals

Each year the stubble is disked on Plots 70 and 71 soon after harvesting the crop, and soybeans are drilled in. Plots 68 and 69 remain in stubble. About two or three weeks before seeding to wheat and rye, the green manure crop on Plots 70 and 71 is turned under and Plots 68 and 69 are also prepared for seeding. On account of the cowpea wilt organism in the soil, Ito San soybeans were substituted for the cowpeas on Plots 70 and 71 in the fall of 1913.

Crop for 1915.

On July 8, 1914, plots 70 and 71 were disked and seeded to Ito San soybeans. On August 13th record was made that the soybeans on these plots were about 10-11 inches high and that they were well inoculated as indicated by both the color and abundant nodules found on the roots. On the above date note was also made of the appearance of volunteer white and red clover on plots 68 and 69, the growth being more abundant on 68 than on 69. Note is made of this because the coming of the clover supplies a certain amount of nitrogen, which in this case is not intended, inasmuch as it will introduce some error, by making the effect of the soybeans on plots 70 and 71 appear less than it really is.

In an earlier publication* we have noted the tendency of clover to come in on land that is kept well supplied with lime and minerals.

On August 31st note was made that the beans were 12 to 15 inches high and that the pods were setting nicely. At this time volunteer clover had spread over a great part of plot 68. There was but little on plot 69.

On September 8th just two months from the time of planting the beans, all plots were plowed, harrowed, and rolled, a chain being required to turn under the soybeans.

*Lipman and Blair: Field Experiments on the Availability of Nitrogenous Fertilizers. N. J. Agrl. Expt. Stations Bulletin 260, p. 11.

On September 29th each plot received 20 pounds of acid phosphate and 10 pounds of muriate of potash and on the following day wheat and rye were seeded in accordance with the plan.

The wheat and rye were slow in coming up on account of the dry weather, and for the same reason, growth during the fall was slow, though there was a good stand.

Table XVII.

Rye and Wheat With and Without Legumes—1915. (1/20 Acre Plots)

Number	CROP	GRAIN PER PLOT.			STRAW PER PLOT.			PER ACRE.		
		Dry matter, lbs.	Per cent nitrogen	Nitrogen, lbs.	Dry matter, lbs.	Per cent nitrogen	Nitrogen, lbs.	Grain bushels	Straw, lbs.	Nitrogen, lbs.
68	Rye alone............	42.0	1.900	.798	56.0	.344	.193	14.00	1120	19.82
69	Wheat alone..........	32.0	2.096	.671	34.0	.364	.124	10.66	680	15.90
70	Rye followed by soybeans............	62.0	2.146	1.331	86.0	.443	.381	20.66	1720	34.24
71	Wheat followed by soybeans............	54.0	2.205	1.191	68.0	.394	.268	18.00	1360	29.18

On July 9th the wheat and rye were harvested, the weights recorded and samples prepared for analysis in the usual way. The yields of grain and straw and the nitrogen recovered are not large. However, 14 bushels of rye, and 10-2/3 bushels of wheat, per acre, with continuous cropping for a period of seven years, without any nitrogeous fertilizer or green manure crop, is not an especially bad record. Likewise 20-2/3 bushels of rye and 18 bushels of wheat per acre with continuous cropping for a period of seven years and only green manure crops as a source of nitrogen, is not a discouraging situation for a rather poor sandy loam soil. An examination of the table shows at once that there is a higher percentage of nitrogen in both the grain and straw from the legume than from the non-legume plots. That is, in addition to almost doubling the yield of both grain and straw (exactly double for the wheat straw) the legume has given a crop that is richer in protein.

The rye plot with the legume has given an increase per acre of 14.42 pounds of nitrogen over the check plot, and the wheat plot an increase of 13.28, equivalent respectively to about 83 and 90 pounds of nitrate of soda.

Attention has already been called to the fact that in pot experiments thick seeding of soybeans resulted in a greater recovery of nitrogen from a given area than thin seeding, and it seems entirely possible that in this experiment thicker seeding with a variety selected for high nitrogen content and large growth, might yield considerably more nitrogen for the succeeding crop.

The yield of grain for 1915 was larger than for either 1913 or 1914, but the yield of straw for this year was less than for either of the preceding years.

PLATE VIII.

PLOT 71. PLOT 69.

PLATE VIII.—Continuous wheat with and without a Legume Crop.

The long period of dry weather in the fall of 1914 may have had something to do with this. Hall† has shown that in the case of barley the proportion of grain to straw was greater in a dry than in a wet season. In the same connection he has pointed out that in a dry season the percentage of nitrogen in the dry matter of the grain is higher than it is in a wet season, and on comparing the nitrogen content of the wheat and rye grain for 1914 with that for 1915 we find it decidedly higher in 1915.

III.

VEGETATION EXPERIMENTS.

Comparison of Basic Slag With Other Phosphates.

The work here reported is a continuation of the work begun in cooperation with the basic slag committee of the Association of Official Agricultural Chemists, a brief account of which was given in the Annual Report of this Station for 1913.* It has not been possible to conduct this work on a field scale as suggested by the committee, but it is believed that the results secured with pot experiments have a certain value and they are accordingly put on record.

Series No. 1.

Earthenware pots holding 20 pounds of white quartz sand were used. The general treatment consisted of 4 gm. potassium sulphate, 3 gm. sodium nitrate, 5 gm. calcium carbonate, ½ gm. magnesium sulphate and ¼ gm. ferric sulphate. The pots were seeded to barley, the experiment being conducted in the greenhouse during the winter of 1913-14. The moisture was maintained at about 10 per cent. The phosphorus treatment together with the yield of dry matter and other data are recorded in Table XVIII.

†Hall; The book of the Rothamsted Experiment Station, pp. 85 and 86.
*N. J. Agr. Expt. Station, Annual Report, 1913, pp. 481, 484.

Table XVIII.

Comparison of Basic Slags With Other Phosphates. Barley.

Number	SPECIAL TREATMENT.	Dry matter gm. Per pot	Dry matter gm. Average	Per cent nitrogen	Total nitrogen. mg. Per pot	Total nitrogen. mg. Average
1		1.5		3.000	45.00	
2	No phosphate.	1.5	1.50	3.010	45.15	45.08
3		10.2		2.026	206.65	
4	6.000 gm. Acid Phosphate..........17.82% P_2O_5.	9.5	9.85	2.183	207.39	207.02
5		.3		4.918	14.75	
6	4.965 gm. Sodium Phosphate..... 20.87% " ..	.3	.30	4.524	13.57	14.16
7		8.9		2.252	200.43	
8	5.665 gm. Basic Slag A.......... 18.30% " ..	11.2	10.05	1.593	178.42	189.43
9		9.2		2.223	204.52	
10	5.445 gm. Basic Slag B.......... 19.04% " ..	12.0	10.60	1.829	219.45	211.99
11		7.8		2.951	230.18	
12	7.785 gm. Basic Slag C.......... 13.31% " ..	10.3	9.05	2.754	283.66	256.92
13		9.0		2.351	211.59	
14	6.537 gm. Basic Slag D.......... 15.86% " ..	9.8	9.40	2.192	214.82	213.21
15		6.2		2.961	183.58	
16	7.050 gm. Blue Rock Phosphate... 29.40% " ..	6.3	6.25	2.813	177.22	180.40
17		15.1		1.740	262.74	
18	2.241 gm. Double Super Phosphate 46.25% " ..	15.3	15.20	2.174	332.62	297.68
19		6.5		2.872	186.68	
20	No Phosphate.	6.4	6.45	2.931	187.58	187.13

Referring to this table it should be pointed out that the pairs of checks, that is, pots 1 and 2, and 19 and 20, where no phosphorus was used, differ so widely that they must be considered of little value. This, however, does not prevent, in the least, a comparison of the yields obtained with the different slags, and since no attempt is here made to calculate the percentage of phosphorus recovered, this is all that is necessary.

The low yield with sodium phosphate is due to the fact that the plants were injured and finally died some time before the crop was mature. It is not clear whether this injury was due to the sodium of the salt or to an excess of quickly available phosphoric acid. The latter explanation would hardly seem to hold, in view of the fact that the double superphosphate, pots 17 and 18, gave a higher yield than any of the other materials.

The fact that nitrate of soda was used as a source of nitrogen means an additional supply of sodium over that furnished by the sodium phosphate, and this would seem to point to the sodium as the cause of the injury, since in the case of the double super-phosphate the base is calcium.

This same injurious effect was noted in earlier pot experiments* in connection with sodium phosphate when sand was used, but was not observed when the same amount of sodium phosphate was used with 20 pounds of soil. This may mean that the toxic substance, whatever it is, is absorbed by the soil to a greater extent than by the sand.

*Lipman and Blair, Report Soil Chemist and Bacteriologist, 1912, p. 482.

The unusually high percentage of nitrogen in the samples from pots 5 and 6—4.92 and 4.53 per cent respectively—indicates a decidedly abnormal condition of growth. The nitrogen content is likewise high in the check pots (1, 2 and 19, 20); in those that received the lowest grade of slag (11 and 12); and in those that received the blue rock phosphate (15 and 16). It would thus appear that the withholding of available phosphoric acid to the extent of limiting growth results in the abnormal utilization of the available nitrogen present, even to the extent of injuring the plant. This tendency of the plant to take up more nitrogen than is required, when it is present in large excess, has already been noted.* The average yields of dry matter obtained with the various slags is practically the same as the average with acid phosphate. The yield with double super-phosphate is considerably more than with either acid phosphate or the slags. The slags with a high content of phosphoric acid gave a slightly higher yield than those with low phosphoric acid content.

Under normal conditions of growth the total yield of nitrogen with a given plant may usually be taken as a fair measure of the growth of that plant. Judged by this standard the slags have given practically as good yields as the acid phosphate. In the case of slag C the yield is decidedly better than the yield with acid phosphate.

Series No. 2.

The plan of this experiment is similar to that of No. 1. Earthenware pots holding 20 pounds of sand were used. The general treatment consisted of 2 gm. potassium chloride; 2 gm. sodium nitrate; 10 gm. ground limestone; ½ gm. magnesium sulphate; and ¼ gm. ferric sulphate.

The crop grown was buckwheat. The phosphorous treatment together with the yields of dry matter and nitrogen are shown in Table XIX. The amount of phosphoric acid in 4 gm. of acid phosphate was taken as the standard for phosphorous treatment and sufficient amounts of the other materials to give an equivalent in phosphoric acid. Two exceptions to this should be noted. In the case of basic slag E, pots 19 and 20, and blue rock phosphate, pots, 21 and 22, a quantity was taken that would give double the amount of phosphoric acid contained in the 4 gm. of acid phosphate.† Here as in series No. 1, the sodium phosphate materially depressed the yield although the application was only two-thirds of that in series No. 1.

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*Lipman, J. G. Report of Soil Chemist and Bacteriologist, 1912, pp. 209, 211.

†Slag E is an American product prepared at Birmingham, Alabama. The other slags were furnished by the basic slag committee, the source not being stated.

Table XIX.

Comparison of Basic Slags With Other Phosphates. Buckwheat.

Number	SPECIAL TREATMENT.	Dry matter gm. Per pot	Dry matter gm. Average	Per cent nitrogen.	Total nitrogen mg. Per pot	Total nitrogen mg. Average	Increase over check, mg.
1		3.2		1.222	39		
2	No phosphate.	3.3	3.25	1.222	40	39.5	.....
3		23.4		1.100	257		
4	4 gm. Acid Phosphate 17.82% P_2O_5 ...	20.7	22.05	1.222	253	255.0	220.5
5		8.0		1.520	122		
6	3.415 gm. Sodium Phos. 20.87% " ...	5.1	6.55	1.362	69	95.5	56.0
7		17.2		1.175	202		
8	3.890 gm. Basic Slag E 18.33% " ...	19.4	18.30	1.110	215	208.5	174.0
9		17.3		1.119	194		
10	3.895 gm. Basic Slag A 18.30% " ...	15.5	16.40	1.250	194	194.0	160.5
11		20.1		1.119	225		
12	3.740 gm. Basic Slag B 19.04% " ...	17.0	18.55	1.212	206	215.5	181 0
13		17.0		1.380	235		
14	5.355 gm. Basic Slag C 13 31% " ...	20.2	18.60	1.194	241	238.0	203.5
15		18.5		1.156	214		
16	4.494 gm. Basic Slag D 15.86% " ...	18.1	18 30	1.119	203	208.5	174 0
17		20.4		1.175	240		
18	3.890 gm. Basic Slag E 18.33% "	16.5	18.45	1.175	194	217.0	182.5
19		15.7		1.138	179		
20	7.780 gm. Basic Slag E 18.33% " ...	18.6	17.15	1.483	276	227.5	193.0
21		7.2		1.259	91		
22	4.849 gm. Blue Rock Phos. 29.4 % " ...	9.7	8.45	1.380	134	112.5	78.0
23		10.9		0.877	96		
24	1 549 gm. Double Super Ph. 46.02% " ...	18 0	14.45	1.110	200	148.0	113.5
25		2.5		1.250	31		
26	No Phosphate.	2.6	2.55	1.091	28	29.5	.....

The yields of dry matter with the slags were fairly uniform, the average amount being close to four-fifths of the yield with acid phosphate. The blue rock phosphate yielded somewhat more than the checks, but is decidedly below all of the slags. It is not clear why the yield with the double super-phosphate should have been lower than the yields with the slags.

The percentage of nitrogen is fairly uniform throughout the series, though it is noteworthy that the highest average occurs with the sodium phosphate and the lowest with the double super-phosphate.

Series No. 3.

The plan of Experiment No. 3, is identical with that of No. 2, except that 1 gm. of nitrate of soda, instead of two, was used. The crop grown was soybeans instead of buckwheat. The beans were planted April 26th, and harvested as forage August 27th. Table XX shows the phosphate treatment together with the yields of dry matter and nitrogen.

Table XX.

Comparison of Basic Slags With Other Phosphates.
Soybeans.

Number	SPECIAL TREATMENT.	Dry matter gm. Per pot	Dry matter gm. Average	Per cent nitrogen	Total nitrogen mg. Per pot	Total nitrogen mg. Average	Increase over check, mg.
1		9.4		2.043	192		
2	No Phosphate	12.5	10.95	1.735	217	204.5	.....
3		28 0		2 816	788		
4	4,000 gm. Acid Phosphate	29.5	28.75	2.677	789	788.5	575.3
5		27 3		2.905	793		
6	3.415 gm. Sodium Phosphate	31.6	29.45	2.905	918	855 5	642 3
7		21.5		2.528	543		
8	3.890 gm. Basic Slag E	14 7	18 10	2.767	406	474.5	261.3
9		12 2		1.914	234		
10	3.895 Basic Slag A	17 2	14.70	2.419	416	325.0	111.8
11		25.9		2.647	685		
12	3.740 gm. Basic Slag B	17.7	21.80	2.231	395	540.0	326.8
13		16.7		2.201	367		
14	5.355 gm. Basic Slag C	25 0	20.85	2.479	620	493.5	280.3
15		15.8		2.151	340		
16	4.494 gm. Basic Slag D	18.0	16.90	2.399	432	386.0	172.8
17		27.5		2.647	728		
18	3.890 gm. Basic Slag E	22 9	25.20	2.518	577	652 5	439.3
19		24.5		2.627	644		
20	7.780 gm. Basic Slag E	24.8	24 65	2 846	706	675.0	461 8
21		8 2		2.518	207		
22	4.849 gm. Blue Rock Phosphate	10.3	9.25	2.479	255	231.0	17.8
23		37 8		3 103	1173		
24	1.549 gm. Double Super-Phosphate	35.0	36.40	2 895	1014	1093.5	880.3
25		9.5		2.499	237		
26	No Phosphate	8 2	8.85	2.518	207	222.0	...

With three exceptions the duplicate weights are in sufficient agreement to be satisfactory. It is of especial interest in this case to note that not only did the sodium phosphate not depress the yield but on the other hand it gave next to the largest yield of both dry matter and nitrogen. It is not clear whether this is due to the reduction in the amount of nitrate of soda applied, or whether it is due to a physiological condition which makes soybeans able to stand a higher concentration of salt than the barley or buckwheat. In the yield of total dry matter and nitrogen the double super-phosphate stands first, the sodium phosphate second, the acid phosphate third, and basic slag E fourth. The latter gave a yield of dry matter considerably above the other slags, the amount being about seven-eighths of the yield with acid phosphate. The average yield of dry matter with the other slags amounts to about two-thirds of the yield with acid phosphate while their average yield of nitrogen is only about two-fifths of the yield of nitrogen obtained with acid phosphate. The average yield of dry matter with the blue rock phosphate is slightly less than the average yield in the check pots.

The exceptionally high yield of nitrogen with the double super-phosphate, sodium phosphate and acid phosphate is especially interesting as indicating the importance of soluble phosphates in the utilization of atmospheric nitrogen by means of leguminous plants. Undoubtedly, as pointed out by Fred and Hart*, soluble phosphates play an important part in the development of soil bacteria.

The three experiments taken together indicate a somewhat higher availability for the phosphoric acid of basic slags than has generally been assigned to such materials. If they are thus available for a single crop grown in quartz sand, there certainly seems good reason for believing that they would be even more available under normal field conditions.

IV.

RESEARCH PUBLICATIONS.

During the year a number of papers dealing with research problems in soil fertility, have been published by Fellows and Assistants in the Experiment Station and Rutgers College, and in the following abstracts attention is called to some of these papers:

SOIL PROTOZOA.

George P. Koch, U. S. Dept. Agr., Jour. Agr. Research, 4, (1915), No. 6. pp. 511-559; 5, (1915), No. 11. pp. 447-488.

Experiments on the development of protozoa of different soils in different culture solutions and under various conditions were performed.

The loop method for counting bacteria was improved upon and found to be very satisfactory for counting protozoa.

It was found that the composition of the media exerted a definite influence upon the development of the protozoa. In dried blood extract, at 22°C, the maximum development of all ciliates and flagellates was from three to four days while in soil extract the greatest numbers appeared from the second to the fifteenth day after inoculation.

Very few large ciliates developed as compared to the numbers of small ciliates and flagellates. The number of amœbæ was very small.

Varying the amounts of soil inoculations influenced the numbers of organisms as well as the time of excystation, as per gram of soil there was the greatest development with the least amount of soil used for inoculation. When the largest quantities of soil were used the maximum numbers for those inoculations developed sooner than where the smallest portions of soil were used.

The development of protozoa in culture solutions varied considerably with the physical condition and the kind of soil. Drying the soil slightly favored the development of flagellates in soil extract. More flagellates developed from the more heavily manured soils while more large and small ciliates excysted from the less composted soils.

Experiments showed that soil protozoa develop differently under different conditions of temperature; the lower temperatures retard the development while the higher temperatures encourage an early development.

*Fred, E. B., and Hart, E. B. The Comparative Effect of Phosphates and Sulphates on Soil Bacteria. Research Bulletin No. 35, Agr'l. Expt. Station of the University of Wisconsin.

Another series of experiments on the activity of the protozoa in the soil showed that protozoa are active in greenhouse soils but to a limited extent. In fourteen field soils of different character and cultural treatment no motile protozoa were found to be present under normal and slightly abnormal conditions of moisture.

In studying the effect of moisture on the activity of protozoa in the soil under constant and variable temperatures, it was found that the moisture was the influencing factor which determined the presence of the organism in the living state.

Active protozoa were always noted as soon as free water was present.

Methods for the Study of Soil Protozoa.

David A. Coleman, Nicholas Kopeloff, H. Clay Lint. Trans. Am. Mic. Soc., 34 No. 2 (1915) 149-154. Science, N. S. Vol. 42, No. 1078, (1916) 284-286. Jour. Agr. Res. V. No. 3, (1915) 137-140.

While pursuing some investigational work as to the possible role protozoa may play as a factor in soil fertility, the writers were confronted by the lack of suitable methods at hand. The nature of the problems outlined necessitated the development of methods covering the various phases introduced. A number of the points brought out in this work have been published as short articles in scientific journals during the past year. The more prominent features of the work may be summarized as follows:

I. Method for estimating numbers of Soil Protozoa.

In view of the fact that the methods employed for counting protozoa have been unsatisfactory, the authors have adapted the well known blood-counting apparatus (Blutkörperzählapparat) to the counting of protozoa. The principal underlying the use of this instrument is the microscopical observation of a drop of standard size. The organisms may be examined in the stained or unstained, in the living or dead state. *Picrosulphuric acid (Kleinenberg) is recommended for killing and rapid staining simultaneously.* The advantages of this apparatus for the counting of soil protozoa are as follows:

1. It is a direct method, thus eliminating many errors attending incubation, etc., and the results can be reported immediately.

2. It is more accurate than any other method in use, because it is a standard instrument and no mechanical variation is possible.

3. It is rapid and saves considerable time in contradistinction to other methods, and the technique is simple. For example, triplicate counts on any media were recorded in ten minutes.

4. The counts check more closely than those of other methods used.

5. It can be used to advantage whether the number of protozoa present is large or small.

6. It can be used for living, killed, or stained organisms and permits of a thorough observation of the individual organisms.

7. The experimental error is 5 per cent.

II. Method for the elimination of fungi.

A method was devised for the elimination of fungi, based upon the principle of dilution, in such a way as to reduce the possibilities for the occurrence of fungi. The method of procedure was to pour plates of ten different fungi media in duplicate.

Upon cooling, a block of each medium about 2 cm. square was cut out with a sterile knife, and 1 c. c. of sterile soil extract was introduced by means of a sterile pipette into the cavity formed. A platinum loopful of a three-day-old culture of soil organisms in soil extract, known to contain numerous bacteria, protozoa and fungi, was then carefully rinsed off in the medium occupying the cavity.

At the same time poured plate cultures of one loopful of the three-day-old culture of organisms were made on the ten different agars mentioned above. Likewise after one week poured plate cultures were made on the ten different media by inoculation with one loopful of the solution present in the cavity of the agar plate.

The results show that on the plates where a portion of the agar was removed and 1 c.c. of soil extract substituted, the bacteria and protozoa developed in large numbers, which might in all probability be due to the fact that a large surface is exposed for such a small quantity of media. The important point, however, which is to be noted from this experiment is that despite the fact that suitable media were furnished for the growth of fungi, none was evident, even after thirty days' incubation.

From the observation of the poured plate cultures made from the original three-day-old cultures we note that fungi appear after four days. On the poured plate cultures made from the solution in the cavity of the agar plates, no fungi developed. This experiment was repeated and the previous results corroborated.

Thus it is certain that whereas fungi were present in the original culture the process of high dilution was responsible for their elimination from the specially prepared cavity on the agar plates.

Thus the dilution method followed by the peculiar manner of plating, as outlined, makes it possible to separate fungi from bacteria and protozoa.

III. Media for the development of protozoa.

In order to determine which medium would be best adapted to the large and rapid multiplication of the various kinds of protozoa, the following media were employed in dilutions of 0.5 per cent, 1 per cent, 3 per cent, 5 per cent, and 10 per cent. Dried-blood, hay infusion, hay infusion plus 0.5 per cent egg albumen, peptone, horse, cow and chicken manures, egg albumen, bouillon,, and soil extract in dilutions of 400 c.c., 600 c.c., 800 c. c., 1000 c. c., 1200 c. c., per kg. of soil.

The results of this investigation showed that:

(1). Ten per cent hay infusion proved to be the most favorable medium for the development of large numbers of small flagellates, as well as small and large ciliates. Hay infusion in various concentrations with, and without, the addition of egg albumen, proved to be well adapted to the development of the organisms. Hay infusion plus 5 per cent egg albumen proved superior to all other media for the development of ciliates.

(2). Soil extract is an excellent medium, though somewhat inferior to hay infusion plus 5 per cent egg albumen, and with the soil used in this experiment lower concentrations than those recommended by Löhnis developed protozoa in a shorter period of time.

(3). Three per cent chicken manure is an excellent medium for the development of small ciliates.

(4). The numbers and species of protozoa which can be obtained from a given soil are largely dependent upon the media employed, time of incubation, as well as the kind of soil used.

(5). In general the order of appearance of protozoa was as follows: small flagellates, small ciliates, large flagellates and finally large ciliates. This is in accordance with Cunningham and Löhnis' observations.

IV. Method for the separation of types of soil protozoa.

The method of procedure was as follows: The numbers of protozoa in the stock culture solution were first counted by the method previously described and recorded under classes of (1) flagellates, (2) small ciliates (12 to 20μ), and (3) large ciliates (25 to 60μ), No amœbæ developed in the short period of incubation. Ten c.c. of the culture solution were then placed (by means of a sterile pipette) on filter paper, previously sterilized with alcohol, and allowed to filter through for one minute. The protozoan content of the filtrate was then recorded in triplicate and the filtrate incubated for five days at 22°C, in order to allow the excystment of any encysted forms. The filtration and incubation processes were then repeated, if necessary, until all the living protozoa of the desired type had been separated out. The filter paper was used in from one to five different thicknesses (Schleicher and Schüll's No. 589).

It was found that (1) large ciliates are not able to pass through the filter paper at all, which fact is in agreement with the experience of Russell and Hutchinson. (2) The number of small ciliates decreases rapidly in increasing the thicknesses of the filter paper from two to four. Thus, with four thicknesses of filter paper all of the ciliates found in the solution employed were separated from the flagellates. (3) It was a simple matter to separate the small from the large ciliates. In this way it becomes possible to employ mass cultures of flagellates, small ciliates, or large ciliates.

V. A method for the separation of protozoa from bacteria.

In an effort to determine the effect of filtration on the separation of soil protozoa from bacteria, a bacterial count was made of the stock-culture solution previously employed, known to contain soil micro-organisms. Ten c.c. of this solution were then filtered through five thicknesses of sterilized (with alcohol) filter paper (S. & S. No. 589). The residue on the filter paper, consisting of all of the protozoa originally present, together with some adhering bacteria, was then plated out on Lipman and Brown's synthetic agar. The bacterial count showed that 90 per cent of the bacteria had passed through the filter paper (after making due deduction for contamination from the air by exposing agar plates for the same length of time as was necessary for filtration), thus leaving the protozoan residue comparatively free from bacteria.

This method in all probability would not allow complete separation of the protozoa from the bacteria. Consequently the work was not carried out any farther.

In reviewing the literature prior to starting the experimental work abstracts of the more important contributions together with an extensive bibliography were prepared. This paper awaits publication in the Centralblatt fur Bacteriologie und Parasitenkunde, Abt. II.

REPORT OF THE DEPARTMENT OF BIOLOGY

Department of Biology

*JULIUS NELSON, PH.D., *Biologist.*

†THURLOW C. NELSON, B.SC., *Assistant Biologist.*

†P. CALYDON CAMERON, *Laboratory Assistant.*

*Died February 15, 1916.
†Temporary appointments for summer field work.

CONTENTS.

Report of the Department of Biology

Julius Nelson [1]

I.

INTRODUCTORY.

The experimental work of the Biological Department, during the past year, contained in the field of oyster culture and industry, was broadened and deepened in scope. Observations were made of the temperature changes in sea water during the winter at Keyport. At the laboratory in New Brunswick, analysis of oysters were made to ascertain their water content, their copper content and the nature of the color in green and blue oysters. These are all matters of great concern to men practically interested in the oyster industry. During the summer the facilities of the stations at Barnegat and at Edge Cove, Tuckerton were fully utilized for obtaining the data bearing on oyster propagation, presented in condensed form in the tables of the report. The former station was in charge of P. C. Cameron, and the latter as the head station, was under the Biologist, assisted by T. C. Nelson, B.S., *instructor in the University of Wisconsin.*

The Biologist also spent the month of August making a plankton survey of Richmond Bay P. E. I. at the expense of the Canadian government. Very satisfactory increase in a knowledge of oyster propagation, was thus secured, that will bear fruit in improved methods of future study of our own oyster fields.

The New State Board of Shell Fisheries.

In July, the newly organized State Board of Shell Fisheries with George A. Mott as director, took charge of and succeeded to the work previously under the several oyster commissions and the Bureau of Shell Fisheries. This change has not annulled the law creating the oyster observation stations, and the new Board simply takes charge of the affairs of the Bureau. Director Mott is as much in favor of this cooperation with the Biologist Department as was the former Chief of the Bureau; and it will depend simply on the Appropriations Committee whether or not this development of the work is to be favored or the reverse.

[1] *Dr. Nelson died on February 15, 1916, before this Report went to press.*

II.

SUMMARY OF CLIMATIC EFFECTS ON OYSTER PROPAGATION.

The past season, owing to a cold spring, was several weeks delayed. The water warmed up slowly, being only 64°F. on May 20th, June June 11th it had reached 70°F., and by the middle of June was 81°F. But then followed cold weather bringing the temperature down to 66°F. or 68°F., from which there was a slow rise to 78° or 79° during the hot spell at the close of the month. From this level there was a fall to 75°F. which was maintained until the middle of July when another hot wave raised the temperature to 80°F. From this there was a decline to the 75°F. average until the arrival of the main warm spell of the season July 27th to August 3rd, when the water registered 82°F. to 85°. There was again a fall to a 74°F. average until the 12th when temperatures above 80°F. again prevailed. From August 16th on, there was a steady decline towards the 70°F. level until the 9th of September when the stations were closed.

It will be noticed from an inspection of the tables that the water temperature fluctuated with the air temperature. It will also be noticed that at the times of warm waves from the first of July on (five in number) there was active spawning at each period. It will also be noticed that spatting began actively at the second period (mid July) and occurred at each of the subsequent periods, three in number. The principal period of activity was that from July 27th to August 9th. This is almost exactly one month later than during periods with warm spring weather, and is two weeks behind the average.

There was a similar delay in propagation in Richmond Bay, where however, the corresponding periods are a month later than in New Jersey. If cold autumn weather is not specially delayed, it will mean danger that the fine lot of late fry in the water may be prevented from setting; and those that do set, will have to winter over as very small spat. The considerable number of dates on which spawning and subsequent spatting occurred this year has been favorable to oyster seed production, although it has made it difficult to place cultch at the best time.

III.

SPECIAL RESULTS OF THE SEASON'S WORK.

Besides the determination of the periods of spawning and spatting and their relation to the weather conditions as summarized in the preceding section, we give the following fifteen points as the results of special observations, experiments and calculations, by the three workers in the oyster laboratories during the summer.

(1). Canadian oyster larvæ at the time of spatting are a fourth larger than those of native New Jersey oysters. This discovery has a bearing on the problem still unsettled whether there is a boreal variety of oyster distinct from the *Ostrea Virginica*. If future investigations should show

PLATE IX.

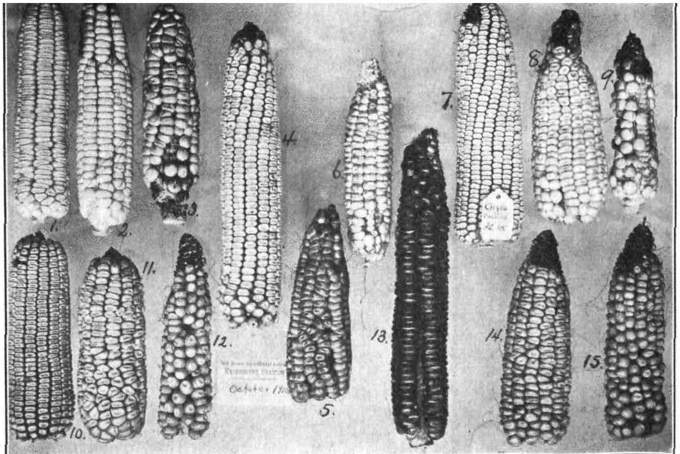

PLATE IX:—CROSSED CORN: *Cuzco with United States Field Kinds.*

Cuzco upon *Hickory King* F_2 at *2, 3;* upon Cockesberry at *5, 6;* upon Mastodon at *8, 9;* upon Early Yellow Dent at *11, 12;** upon Eight Rowed Flint at *14, 15.* No Cuzco corn matured ears, but the five other parents are represented by ears *1, 4, 7, 10, 13,* to the left of their crosses respectively, and grew in adjoining rows in the field.

PLATE X.

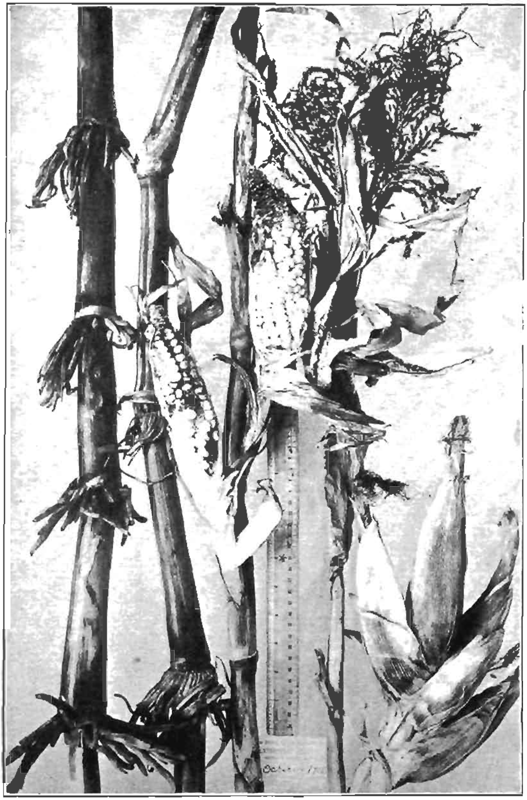

PLATE X:—CROSSED CORN: Cuzco with United States Field Kinds.

Portions of a single stalk of the Cuzco upon Early Yellow Dent, showing the large size whorls of ærial roots, and poor crop. A "band" of abortive ears is also shown separately.

that the size of the larval spat depends on the environment, colder water, lack of cultch, etc., then of course that discovery would give a new turn to the evidence.

(2). The soft parts of an oyster occupy only about half of the shell cavity. This allows for the swelling produced by decrease in the salinity of the water. It yet remains to determine the percentage of this space occupied under different degrees of salinity.

(3). The swelling produced in oysters by different methods of preparation for market involving their treatment with fresh water should not be considered as a single question, but as three independent propositions, viz: (a) the "floating" of oysters in the shell; (b) the washing of shucked oysters for the wholesale market; (c) the soaking of oysters opened by the retailer.

(4). Some oysters contain a far higher percentage of copper than do others. This may or may not be associated with the presence of a green pigment. It is perhaps associated with the need for more oxygen.

(5). The green or blue color sometimes developed in oysters may not be the result (as has been stated) of the absorption of the color from the food. This matter needs much more investigation.

(6). The relation of certain copepod and other plankton organisms as enemies preying on oyster larvæ is of great interest and importance. In our investigations we have generally found that a period of great increase in oyster larvæ is ushered in by an increase in small veligers. In our Canadian researches, we found that a great abundance of snails was associated with a scarcity of oyster fry.

(7). The most accurate method for determining the number of oyster fry in a plankton sample, is that of sedimentation rather than filtration or towing with the finest net.

(8). Oysters exposed at low tide are delayed in spawning; and for those always covered, the spawning is dependent on temperature.

(9). Oysters transplanted during the spawning period are delayed in spawning; the transplanting of "spent" oysters into warmer water may cause a fresh lot of spawn to be produced.

(10). The length of the free larval life of oyster fry at 77° F. is 16 days; at 80° F., 13 days.

(11). The temporary raising of the temperature of water by warm waves causes the fry to rise to the surface, while cold weather drives them down.

(12). Larvæ reared by artificial fertilization, reach the shell stage in their development only when the fertilization is made within ten minutes after the oysters are taken out of the water.

(13). At 90° F. the shell stage is reached within 12 hours after fertilization. Larvæ were kept and fed until they doubled in size.

(14). Larvæ tend to stay near the bottom at night, while they rise when daylight appears.

(15). The adult oyster discriminates in its food, rejecting what is unsuitable. The larval oyster, like the adult mussel (Modiolus) swallows everything small enough.

Table I.
Winter Observations of Water at Keyport, 1914-1915.

DATE.	Hour.	Tide.	Place.	Density.	Temp. deg. F.	Remarks.
October 26	Noon	Third ebb	A	1019	64	
October 26	2 p. m.	....	A	1014	....	
October 26	2 p. m.	....	B	1016.5	....	
October 26	3.30 p. m.	......	A	1006	......	
October 29	11 a. m.	Low ebb	C	1022	50	
October 29	1 p. m.	Low	A	1018	....	
October 29	4 p. m.	Half flow	A	1020	....	
January 9	1 p. m.	High flow	A	1010	35	Surface
January 9	1 p. m.	High flow	A	1013	33	Bottom
January 9	3.30 p. m.	High ebb	A	1010	33	Top and bottom
March 13	1 p. m.	Low ebb	B	1001	45	
March 13	3 p. m.	Half flow	B	1013	43	
April 2	2 p. m.	Low	B	1008.5	48	
April 23	1 p. m.	High flow	A	1009	60	
May 20	2 p. m.	Third ebb	B	1015	64	
May 20	2.30 p. m.	.....	A	1007.5	64	

A is in Luppatatong Creek above the Ellsworth Company oyster opening house.
B is at the mouth of this creek.
C is in Prince's Bay off Gre t Kills, Staten Island.

IV.

THE "SOLIDITY" OF OYSTERS.

By "solidity" of oysters we mean, the proportion of the contents of an oyster shell that is nutrient as distinct from the water present. This question has become one of great importance in connection with the claim of the Federal Bureau of Chemistry. That the practice of "floating" oysters before sale, thus producing an increase in their volume, constitutes an "adulteration" with water, just as the addition of water to milk is an adulteration. To determine whether water has been added to milk it was necessary to fix a standard by chemical analysis of various samples.

The question has arisen, why not have a legal standard of solidity for oysters? Thus cases of adulteration with water by soaking after opening, or "floating" before opening (or both) could be detected. Analysis of *natural oysters from all sorts of waters, and under all sorts of conditions* have shown that oysters vary in their water content to a far greater extent than does milk. Under the circumstances if a standard were promulgated it would have to be so low that it would tempt persons handling oysters of a superior grade, to swell up their product with water. The percentage of adulteration under such circumstances would be considerable, for some oysters have bulk for bulk, after shucking, twice as much water as other samples.

Therefore it would be difficult to prosecute for soaking or floating, when such a practice really adds less water than nature adds in certain circumstances. It is plain that even 20 per cent of water extra, would be a *serious matter in case oysters are bought as an article of diet. It is* of course only from this point that the paying public views the matter. All people want as much for their money as they can secure. But from the point of view of the Board of Health, the real menace to be found in this practice of "plumping" oysters lies in the possibility of infection through the use of contaminated water. The writer has gone on record as believing that this is the real reason underlying the movement against "floating," etc. From a pecuniary point of view oysters are not to be considered as a staple of nutrition, but rather of condimental value, like celery, rhubarb, and similar side dishes. If there were absolutely no such thing as any suspicion of the practice of "plumping" oysters in any manner, the fact would remain that two samples of oysters bought at the same price might be worth only half as much in one case as in the other from a dietary point of view. There is at present no practical way for the public to judge of the matter. If an attempt be made to judge by the appearance of the oysters, the public will almost invariably choose the plumpest and "fattest" looking oyster, such as produced by floating. If the same sample had been left unfloated, it would be discarded. Every one who has cooked oysters knows that there is a great shrinkage during cooking, but usually oysters are not cooked long enough to reduce to the last possible degree. If they were, then it would be easy to see just which sample had the most meat.

Oysters shrink after opening more and more, whether to be eaten raw or cooked, and they are best when eaten before much shrinkage has occurred. Hence we prefer oysters cooked quickly or eaten as soon as out of their shells, before their liquor drains away. In other words a certain proportion of water is a benefit in many kinds of food; but we want it pure. Hence for the benefit of those who prefer floated oysters (which are undoubtedly plumper and firmer than the unfloated product) it becomes necessary for boards of health to see that the water used for floating oysters is pure, as well as that where oysters are growing. Both objects are covered by a law that prohibits oysters from being marketed from polluted waters; and this includes of course the water in which oysters are washed after shucking.

A question arises here, why should oysters need washing after opening, when it is the practice of epicures to swallow them just as they are, on the half shell? Why not cool them below the decomposition degree, and send them out without washing? One of the condimental values, an important dietary value of oysters (also their salty flavor or "tang" of the sea), resides in the natural sea water clinging to their tissues; and this is largely lost by washing. If oysters are washed longer than five minutes, they lose salts also from their tissues, and begin to swell. We have been assured by practical oyster producers that washing in salt water will not do. We suspect that the reason is largely if not entirely, that the oysters so treated come out flabby, even though a chemical analysis of such oysters shows the presence of more "solids" than in the case of the swollen oysters. In this connection it should be noticed that sometimes in the chemical analysis, the solids are stated in percentages of the bulk or weight of the oysters analyzed, which is a perfectly proper procedure. But the difference between the percentages in the case of a comparison between swollen and shrunken oysters, does not represent a corresponding loss in solids in the watery samples. Some of the salt, etc., does have to leave in order that the water may enter. There is a loss, but it is not represented by the difference in the percentages. It would be necessary to add sufficient water to the unfloated sample to bring it up to the bulk (not weight) of the floated sample, and then compare the analysis to get a *proper statement of the loss of solids through floating*. This view is taken in case the oysters are handled as individuals. On the other hand when purchased opened by measure, it is evident that more solids are present in the sample that has not been freshened. The "solids" are to an important extent, represented by sea salts, which are condimental, not the bearers of "Calories." Aside from the plumper appearance and whiter color produced by washing, this process causes the oyster to lose some slime and a considerable amount of dirt. Thus there is an esthetic object in washing oysters of quite as much importance as the value of the salts lost. The loss of slime, dirt, and salt causes a decrease in the rapidity of fermentation.

Freshly shucked oysters are said to "heat" quickly in bulk in containers, but this is obviated through thorough washing. Here is a problem worth scientific attention.

It is quite necessary to distinguish between three different practices in connection with the swelling of oysters from the use of water fresher than that in which they have grown. (1) The practice of floating oysters in the shell; (2) the practice of washing shucked oysters that are marketed as "solid meats" that is, without "liquor"; (3) the practice of retailers to put all oysters opened, whether freshened or "salts" into a bucket of tap water from which they are sold to the public, after standing a varying length of time. From such a bucket the oysters are fished out, either as "solid quarts" or with a proportion of the water, believed by the purchaser to be oyster "liquor" of great strength and value, which mistaken notion the retailer does not take pains to correct.

The reason for distinguishing between these forms of plumping is because the extent of the plumping differs. An oyster in the shell can swell only as much as the chamber in which it lies will allow, and besides such an oyster controls the amount of loss of salines by shutting its shell. On the other hand a shucked oyster is helpless, and takes up just as much water as the manipulator chooses to add. If the washer of oysters obeys the national law, and washes only a limited time, his oysters may not be as plump as those floated in the shell. They may exceed the latter in volume if washed for a longer time. There are those who advocate long washing as necessary to insure long keeping. On the other hand the *retailer* is not reached by any National law, and he not only swells the oysters to their full capacity but he also removes all the salts. A Federal law forbidding the sale of floated oysters would encourage this practice since the saltier the oyster the more it will swell. Thus, such a law would fail to benefit the public even more than one fixing a standard of solidity.

The real reason for condemning the practice is also the basal reason for the practice, viz., the oysters are increased in volume by treatment with fresh water. The real point at issue is one of volume directly, and only indirectly one of "dry solids" determined by chemical analysis. Therefore we should study the effect on the volume of oysters of the addition of fresh water.

Volumetric Analysis of Oysters for Solidity.

Sample A consisted of ten oysters shipped from Keyport, N. J., having a volume of 920 c. c. as measured by water displacement in a graduated cylindrical jar. After shucking the shells displaced 590 c. c., leaving the space in the shell (when shut) as 330 c. c. The volume of the liquor drained from these oysters was 88 c. c., and the flesh 190 c. c.; the sum of these being 278 c. c., proved that 52 c. c. of sea water liquor had been lost by these oysters since they were taken from the sea. When freshly taken from the sea 57.6 per cent of the shell cavity was occupied by flesh and 42.4 per cent of it was occupied by water. Doubtless it is this reserve water on which the animal depends when exposed to the air. As a change in the salinity of its natural environment will cause swelling of the flesh when the water is freshened by rain, it is evident that the animal has ample space in which to expand. Usually it shuts out the fresh water when it has increased one-fourth in bulk. We exposed the flesh of these oysters during one day to the action of tap water and secured and increase of 190 c. c., to 215 c. c., or one-eighth; two days later the flesh volume was 240 c. c., an increase of one-fourth of the original volume.

Sample B consisted of ten oysters from Keyport, of a volume of 830 c. c. in the shell, the shells alone 545 c.c., thus the cavity was 285 c. c. The liquor measured 92 c. c., the flesh 165 c. c., a total of 257 c. c., which showed that 28 c. c. of water had been lost by the oysters since they were "lifted." The proportions of cavity to water space and meat space is practically the same as with A. A day's soaking of the flesh gave an increase of one-ninth and three days', a one-third increase.

Sample C was composed of three oysters of 240 c. c., volume of which shell was 150 c. c., leaving 90 c. c. for the cavity. The liquor was 18 c. c. in volume, the flesh 35 c. c., and the lost water 37 c. c. The meat occupied only 39 per cent of the cavity.

In the practice of floating in the shell the oysters are left in the fresher water until the fluid in the extra shell cavity has been replaced with fresh water. If such oysters are shucked at once it is plain that they have only just begun to swell. It is known however that such oysters do not lose their water during shipment so rapidly as salt oysters do, therefore they keep longer. Meanwhile if several days go by, before shucking, the oyster absorbs this water until it is all in the flesh so the cavity is nearly filled by the meat. It is evident that there can be no question of loss of nutrients by the flesh under these circumstances. Where oysters are sold by the count like eggs, the size varying, there can be no comparison with the case of watered milk; neither can comparison be justly made with the oysters soaked after shucking, nor yet with the washing of oyster meats as conducted in shucking houses. The three cases are independent, and each must be studied on its own merits. It is plain that the problem is far more complicated in any of these cases than that involved in milk adulteration. We need a wide field of observation to see just what the limits of speed and amount of swelling is in these cases and also the injuries and the benefits connected with various methods of handling oysters for sale.

V.

COPPER CONTENT OF GREEN OYSTERS.

In 1892 we conducted a study of green clams. These shellfish had assumed a bright green tint particularly in their liver, gills, and heart. The color seemed to be attracted most to the tissues involved in respiration and metabolism. At that date it was known that oysters in Marennes, France, are placed purposely in ponds where they may become green to prove to the public that they have undergone this treatment. Such ponds are extra well supplied with diatoms as food for the oysters and the result is a rapid growth, a genuine and desirable "fattening" which ensues. such oysters commanding an increased price. European scientists who had studied this coloration traced the origin of the color to a pigment present in the food of the oysters.

The last twenty years have shown a slight and inadequate advance in our knowledge of this phenomenon. It is known that oysters from certain beds are green every year, and at times may become green in other places. The American public on seeing these green shellfish, at once think of copper, and these oysters, which are of inferior flavor as compared with those of Marennes, do leave a "coppery" taste in the mouth after eating. Oysters that are not green have such a coppery taste on certain beds. In Europe a coppery taste in oysters is esteemed with favor. But it is yet to be proved that this "taste" actually is due to copper. It is still more uncertain that the green color is due to copper.

Certainly it is not the green mineral salt of copper.

It was demonstrated in 1878 that the blood and tissues of shellfish generally, contains copper, where it plays the same role as iron does in red blooded animals. Iron is also present in variable quantity. The iron and the copper in these bloods enter into combination with protein to make substances that carry oxygen. In red blood the iron compound is called "hemoglobin"; and Fredericq called the corresponding copper compound "hemocyanin." The latter gives the blood a pale bluish color scarcely noticeable as compared with the deeper color of the red hemoglobin. These latter may exist dissolved in the plasma (red blood of worms), or be concentrated in corpuscles (blood of vertebrates). Hemocyanin is generally dissolved in the plasma; whether hemocyanin can become concentrated in blood corpuscles is an open question.

Pigments of diverse colors and chemical composition are widely produced in vegetable and animal organisms, and some of them have respiratory functions. The green pigment (chlorophyll) of plants in general, is a combination of magnesium with protein; and various varieties of this are present in the diatoms and low plants. Some of the related pigments and decomposition products of chlorophyll (phyllocyanin) having parted with the magnesium, are known to make combinations with other metals, among which are both copper and iron. These vegetable pigments often existing free from metallic combination, and capable of making compounds with copper, iron, etc., are assumed by one class of investigators to be absorbed by the tissues of the animals feeding on the plants in which they are present. Another class of investigators thinks that they are built up as independently in the animal body as in the plants, in response to conditions that favor their existence. One thing must be remembered, that the green or the blue, or red, etc., is shown by copper salts, and other metallic salts, and is seen in those pigments that *contain these metals, and also in the pigments free from the metals.* Hence we conclude that the metal is not responsible for the color, which depends on the special arrangement of the other atoms in the molecule. It follows therefore that various samples of shellfish which are alike in being green in color, may be unlike in respect to the metal that is present; and a metal may even be absent from the colored substance. Vice versa, a sample of uncolored shellfish may contain more metal in its tissues than other shellfish whether colored or uncolored. Let us at once dismiss from our minds, that the green color is due to copper. If then chemical analysis of a sample of green oysters should show the presence of more copper than usual it would in nowise prove that all green oysters contain extra copper, nor even that the green pigment contains copper. Chemical analysis of green oysters has sometimes shown they have no extra amount of copper.

We have stated above that copper is used by shellfish as a carrier of oxygen. In this connection it is interesting to note that the green color of the Marennes oysters is acquired in ponds (claires) where there is a deficiency of aeration. It is also likely that there is a deficiency of oxygen in waters generally that produce green oysters and clams; and it may be that there is a relation of some sort here, either a larger amount of respiratory pigment is produced, or its composition is changed—some of its oxygen being given up to the tissues, or it may have a higher oxygen combination. Of course these combinations are unstable or they would not benefit the animal. Whether the copper is merely associated with the pigment, or a part of it, has to be independently determined.

In this connection, the following observation is of interest: Last March certain oysters with flesh of a deep green color were received from beds in Raritan Bay. These oysters when opened and exposed to the air, slowly changed from green to a reddish brown. Here was evidently a change in chemical composition, but to what extent this involved an oxidation, we could not say. Later we received some oysters with bright blue flesh. The pigment was easily dissolved in formalin; and under decomposition of the oysters, collected in clumps, but did not go into solution in water. It was also soluble in methyl alcohol, acetic acid, ether and glycerine, but turns brown in chloroform, benzol, acetone, carbon disulfide, and petroleum ether. On exposure to dessication in air, these oysters turned a deep dark green, evidently a variety of the same pigment; and doubtless the blue pigment was produced by conditions similar to those producing the green pigment. The change from blue to green under exposure to air is probably of the same nature, as the change from green to brown. We strongly suspect that uncolored oysters have this substance always present and that it will be possible by suitable culture to produce oysters of any desired color. The Ancient Romans are reported to have served oysters of not only green and blue colors, but of red and black. The majority of the oyster fry just before setting as spat show a marked red coloration, particularly striking in the case of the Canadian oyster.

Analysis of Blue Oysters for Copper.

Some of the blue oyster were analyzed by Robert F. E. Stier for copper, for his graduation thesis, June, 1915. The procedure was as follows: (1) Evaporation of the flesh on porcelain plates over boiling water until dry enough to grind. (2) Incineration of the powder in a porcelain crucible at red heat: the last trace of carbon driven out by growing heat. (3) Dissolving the ash in 40 per cent nitric acid, and evaporation to 50 c. c. (4) Treating with ammonia: If blue color does not appear. (5) Acidulating with sulphuric acid. (6) Alkalinizing with ammonia until the blue appears. (7) Addition of nitric acid until the color disappears, to prepare for electrolysis. The electrolytic apparatus involved the use of an electrolyzing direct current of 2 amperes at 7 volts. The electrodes were respectively a platinum sheet at one pole, and a platium wire cylinder for the solution. The latter electrode was attached to rotating apparatus, worked by extra motor on an alternating current. (8) The cylinder was rotated in the solution 20 minutes and lifted from the solution while the direct current was still on. (9) Washing in water followed by alcohol, drying and weighing. (10) Comparing with weight of electrode before the deposition of metal began, to ascertain the weight of metal (copper?) in the sample. Other metals if present might also be deposited. To show if all the metal deposited was copper, comparison was next made by colorimetric determination. For this purpose: (10) Dissolve the metal on the platinum, in the least quantity of dilute nitric acid. (11) Neutralize with ammonia. (12) Acidulate with acetic acid. (13) Put into a 100 c. c. Nessler tube, add 5 drops of 4 per cent potasium ferrocyanido and fill with distilled water to the 100 c. c. mark. (14) Dissolve 3.93 gm. of pure copper sulphate crystals in a litre of water. Each cubic centimeter of this represents 1 mg. of copper. Five additional Nessler tubes receive respectively 1, 2, 3, 4, 5, c. c. of this solution and 5 drops each of the ferrocyanide solution and are filled with water to the 100 c. c. mark. (15) Comparison is made successively between tube No. 1 and the other five in the usual way, diluting if necessary, and calculating the percentage of copper.

Three samples of blue oysters and two samples of uncolored (ordinary) oysters were analyzed, and the color test showed the blue oysters contained 40 mgm. of copper apiece the uncolored ones only 9 mgm, or less than a fourth as much. The weight of metal deposited on the electrode, which appeared copper plated was for the three "blue" samples, respectively, 21.2, 17.7, and 17.3 milligrams, and for the "white" oysters, 3.8, and 3.1 mgm., *practically a fifth as much. The ash in the first two samples* weighed 687.7 milligrams. In the last two, 719.9 milligrams, thus approximately alike. Electrolysis, more reliable than the other method, showed less than half as much copper as by the color tests.

VI.

DESTRUCTION OF OYSTERS BY CRABS.

A considerable percentage of the adult oysters on beds are found open and entirely empty, and it is an important question what has destroyed them. Suspecting that crabs were the culprits, the assistant placed 50 oysters at the laboratory dock and patiently watched them. A crab was seen repeatedly to come up at the hinge-end of an oyster and carefully encircle it with its arms, attempt to insert the tip of its claw in the shell and fail because the oyster snapped its shell shut too quickly. Then the crab carried the entire cluster of oysters out of sight; but these oysters were recovered and several were found empty. At last all the oysters were carefully inspected and twelve per cent at least were found open and recently cleaned out. It would be necessary to watch this in an aquarium to be certain. It is possible some other cause destroys the oyster and the crab cleans out the dead meats.

Plankton Enemies of Oyster Larvae.

After months of careful observation of the living water fleas, snail larvæ worm larvæ, etc., the assistant can report that he has never seen any of them actually swallow an oyster fry. Most of them have mouths too small for the passage of the oyster fry, and secure food by ciliary action in a haphazard way, of the same general nature, vegetable debris, etc., as the oyster larvæ feed on, though somewhat coarser. Neither do oyster larvæ show up in the intestinal tract of these transparent creatures.

However we observed one abundant copepod (probably a species of *Calanus*) which has a well developed cyclopian eye, and mouth appendages furnished with curved and feathered bristles. This water flea makes rapid darting motions and appears to be admirably fitted for a predatory mode of feeding. It is about two hundred times as large as an oyster fry.

This copepod appeared in abundance when oyster larvæ were increasing and when it became most abundant the oyster larvæ suddenly decreased in number, followed soon by a general death of *Calanus* through the development on its body of a vegetable parasite. This parasite appears as clusters of banana shaped cells, that develop from spores and take root on the skin of the *Calanus*, and multiply there until the creature is entirely covered and helpless, resulting in the death of the copepod.

Calanus appeared most abundant between July 10th and 24th. On the 18th the fungous growth was first noticed. The parasite was never found in the water free from *Calanus* nor attached to any other of the organisms present. July 24th on a prevailing last wind that kept the tide high, the copepod was most abundant. The density of the water was only 1013 at 74° F. at all the stations which is too low for ocean water. All the oyster fry were then gone. On the next day it was noticed that the copepods were very numerous and greatly incommoded by the parasite. A third of them were dead and all of the remaining ones were very weak. All the rest were in distress, the eye moved and changed color, from crimson to blue, to violet. By July 26th no more copepods were to be found, but *a new crop of oysters of fry had started. On the next day the highest* number of fry of the season was present, viz: 1508 in a bucket of water taken at high tide of 1013 density at 78° F. The east wind had then abated, and the tide was returning to normal. On July 28th a bucket of water from Station A, having a density of 1009, contained 620 oyster fry and no copepods. A bucketful from Station C with a density of 1016.5 contained only 108 fry and a crop of young copepods with a beginning of the parasite epidemic. From this date on there was a slow increase in copepods, with a slow decrease in oyster larvæ. After August 12th there was a scarcity of copepods up to August 31st, with a fluctuation in the number of oyster fry.

These observations suggest that these copepod feeds on the oyster larvæ but the subject needs further study to prove this conclusively.

Drawings of Marine Worm Larvae in the Oyster Plankton Samples.

Figs. 1 and 2, Plate II, show two views of a chætopodous annelid larvæ rather abundant in the plankton in June and July, and supposed to be the young of a nereid worm rather common on oyster beds. Fig. 1 is a ventral view, and Fig. 2, a foreshortened face view. All the figures were drawn free hand under magnification of the living motile specimens. This larvæ bears two white horns on its head, a tuft of bristles (setæ) on each side of the neck segment, and a circle of trochal cilia at each end of the body, that turn (vibrate) in opposite directions. Those on the head draw particles of food, while those at the tail repel particles. They serve also for propulsion. The setæ are probably organs of touch. Four eyespots are situated on the head, that, while possibly sensitive to light, cannot form images, owing to absence of lenses. Qnohog and oyster larvæ have been drawn alongside for the purpose of giving a notion of comparative *size, and showing that these are too big to serve as food at this* stage, at least, in the growth or development of this worm. Figs. 19, 3, 7, 17, appear to be closely related forms, some of which are probably younger stages of this species. Figs. 9 and 10 also appear closely related, but show decided differences. Fig. 9 has two pairs of ornamental discs on its head, without cilia. Also at its posterior extremity, there are no cilia, but a number of triangular pores through which it may forcibly expel water as motive power. Fig. 10 shows no cilia on the head, but they are present on the tail end, where bristles are absent. Figs. 11 and 12 also appear to be related, but are so different as to be either of different species or of different sexes if of the same species, or they may be metamorphic stages in development, in which case Fig. 12 is the younger larvæ. Figs. 13 and 14 are drawn from the same individual, with proboscis extended and retracted respectively. Fig. 20 shows one of the Nematode worms related to the vinegar eel. Fig. 21 shows a young quohog clam. Figs. 4 and 8 look like different stages of the same worm though there seems to be a slight difference in the arrangement of the pigment (eye) spots. From the juxtaposition of the various bivalved larvæ (oyster, clam, etc.), in the plate, it is evident that these worms cannot feed on them, but eat much smaller food, but of a size larger than the food used by the oyster in its free stages of life.

VII.

OYSTER OBSERVATIONS.

Table II.

Condensed Record of Climatic Data for Edge Cove Oyster Beds, 1915.

Date	Wind	Temp.	Bar	A. M. h. tide	P. M. h. tide	Miscellaneous
une 11	S. str.	71 a. m.		8:00	8:30	
" 12	S. W.	76 eve.		8:30	9:30	
" 13	E.	76 a. m		9:30	10:30	Much rain in evening.
" 14		74 a. m.		10:30	11:30	Much rain in morning
" 15	S. str	81 noon.		11:30	12:00	
" 18	S. W.–S. E.	71–79		1:00	2:30	
" 19	S. W.–S. E.	70–78		1:30	3:00	
" 20	S. W.–S. E. lt.	73–78		2:30	3:30	
" 21	N. E. str.	60–76		3:30	4:30	
" 22	S. E. str.	55–60		4:30	5:30, 12–73	Rain, .37 in night.
" 23	N. W. str.	50–66		5:30, 23–57	6:45, 7–66	10:20 half tide.
" 24	N. W.–W. str.	46–70		6:30, 10–53	7:30, 4–70	
" 25	N.–S. W.	48–72		7:30	8:30, 5–73	S. W. last night.
" 26	S. E. lt.	66–78		8:30, 9–51	9:30, 2–73	Rain, .42 in p. m.
" 27	N. E. str.	60–72		9:30, 4–49	10:30, 2–73	Rain, .80, hail last eve.
" 28	N. E.–S. E. lt.	54–75		9:30, 8–46	11:30, 0–68	Rain, .14 last night
" 29	S.W.–S E. str.	59–76		11:30, 6–45	12:00, 2–63	
" 30	S.–S. E. str.	68–75		Night, 2–63	12:30, 4–48.	Rain, 25 in evening
uly 1	S. W. lt.	70–85		1:00, 5–69	1:15, 10–58	
" 2	N. E.–E.	70–80		2:00, 12–74	2:30, 15–68	
" 3	S. W. str.	66–83		2:30, 20–70	3:00, 9–59	Rain, .4[illegible] n night.
" 4	S. W.	70–80	29.95	3:00, 15–60	3:15, 6–60	Stiff wind last night.
" 5	S. W. str.	73–76	29.80	3:30, 16–60	4:30, 7–56	Rain, .41 in.
" 6	N. W.–W. lt.	59–78	30.00	4:30, 8–40	5:30, 0–46	
" 7	S. W. lt.	60–79	30.10	6:00, 6–32	6:45, 0–54	S. E. rain in night.
" 8	S.E.–N.W. str.	70–77	29.55	7:00, 10–40	7:15, 12–65	
" 9	N.W.–S.W. str.	56–81	29.85	7:15, 6–40	8:00, 11–54	
" 10	S. E.–S.W. lt.	56–77	29.95	8:00, 6–36	8:30, 4–59	
" 11	S. E.	60–80	29.85	8:45, 6–41	9:00, 5–70	Rain, .40 in p. m.
" 12	S.W.–E str.	70–79	29.70	10:00, 12–44	10:45, 11–73	
" 13	S. E.	65–77	29.80	10:30, 15–46	11:00, 6–68	
" 14	S. W. lt.	64–83		10:30, 14–49	11:00, 6–67	
" 15	W.–S. W. lt.	68–88	29.82	11:30, 9–51	11:45, 6–65	Rain, 07 in night.
" 16	S. E.	75–83	29.65	11:45, 12–56	12:[illegible]0, 10–64	Rain.
" 17	S. W.–N. W.	75–94	29.30	Night, 10–64	12:30, 5–55	Rain, .16.
" 18	N. W. lt.	70–85	29.80	1:30, 10–58	2:30, 2–56	
" 19	S. W.	70–86	29.90	2:30, 10–54	3:00, 2–48	E. h. 2.05 at 82.
" 20	N. W.–N. E.	73–77	29.86	3:00, 10–54	4:15, 1–59	Rain, .06.
" 21	E.	66–74	29.90	4:30, 16–53	5:00, 11–70	
" 22	N. E.–E. lt.	64–75	30.00	5:15, 18–52	6:00, 8–69	Cloudy.
" 23	N. E. 1600	59–74	30.15	6:00, 15–50	7:00, 8–73	
" 24	N. E. str.	60–73		7:30, 16–54	8:30, 8–74	Cloudy morning.
" 25	N.–E. lt.	57–74	30.12	8:30, 15–51	9:15, 4–73	
" 26	S. E. lt.	58–75	30.10	9:30, 12–50	10:00, 3–70	Rain, .02 in night.
" 27	S. lt.	63–80	30.05	10:00, 15–50	11:00, 0–65	
" 28	S. W.–S. E.	67–79	29.98	11:45, 2–45	12:00, 0–63	S E. all night.
" 29	S. W.–W.	73–90	29.85	12:00, 3–42	12:00, 0–62	Rain, .01 last night.
" 30	S. W. lt.–S. E. str.	79–90		Night, 0–62	1:00, 0–50	
" 31	N. W.–W.	77–93	29.90	1:00, 0–50	1:30, 0–50	
ug. 1	N. E. lt–S.W. str.	74–87		1:45, 0–45	2:00, 3–50	S. W. rain, .25.
" 2	S E str.	73–86	29.83	2:00, 7–43	2:45, 0–50	Rain, 1.10 in evening.
" 3	N. E.–S. E. str.	70–70	30.00	3:30, 10–43	4:00, 10–72	Rain, 1.58 in night.
" 4	S. E–S. W. str.	70–84	29.80	4:30, 15–50	5:00, 20–60	
" 5	N. E. str.	70–74	29.90	5:00, 15–48	6:00, 10–60	Rain, .58 in night.
" 6	N. E. str.	65–68		6:00, 20–55	7:00, 18–70	
" 7	W. S. E.	62–74	30.00	7:00, 18–50	7:45, 12–68	
" 8	S. str.	69–82	29.92	8:00, 20–58	8:30, 10–60	Rain, .15 in evening.

Table II—Continued.

Date.		Wind.	Temp.	Bar.	A. M. h. tide	P. M. h. tide	Miscellaneous.
Aug.	9	S. W.	70–84	29.88	8:45, 12–54.	9:00, 12–65.	
"	10	N. W. str.	67–80	29 90	9:15, 12–42.	9:15, 6–60.	
"	11	N. W.–N. E.	63–68	30.00	9:30, 12–50.	10:00, 8–65.	
"	12	S. E. str.	70–79	29.90	10:30, 12–55.	10:45, 12–64.	Rain, .23 in evening.
"	13	S. W. str.	77–84	29.90	11:00, 11–54.	11:45, 10–56.	Shower in p. m.
"	14	S. W. lt.	70–86	30.00	12:00, 8–48.	12:00, 5–55.	
"	15	S.W.–N.W. lt.	69–84	.....	Night, 5–55.	1:00, 5–60.	Rain, .05.
"	16	W. lt.	70–87	29 96	1:00, 10–55.	2:00, 6–54.	
"	17	N. W. str.	70–82	29.88	2:15, 10–57.	2:15, 5–54.	
"	18	N. W. str.	51–72	30.00	2:45, 10–50.	3:30, 5–60.	
"	19	N. W. lt.	51–78	29.90	4:15, 18–49.	5:00, 4–60.	Rain, .09 in night.
"	20	S. E lt.	57–79	30.00	4:30, 18–48.	6:00, 10–70.	
"	21	S. E. str.	71–79	29.80	6:00, 18–50.	7:00, 10–73.	
"	22	S.E.–S.W. str.	77–83	29.70	7:00, 18–50.	7:30, 10–70.	
"	23	S. W. lt.	68–83	29.80	8:00, 15–48.	8:45, 5–65.	
"	24	Wl.–S.E. str.	67–84	29.76	9:00, 10–50.	10:00, 6–64.	
"	25	S. W. lt.	73–84	29.70	10:30, 9–47.	10:30, 0–66.	
"	26	N. W. lt.	58–79	30.00	11:30, 8–53.	11:45, 0–56.	
"	27	N. E. str.	59–69	30.18	Night, 0–56.	12:00, 8–60.	
"	28	N. E. str.	63–69	29.90	12:30, 8–60.	1:00, 10–68.	Shower in p. m.; cloudy.
"	29	N.E.–N.W. str.	64–70	29.80	1:00, 30–76.	1:00, 40–75.	Rain 1.01 to this morn.
"	30	E. lt.	63–72	29.86	1:00, 30–68.	1:30, 25–70.	Rain, .56.
"	31	N. W.	60–70	30.00	1:15, 10–43.	2:00, 0–45.	
Sept.	1	N. W.	54–67	30.20	2:15, 0–35.	3:00, 5–51.	
"	2	Light	63–79	......	3:00, 15–45.	3:30, 16–55	
"	3	......	56–74	......	4:00, 12–46	4:30, 0–42.	
"	4	Light.	57–80	......	5:00, 10–48.	6:00, 10–59.	
"	5	Light.	67–77	......	6:15, 14–43.	7:00, 10–65.	
"	6	N. E. lt.	65–79	......	7:30, 22–56.	7:30, 18–70.	
"	7	......	74–80	......	8:00, 20–54.	8:15, 12–67.	
"	8	......	......	......	8:30, 16–56.	......	

NOTE—The density and temperature of the water has been omitted from this table. They will be found in the Table of Plankton Observations.

Explanation of Abbreviations Used in Table II—In the column designated "Wind," the prevailing wind is indicated, "lt," or "str," (light or strong). When there is no description, the wind was moderate. In the column designated "Temp.," the minimum and maximum readings of the Draper record are given in the Fahrenheit degrees. The next column, headed "Bar.," gives the readings of the Aneroid barometer. The next column, headed "A. M. h. tide," (forenoon high water), followed by the column "P. M. h. tide," (afternoon high water), gives the hour of high water followed by the minimum and maximum of the tide record for flood tide in each instance. Of course, the extent of the ebb tide can be calculated from this. In the last column the inches of rainfall are recorded.

Table II—Continued.

Oyster Spawning Data, Tuckerton, 1915.

Date.	Place.	Oysters.	Condition.	Miscellaneous.
June 21	E. garv. anch.	4 m. 3 f.	Fair.	Died in gastrula.
" 23	B. 21 float.	8 m. 7 f.	Part spnd.	No shell.
" 24	E. native.	6 m. 2 f.	Near ripe.	Planted F. and Ag.
" 30	B. 29 float.	5 m. 7 f.	Fair to ripe.	Eggs seem degenerate in one.
July 3	N. C. 1st crate.	....	....	Fert. with 1020 high and get fine shell.
" 3	B. 2nd crate.	2 m. 2 f.	Ripe good.	
" 4	B. 2nd crate.	4 m. 4 f.	Ripe.	No shell. Used 1015 low.
" 7	Bay.	2 m. 8 f.	Fair; part spnd.	
" 8	Bay.	4 m. 3 f.	Part spnd.	Get shell.
" 12	Bay 10, crate.	4 m. 4 f.	Begun spng.	Get fine shell.
" 13	M. garv.	2 m. 7 f.	Ripe full.	
" 14	Bay.	2 m. 2 f.	Near empty.	
" 14	B. 12 cr.	3 m. 5 f.	A fourth spnd.	Get fine shell.
" 15	E. bed C.	14 m. 8 f.	All deg. spng.	
" 15	Bay.	5 m. 9 f.	About thro.	One has *Bucephalus.*
" 21	Bay.	13 m. 17 f.	Various degrees.	No devt. Eggs degen.
" 22	E. cr., bed A.	3 m. 5 f.	Sperm inactive.	Eggs degenerate.
" 22	B. crate	3 m. 6 f.	Some fair.	Few egg degenerate.
" 23	Bay.	4 m. 2 f.	Half spnd.	Fair development.
" 26	Bay.	5 m. 3 f.	Near out.	Five others empty.
" 26	Bay.	4 m. 4 f.	Near out.	Sp. active, eggs fair.
" 27	B. crate.	1 m. 5 f.	Near out; sp. fair.	Eggs poor; add 7 out.
" 27	E. up. bed.	3 m. 5 f.	Near out; sp. fair.	Eggs poor; add 2 out.
" 29	E. bed A.	3 m. 3 f.	Fourth out; good.	Add 1 out.
" 31	E. bed A.	3 m. 5 f.	Half out; good.	Shell in 12 hours.
Aug. 5	Bay.	16 m. 14 f.	Near out; sp. poor.	Eggs fair to good.
" 6	E. bed A.	0 m. 5 f.	Fourth spnd.	Eggs good.
6	E. bed A.	4 m. 4 f.	Fifth spnd.	Sp. fair; eggs good.
" 9	E. bed A.	2 m. 5 f.	Poor.	Add 3 spnd. out.
" 9	E. bed A.	4 m. 5 f.	Poor, eggs absor.	Add 2 beg. fatten.
" 9	E. mouth.	5 m. 2 f.	Very poor.	Add 8 out.
" 9	E. bed A.	1 m. 5 f.	Fair to poor.	Add 2 out.
" 9	E. bed A.	5 m. 3 f.	Fair.	Add 8 out.
" 10	Crate.	1 m. 7 f.	Mod.	Add 4 out.
" 11	Crate.	5 m. 3 f.	Fair to good.	Add 2 fattening.
" 21	E. garv. anch.	22 m. 16 f.	Half out; good.	Add 12 out; 1 Buceph.
Sept. 4	Crate.	All.	Well filled.	J.N.

NOTE—First spawning period for Bay was on July 7th to 14th. First spawning period for Creek was on July 15th to 21st. Main spawning of season was July 27th to 31st. Secondary spawning period was August 9th to 18th. Tertiary spawning period was August 23rd. For further data and discussion, see Report of T. C. Nelson.

Explanation of Abbreviations: In the column headed "Place," "E. garv. anch" stands for garvey anchorage in Ezra Creek. "B. 21 Float" means that the oysters were taken from the Bay on the 21st and placed in the floating tank from which they were taken for experiment, at the place in the first column. "N.C." means mouth of creek north of laboratory. "Cr." means a crate in Ezra Creek, near the laboratory. "B 2nd crate" means taken from Bay and placed in the crate on the 2nd of the month. "Bed A" means a natural oyster reef in Ezra Creek. "M. grav." means a National oyster bed in the Mullica River, known as the "gravellings."

In the other columns, "m." is males, "f." females, "sp." is sperms, "spnd." is spawned and "spng." is spawning. "Buceph" is the ox-horned fluke worm.

Table III.
Oyster Plankton Observations at Edge Cove, 1915.

Time	Tide	Wind	Place	Water	1st	S	M	L	C	Miscellaneous
June 11, 9 a. m.	High	S. str.	E.	18 at 71	2	2				Much sediment; P.C.C.
“ 11, 8 p. m.	High		E.	18.5 at 71	13	13				A fifth b
“ 12, 5 p. m.	Low ebb	S. W. str.	E.	16 at 82	0					Much dirt.
“ 12, 9 p. m.	H. flow		F.	18.5 at 74	7					Clean.
“ 13, 10:45 p. m.	High	E.	E.	18.3 at 76	2	2				A fifth b.
“ 13, 9 p. m.	High		E.	17 at 75	8	5	3			Do. Rain 6 to 9 p. m.
“ 14, 10 a. m.	High		E.	07 at 74	1	1				Do. Rain at 2 a. m.
“ 14, 10 p. m.	High		E.	17.5 at 74	8	6	2		1	Do. Many snails.
“ 15, noon.	High	S. str.	E.	15 at 81	8	6	2			Do. P.C.C.
“ 19, 1 p. m.	H. flow	S. mod.	S. 2.	18 at 79		*			*	4 dips. T.C.N
“ 20, 3:35 p. m.	High	S. lt.	E.	18 at 80	0					All G. after rain. J.N
“ 21, 7:47 a. m.	Ebb	N. E. str.	N. C.	18 at 72	1	1			1	4 dips. T.C.N.
“ 21, 10 a. m.	Ebb		S. 3.	19 at 74	0					
“ 22, 9:15 a. m.	Ebb	S. E. str.	N. C.	19 at 69	0					300 c.c., settling. Rain.
“ 24, 9:20 a. m.	Half ebb	W. str.	N. C.	20 at 65	0					300 settled. T.C.N.
“ 24, 9:30 a. m.	Ebb		E.	20.5 at 63	1	1				Net dips 100. J.N.
“ 24, 10 a. m.			S. 3, b.	20 at 68	5	5				Tow 300 ft. T.C.N.
“ 24, 10 a. m.	Ebb.		S. 3.	20 at 68	0					300 c.c., 19 at 70, l. T.C.N.
“ 25, 8:45 a. m.	H. ebb.	N. to S. W.	N. C.	19 at 68	0					Do. d, 20 to 71, h.
“ 26, 10 a. m.	H. ebb.	S. E. lt.	N. C.	20 at 73	0					Do. Many snails. Rain.
“ 27, 9 a. m.	High	N. E. str.	N. C.	19 at 72	0					Do. Many snails. Rain.
“ 28, 10:30 a. m.	High	E. lt.	N. C.	19 at 74	0					Do. *Very many snails.* *Rain.*
“ 29, 9:45 a. m.	Flow	S. str.	S. 3, b.	20 at 73	0					Do. Copepods.
“ 29, 9:35 a. m.	Flow.		C. B.		0					Tow. 25 min., Copepods.
“ 30, 11:30 a. m.	High.		N. C.	20 at 76	0					300 c.c. snails; Copepods.
“ 30, 3:10 p. m.	Ebb.	S. E. str.	N. C.	20 at 79	0					Do. Rain.
July 1, 10:10 a. m.	Flow.	S. W. lt.	S. 3, b.	21 at 75	0					300 c.c.
“ 1, 10:30 a. m.			C. B.		4	3	1			Net *tow, 20 m.*
“ 1, 1:15 p. m.	High.		N. C.	20 at 80	0					300 c c.
“ 2, 6:45 a. m.	Ebb.		E. g.	21 at 73	0					Net tow, 15 m.
“ 2, 9 a. m.	Flow.	E. mod.	S. 3, b.	21 at 75	1	1				300 c.c.
“ 2, 9:30 a. m.			S. W. 3.	20 at 75	5	4	1			Net tow, 15 m.
“ 2, 2:30 p. m.	High.		E.	20 at 81	0					300 c c. T.C.N.
“ 2, *7 p. m.*	*L. ebb.*		*Cove.*	*19 at 76*	*0*					*Net 100 dips.* *J.N.*
“ 3, 8 a. m.	Ebb.		S. 3, b.	20.5 at 76	4	4				4400 c.c., Copepod. T.C.N.
“ 3, 8 a. m.	Ebb.		C. B.	21 at 75	1	1				Net tow, 15 m.
“ 3, 2:30 p. m.	H. flow.	S. W. str.	E.	20 at 81	0					300 c.c. T.C.N.
“ 4, 7 a. m.	L. ebb.	S. W. lt.	E.	18 at 74	1	1				All b. voil. J.N.
“ 4, 5 p. m.	Ebb.	S. W. mod.	E.	19 at 80	0					All b.
“ 6, *noon.*	*L.*	N. W. mod.	*M.*	*10 at 76*	*1*	*1*				*All b. Mullica.*
“ 6, 3 p. m.	Half flow.	W. lt.	M.	14.5 at 76	14	14				All b. Mullica.
“ 6, 3:30 p. m.	Half flow.	W. lt.	M.	14.5 at 76	423	*				Tow one-ninth mile. J.N.

Table III—Continued.

Time.	Tide.	Wind.	Place.	Water.	Fry.	S.	M.	L.	C.	Miscellaneous.	
July 6, 8 p. m.	Ebb.	Calm.	C. C.	20 at 76	16	16				All bucket.	J.N.
" 8, 7:30 a. m.	High.		N. C.	20.5 at 73	1		1			300 c.c.	T.C.N.
" 8, 7 p. m.	High.		E.	21 at 75						Do.	
" 9, 7:45 p. m.	High.		E.	20 at 76						Do.	
" 9, 8:15 p. m.	High.		Cove.		11	0	6	5		Tow 10 m.	
" 10, 9:15 a. m.	High.		C. B.	21 at 75	6	2	3	1		Tow 15 m. Nauplii.	
" 10, 9:25 a. m.	High.		S. 3, b.	21 at 73	1		1			300 c.c.	T.C.N.
" 11, 7:30 a. m.	Half flow.		E.	21 at 74	3	3				Net bucket.	J.N.
" 11, 8:05 a. m.	Flow.		S. 3, b.	21 at 75	0					4400 cc.	T.C.N.
" 11, 8:20 a. m.	Flow.		C. B.	20.5 at 75	1			1		Net 100 dips, Copepods.	T.C.N.
" 11, 9 a. m.	High.		E.		4		2	2		Net b. Cop-Tintinnia.	J.N.
" 11, 11:30 a. m.	Half ebb.	S. str.	C. h.		0					Net.	J.N.
" 12, 9:10 a. m.	Flow.		C. B.	21 at 76	4		4			100 dips. Coscin. Cop.	T.C.N.
" 12, 9:15 a. m.			S. 3, b.	21 at 75	1		1			4400 c.c. snails.	T.C.N.
" 13, 11 a. m.	Flow.		M.	15 at 76	0					Half ebb, 13 at 77.	T.C.N.
" 14, 11:35 a. m.	Flow.		C. B.	21 at 80	147	147	0	0		Tow 10 m. Cop. Coscin.	
" 14, 11:40 a. m.			S. 3, b.	21 at 78	10					300 c c.	
" 14, 7:45 p. m.	Flow.		C. m.	20.5 at 79	120	120				Tow 10 m. Cop. Coscin.	
" 14, 10 p. m.	Flow.		E.	20 at 80	0					300 c.c.	
" 15, 3:30 p. m.	Ebb.		S. 3, E.	20.5 at 82	320	320				100 dips. Cop. (rain).	
" 15, 3:40 p. m.			B. b.	21 at 80	27	27				4400 c.c., snails.	
" 16, noon.	Flow.		C. m.	21 at 78	4	4				300 c.c. (rain).	
" 17, 7:20 a. m.	Low.		Bay.	21.5 at 80	45	40	5			100 dips, Cop. Coscin.	T.C.N.
" 18, 7 a. m.	Low.		C. C.	21 at 78	1	1					J.N.
" 18, 7 a. m.		N. W. mod.	C. h.	21 at 78	1	1				Hot day.	
" 18, 3 p. m.	H. ebb	S. W. str.	E.		80	*			?	Net 30 pts., 2 buckets.	
" 18, 3:10 p. m.			E.		182	*			?	Vertical 50, 4 b.	
" 18, 3:20 p. m.			E.		282	*			?	Swing, 50; 7 buck.	
" 18, 3:30 p. m.			E.		34	*	1		?	Vertical boustraph. 50.	
" 20, 1 p. m.	32, flow.	N. mod.	E.	20 at 80	34	34	1			Swing 10, 1.5 b.	
" 20, 2 p. m.	48, flow.		E.	21 at 80	50	*	*			Swing 10.	
" 20, 2:30 p. m.			E.		15					All b.	
" 20, 3 p. m.	58, flow.		E.		131					Swing 15; 2 b.	
" 20, 3:15 p. m.			E.	21 at 78	53		1			All b. med., 140 microns.	
" 20, 4:30 p. m.	60 h.		E.		121				*	Swing, 16, cage.	
" 20, 4:30 p. m.	High.	N. E. mod.	E.		93			1		Swing 10.	
" 20, 4:45 p. m.		N. E. 600.	E.	20 at 78	9					All buck.	J.N.
" 21, 10:15 a. m.	Ebb.	E.	S. 3, b.	21 at 77	11	4	7		1	1100 c.c.	T.C.N.
" 21, 10:15 a. m.			S. 3.		125					Tow 10 m. No Cop.	T.C.N.
" 21, 2 p. m.	45 flow.	E. mod.	E.	20 at 80	10					Half b.	J.N.
" 21, 2:15 p. m.			E.		23	?			*	Swing 16.	
" 21, 2:30 p. m.			E.		35					Vert. 50 lifts.	
" 21, 3:30 p. m.	62, flow		E.		4					10 pts.	

Table III—Continued.

Time.	Tide.	Wind.	Place.	Water.	Fry.	S.	M.	L.	C.	Miscellaneous.	
July 21, 3:35 p. m.			E.		19	*	*			Net 10 pts.	
" 21, 3:40 p. m.			E.		17					Swing 10.	
" 21, 3:45 p. m.			E.	21 at 78	21					Vert. 10 lifts, 5 qts.	
" 22, 7:15 a. m.	40 ebb.	E. lt.	E.		14					Swing 20.	
" 22, 7:45 a. m.			E.		2					Net 10 pts.	
" 22, 8:15 a. m.	30 ebb.		E.		5					Net 10 pts.	
" 22, 9:15 a. m.			E.		11			1		Swing 10, large 300 m.	
" 22, 10 a. m.	20 ebb.		E.		4					Net 10 pts.	
" 22, 10:30 a. m.			E.		2					Swing 10.	
" 22, 11 a. m.	Low.		E.	20 at 76	0					Bucket 10 pts. Turds.	
" 22, 2:15 p. m.	30 flow.	E. mod.	E.		1					b. 10 pts.	
" 22, 2:30 p. m.			E.		2					Net 10 pts.	
" 22, 2:45 p. m.			E.		4					Swing 10.	
" 22, 3 p. m.	45 flow.		E.		7					Swing 10.	J.N.
" 22, 3:30 p. m.		N. E. str.	C. B.	21 at 79	60	15	45		5	Tow 10 m.	T.C.N.
" 22, 3:35 p. m.			S. 3, b.	21 at 79	14	3	11			300 c.c.	T.C.N.
" 22, 4 p. m.	55 flow.		E.		3					Net 10 pts.	J.N.
" 22, 4:30 p. m.			E.		10					Swing 10.	
" 22, 5 p. m.	65 flow.		E.		8					Net 10 pts.	
" 22, 5:30 p. m.			E.		2					Swing 10.	
" 22, 6 p. m.	70 h.		E.	19.5 at 77	5					Net 10 lifts.	
" 22, 6:30 p. m.			E.		4					Net 13 pts.	
" 23, 7 a. m.	50 ebb.	N. E. str.	E.		4					Swing 33 short.	J.N.
" 23, 9 a. m.			S. 3, b.	21.5 at 75	4		4			2200 c.c.	T.C.N.
" 23, 9:25 a. m.			C. B.	21 at 76	4	1	3			300 c.c.	T.C.N.
" 23, 4 p. m.	50 flow.	N. E. 1600.	E.		31			1		Swing 100	J.N.
" 24, 7 a. m.	50 ebb.		E.		25			2	2	Swing 25.	J.N.
" 24, 9 a. m.			S. 3 b.	21.5 at 74	0					2200 c.c. silt.	T.C.N.
" 24, 9:10 a. m.			C. B.	21.5 at 75	0					2200 c.c.	T.C.N.
" 24, 4:30 p. m.	37 flow.		E.		24			1	*	Swing 25.	J.N.
" 24, 5:30 p. m.	51 flow.		E.		86			5		Swing 25, *snails, turds.*	
" 24, 6:30 p. m.	63 flow.		E.		63			6		Swing 10.	J.N.
" 24, 7:30 p. m.	73 flow.	Calm.	E.	20 at 74	132			13		Swing 10.	J.N.
" 24, 7:45 p. m.			C. B.	21.5 at 75	0					2200 c.c.	T.C.N.
" 24, 7:50 p. m.			S. 3, b.	22 at 74	1		1		1	2200 c.c.	T.C.N.
" 25, 8 a. m.	50 h.		E.		36					Swing 10.	J.N.
" 25, 8 a. m.			C. B.	22.5 at 72	1		1			2200 c.c.	T.C.N.
" 25, 8:10 a. m.			S. 3, b.	22.5 at 72	2	2				2200 c.c.	T.C.N.
" 25, 3:25 p. m.	Low.		S. 3, b.	22 at 78	8	8				2200 c.c.	T.C.N.
" 25, 3:30 p. m.			S. 3.	21 at 77	6	6				2200 c.c.	T.C.N.
" 25, 5 p. m.	30 flow.	Calm.	E.		33			3		Swing 10. Copep.	J.N.
" 25, 6 p. m.	45 flow.		E.		61			*		Swing 10.	
" 25, 7 p. m.	55 flow.	Calm.	E.		30			2		Swing 10, 50 ft.	

Table III—Continued.

Time.	Tide.	Wind.	Place.	Water.	Fry.	S.	M.	L.	C.	Miscellaneous.
July 25, 7 p. m.			E.		18					Net 10 pts.
" 25, 8 p. m.	65 flow.		E.		15					Swing 10.
" 25, 8 p. m.			E.		18					Net 10 pts. J.N.
" 26, 8:05 a. m.	Flow.		S. 3.	22 at 76	11		1			4400 c.c. T.C.N.
" 26, 8: 0 a. m.			S. 3, b.	21 at 75	7		7			4400 c.c. T.C.N.
" 26, 9:30 a. m.	50 h.	S. E. lt.	E.		21	*	*			Swing 10, snail, Tintin. J.N.
" 26, 10:30 a. m.	40 ebb.		E.		2					Swing 10, 50 ft. J.N.
" 26, 6 p. m.	30 flow.		E.		56	56				Do. J.N.
" 26, 7:30 p. m.	50 flow.		E.		75	75				Do. J.N.
" 27, 10:30 a. m.	50 ebb.		E.		153					Do. J.N.
" 27, 10:40 a. m.			C. B.	21 at 78	28	28				300 c.c. 840 fry. T.C.N.
" 27, 10:50 a. m.			S. 3, b.	22 at 79	207	207				44[illegible]0 c.c. T.C.N.
" 27, 11:30 a. m.	40 ebb.		E.		583	*				Swing 10, 50 ft. J.N.
" 27, noon.	35 ebb.		E.		198	*				Net 10 pts, 20 ft. J.N.
" 27, noon.			E.		207	*				Swing 5, 20 ft. J.N.
" 27, 10:10 p. m.	Flow		E.	21 at 78	857	*			132	1466 c.c. T.C.N.
" 28, 11:15 a. m.	High.	S. E. lt.	S. 3.	21 at 78	306	*			2	300 c.c. 9180 fry.
" 28, 11:20 a. m.			S. 3, b.	21 at 78	231	*			5	Do. 6930 per b.
" 28, 11:40 a. m.	H. ebb.		E.	21.5 at 80	78	*			12	Do. (1100 c.c.)
" 28, 9:35 p. m.	Flow.	S. str.	E.	22 at 78	1	1			2	Do. (6 qts.)
" 29, 7:25 a. m.	L. flow.	S. lt.	S. P.	21.5 at 78	28	28			1	Do. 740 fry per b.
" 29, 7:35 a. m.			S. W. 3.	21 at 78	1	1				Do. Coscin. Tintin.
" 29, 7:40 a. m.			S. 3, b.	21 at 78	41	41				Do. 1230 per b.
" 29, 11:30 p. m.	H. flow.	S. W. lt.	E.	21 at 81	0	0			2	Do. 10 snails.
" 29, 11:40 p. m.			E.	21 at 82	5	5			2	Do. Nauplii; Tintinnias.
" 30, 8:46 a. m.	Flow.	S. W. lt.	S. W. 3.	21 at 81	143	106	37			2200 c.c. Tintinnias.
" 30, 8:50 a. m.			S. 3, b.	21 at 80	99	64	35		1	Do. A fourth b.
" 30, 3 p. m.	Ebb.	S. E. str.	S. 3.	20.5 at 83	185	44	131		1	Do. Silt.
" 30, 3:05 p. m.			S. 3, b.	20.5 at 82	345	237	105	3	3	Do.
" 30, 3:25 p. m.			E.	20 at 87	159	72	84	3		Do.
" 30, 9:10 p. m.	Flow.	S. W. lt.	E.	21 at 83	0					300 c.c.
" 31, 2 p. m.	High.		S. 3.	21 at 84	124	104	19	1	12	2200 c.c.
" 31, 2 p. m.		N. W.	S. 3, b.	21 at 84	221	161	55	5	37	Do.
" 31, 2:?0 p. m.	Ebb.		E.	20.5 at 88	243	189	33	21	30	Do.
" 31, 10:30 p. m.	Flow.		S. 3.	21 at 82	352	322	11	19	13	Do.
" 31, 10:30 p. m.			S. 3, b.	21 at 82	1540	1430	10	100	180	Do.
" 31, 11:15 p. m.	Flow.		E.	20 at 82	310	250	0	70	20	1100 c.c.
" 31, 11:15 p. m.			E. b.	20 at 81	550	440	30	80	100	1100 c.c.
Aug. 1, 3:15 p. m.	H. ebb.	S. str.	E.	20.5 at 82	580	80	490	10	20	Do. Shower 1 p. m.
" 2, 3:30 p. m.	H. ebb.	S. str.	E.	20 at 87	240	120	114	6	164	Do. Shower 8 p. m.
" 4, 3 p. m.	Flow.	S. W. str.	E.	16 at 82	10	2	7	1	2	Do. Rained all night.
" 4, 5:30 p. m.	H. ebb		S. 3.	20 at 79	28	14	11	3	4	Do. E. 11:30 a. m. 10.5 at 79.1
" 4, 5:30 p. m.			S. 3, b.	20 at 80	8	8	0	0	2	Do. Silt, settl.

Table III—Continued.

Time.	Tide.	Wind.	Place.	Water.	Fry.	S.	M.	L.	C.	Miscellaneous
Aug. 5, 5:40 p. m.	High	N. E. str.	E.	19 at 78						Not counted.
" 6, 6 p. m.	High		S. 3.	19.5 at 74	10	8	2	0		Do.
" 6, 6 p. m.		N. E. lt.	S. 3, b.	19.5 at 73	3	1	1	1		Do. Storm 7:40 p. m.
" 7, 8:15 a. m.	Ebb.	Calm.	S. 3.	20 at 72	3	1	1	1	1	2200 c.c.
" 7, 8:20 a. m.			S. 3 b.	21 at 73	3	1	1	1	1	Do.
" 9, 9:30 a. m.	High	S. lt.	S. E. 3.	20 at 77	61	60		1		Do. Tintinnias.
" 9, 9:30 a. m.			S. 3, b.	20 at 78	74	73		1		Do.
" 10, 9:30 a. m.	High	N. W. lt.	E.	20 at 77	206	205		1		Do.
" 10, 10 p. m.			N. C.	20 at 76						
" 11, 9:05 a. m.	High	N. E. mod.	S. W. 3.	20 at 76	106	105		1	1	1100 c.c.
" 11, 9:05 a. m.			S. 3, b.	21 at 77	22[illegible]	224		1	5	Do.
" 12, 10:45 a. m.	High	S. E. str.	E.	20 at 80	58	57	1	0	8	Do.
" 13, 8:50 a. m.	Flow	W. mod	S. 3.	19.5 at 79	25	24	1		4	Do. Snails; clearing.
" 13, 8:50 a. m.			S. 3, b.	19.5 at 79	35	35			3	Do. Snails.
" 13, 8:50 a. m.			C. B.	19.5 at 80	*		*		*	Tow 12 m. Copeps.
" 14, 9:20 a. m.	Flow	N. W. mod.	C. B.	19.5 at 80	*	*	*	*	*	Tow.; snails; Copeps.
" 14, 9:30 a. m.			S. W. 3.	19.5 at 80						
" 14, 9:35 a. m.			S. 3, b.	20 at 81	91	68	26	0	18	1100 c.c.
" 15, 1:15 p. m.	High	S. W. lt.	S. 3, b.	19.5 at 82	64	49	15	0	3	Do.
" 15, 1:30 p. m.			C. B.	19 at 82	*	*	*	*	*	Tow; snails; Copeps.
" 16, 3 p. m.	Ebb.	W. lt.	S. 3, b.	20 at 83	55	28	13	14	21	1100 c.c.
" 16, 3:11 p. m.			C. B.	19 at 83	*		*	*	*	Tow 10 m. Many large o.
" 17, 2:25 p. m.	Flow	N. W. str.	C. B.	19.5 at 81	*	*	*	*	*	Tow 15 m. Many l. o.
" 17, 2:40 p. m.			S. 3, b.	19.5 at 80	109	94	11	4	6	1100 c.c.
" 18, 3:00 p. m.	High	N. W. str.	C. B.	20 at 75	*	*	*	*	*	Tow 10 m. Many l. o.
" 18, 3:10 p. m.			S. 3, b.	20 at 75	17	11	4	2		1100 c.c.
" 19, 4:25 p. m.	High	N. W. lt.	S. 3, b.	20.5 at 74	17	9	8	0		Do.
" 19, 4:00 p. m.			C. B.	20 at 74	*	*	*	*	*	Tow. Big loss of l. and m.
" 20, 3:25 p. m.	H. flow	S. E. lt.	S. 3, b.	20.5 at 76	22	19	3	0	1	1100 c.c.; 21st and 22d rough.
" 20, 3:30 p. m.			C. B.	20.5 at 75	*	*	*	*	*	Tow. Loss of l. and m.
" 23, 8:45 p. m.	High	N. W. lt.	S. 3, b.	21 at 78	105	102	2	1	27	1100 c.c.; new s. o.
" 23, 8:45 p. m.			C. B.	20 at 77	*	*			*	Tow. Most c.
" 24, 9:05 a. m.	High	W. lt.	S. 3, b.	21 at 79	22	21	1	0	1	1100 c.c.
" 24, 9:05 a. m.			C. B.	20.5 at 78					*	Tow. Most c.
" 27, noon.	H. ebb.	N. E. str.	E.	21 at 73					*	Tow. Few o.
" 30, 3 p. m.	H. ebb	E. mod.	C. B.	21 at 73					*	Tow. Many veligers.
Sept. 3, 4:30 p. m.	High		E.	21 at 72	Few.					J.N.
" 4, 10:30 a. m.	L. ebb.		E.	17 at 75						J.N.
" 7, 8:30 a. m.	High		E.	19 at 76	26	*				Hot day. J.N.
" 7, 8:30 p. m.	High		E.		26	*				Swing 50. J.N.
" 8,			Cove.		26	*				Swing 50. J.N.
" 9.			Cove.		*	*	*	1		Large fry; 280 m. J.N.

NOTE on the meaning of the abbreviations used in the preceding table III. In the column headed "Place" the letters indicate as follows: "E." is Ezra Creek, near the laboratory. "N.C." is a small side branch, north of the laboratory. "B." is the Bay. "M." is the Mullica River, near Turtle Island. "S. 2" means a cluster of two oyster stakes. "S. 3" means three stakes, situated in the Bay. "S. 3 b." means that the sample was secured at the bottom at this point. "C.B." means that sample was taken on a course from the mouth of Edge Cove to the three stakes in the Bay. "Eg." means in Ezra Creek near the garvey anchorage. "C.C." means the common mouth of Ezra and Sapp Creeks. "Ch." means the head of the Cove. "Cm." is the mouth of the Cove. "S.W. 3" means southwest of three stakes. "D" means the dock of the laboratory. The next column, headed "Water," gives the density and temperature in degrees Fahrenheit of the water of the samples taken at the indicated stations. The first number of each set gives the density on a scale of 1,000 for pure water, and the first two figures of the number being always "10" have been uniformly omitted for sake of space.

The columns headed "Fry, s. m. l. c.," respectively give the total numbers of oyster fry in the sample, followed by their distribution into small, medium, and large sizes. "C." means clam fry. A star (*) indicates presence of fry whose number was not counted.

The column headed "Miscellaneous" in this table of "Plankton Observations" contains a variety of abbreviations: "b." always indicates a pail or bucketful of water; the word preceding indicates the fraction that was analyzed to get the number of oyster larvæ present in its "plankton" contents; "dips." means dipperfuls of which 25 to 30 count as one bucketful; c. c. means cubic centimeters of which it takes nearly a thousand to make a quart; "pts." is pints; "qts." is quarts; "l. o." means large oyster larvæ, nearly ready to set as spat; "so." means small oyster larvæ recently hatched; "cop." or "copep." means copepod water fleas, or miscropically small shrimp-like Crustacea; "P.C.C." means observation by Mr. Cameron; "J.N." observation by the biologist; "T.C.N." observation by the assistant biologist. In general where no designation is entered Mr. Cameron is responsible for the Barnegat record, and the assistant biologist for the Tuckerton record.

"Net" means the use of the plankton net as also does "tow." Where "swing" is entered it is understood that the net was used from a stationary boat by swinging it back and forth in the water; "m." means minutes of towing; "ft." the distance of drag of the net; "vertical" means up and down, lifting of the net, the figures following indicate the total distance, but if "ft." is omitted then the number stands for the number of lifts or swings respectively. "Cosc." is the diatom *Coscinodiscus*, "c." is clams, "o." is oyster larvæ.

Table IV.

Oyster Spatting Data, Edge Cove, 1915.

Taken	Planted.	Place.	Inside.	Outside.	Sizes.	Miscellaneous.
July 22...	July 11–13...	N. C...	**	*	.7–1.2 m.m.	Set about July 15th
July 31...	July 30	N. C..	.....	.....	New set.........	From spawn of July 15th.
Aug. 10...	Aug. 6.	N. C. .	.....	.....	.266–1.066 m.m. .	52 spat, 3–4 days old.
Aug. 11...	Aug. 10.	Cr....	.....	.....	....	2 new spat.
Aug. 18...	Aug. 12–17. .	Cr....	.....	.....	....	
Sept. 7. .	Various.....	Cr....	.....	.....	6 to 40 m.m.	Sets of July 31, Aug. 9, Aug. 18.

Additional data, and discussion will be given in a bulletin by T. C. Nelson, to appear separately.

REPORT OF THE DEPARTMENT OF BOTANY

Department of Botany

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**Appointed July 1, 1915.
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CONTENTS.

Report of the Department of Botany.

Byron D. Halsted

I.

INTRODUCTORY.

The work in the Botanical Department for the past year has been under three projects, namely, (1) Plant Heredity, (2) Plant Environment and (3) Plant Toxicology.

Owing to the considerable change in the staff, the lines of research have shifted somewhat, as for example, the work in the project of toxicology was interupted for three months and that in heredity and environment correspondingly more active.

In heredity the chief subjects have been pepper, tomatoes, beans, corn, eggplants, okra and prairie berries.

More than 3000 pepper plants of the third generation of a single cross have been grown and studied, and some preliminary results are given in the later pages of this report, while the bulk of the data will require the following winter for their painstaking consideration. In like manner 3000 plants of a single cross of two tomatoes received attention, and several special creations of this crop have been tested in the field, some of which may prove of commercial value.

Hybrid beans and eggplants have been carried forward another year and show new breeding points of value, that are reported upon in the pages following.

With corn there has been a study of the relative commercial value of the first and second generation of crosses. The inheritance of size of stalk and ear has been under consideration with several crosses, and also that of texture of grain, whether corneous or starchy, and number of rows upon the cob, much of which data is not ready for this report.

Several crosses have been made among squashes and gourds, and hybrids made among species of daturas.

Under environment the chief lines of research have been with position of the corn grains upon the cob, as related to viability of grain, and vigor and variability of offspring. This work has been carried on in the greenhouse and in the field, some results of which are given in this report. In a similar manner material is being gathered for a test of the seeding value of peas, beans, radishes and soybeans, as regards their position in the pod. Some harvests have been made of field grown crops along the line indicated.

In this connection a study is being made of the relation of size of plant, to shape and size of fruit with peppers, when duplicate sets are grown (1) in the greenhouse and (2) in the open field.

Under toxicology the studies have been chiefly with five salts of each of four alkalies, that are closely associated with commercial fertilizers. The subjects for these pot experiments were soybeans and prairie berries. As before stated, there was a halt in this work during the summer, because of a change in the staff. At present the studies are going forward with phosphates in various strengths and in triplicate in (1) earth (2) sand and (3) water. A statement of progress is given in the later pages of this report.

This year for the first time instruction is systematically coupled with the duties of the Department in the sense, that qualified graduates are taken, with compensation, upon a half-time schedule, and in connection therewith are offered facilities for research work for the Experiment Station with the expectation of higher degrees, when adequate results have been accomplished. Three such research assistants have been assigned to this Department.

II.

INHERITANCE IN CORN.

Inheritance of Grain Texture in Corn.

It is well understood, that, when starchy and sugary corns are bred together the inheritance follows the Mendalian rule of dominance for the former, and recessive for the latter. Some tests have been made in the breeding of the flinty type, as represented in pop corns, with kinds, that have the endosperm of a soft or floury nature.

GOLDEN QUEEN UPON TUSCARORA. This cross in the F_1 gave yellow starchy grains upon the Tuscarora ears, instead of the normal soft white grains. These grains, planted in a block of 120 hills, gave large plants that produced ears of medium size, and far below the quantity, desired for commercial purposes.

A record is made of the height of each stalk, and the length and width of all marketable ears, but now there is only time for a general statement of the ears and grains.

Plate I (upper half) shows a set of the F_1 ears, selected, to exhibit the extremes and intermediates in a series from the pollen parent ear Golden Queen (1) to the left and the seed parent ear—Tuscarora—at the right (2). It is evident, that there is a great range from ears, that are small, with round, flinty grains, resembling the pop corn to the squarely-built ears with broad, flat, dented grains, that are like the Tuscorora. It is also shown, that ears, having the characters of the two parents more nearly equally blended are much larger, than either parent. Some of these are with the taper point of the pop corn, and others oval-tipped, like the Tuscarora.

PLATE I.

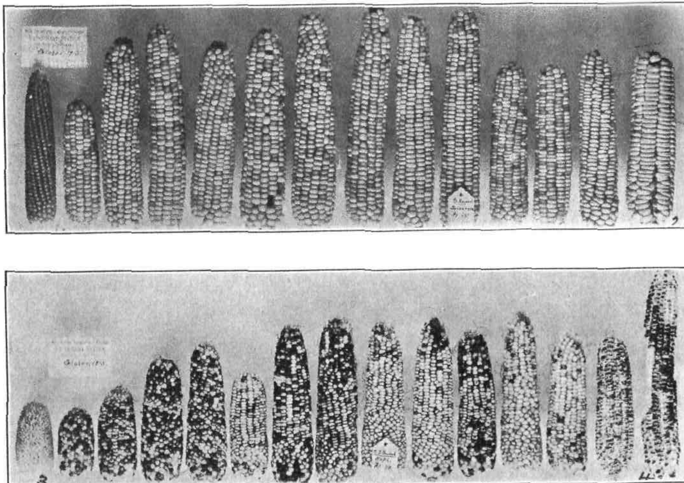


PLATE I:—CROSSED CORN: *Golden Queen upon Tuscarora* F_1.

(Upper row) Ears selected to show extremes and intermediates in a series from those like the Golden Queen ear at *1*, to the opposite extreme at *2*, the Tuscarora.

(Lower row) New Tom Thumb upon Hopi F_1. A New Tom Thumb ear is shown at *3* and the Hopi at *4*, with a large series of intermediates of the cross arranged between.

PLATE II.

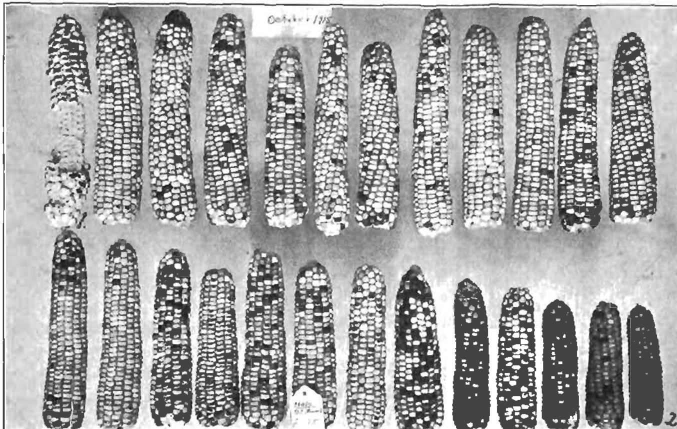


PLATE II:—CROSSED CORN: *Hopi upon Golden Tom Thumb* F_1.

A Hopi ear is shown at *1* and a Golden Tom Thumb at *2* and a selected set of intermediates between, some ears of which are like those of one parent, and some resemble the other closely, even to texture of grain.

Upon these ears the grains show a segregation into the flinty and the floury, the later appearing somewhat larger, than the former, doubtless of less specific gravity and may be expected to breed true to the soft texture of the endosperm. From a random sample of two hundred grains, shelled from eight average ears, there were 152 flinty and 48 floury grains, the former averaging .33, and the later .32 gm. in weight.

From a preliminary inspection it seems likely, that by a close study of the grains those, that carry both factors for texture, may be separated, thus securing (1) pure flinty, (2) pure starchy and (3) a mixture of the two.

New Tom Thumb Upon Hopi. This cross of a peculiar pop and an Indian corn, made in the greenhouse last winter, was grown in its F_1 the past season, and a selection of ears is shown in the lower half of Plate I with a sample of the pop corn to the left (3) and the Hopi (4) to the right. The ears show very generally the peculiar color-makings of the Hopi, and the zigzag arrangement of the grains of the Tom Thumb is very strongly in evidence. In general shape the ears often approach and occasionally duplicate that of the peculiar short broad type of the pop parent, but on the other hand there are no long ears, often met with in the Hopi. Some of the ears have the grains all flinty, and these are of the smaller sizes, while an occasional representative of the Hopi appears, The ears of intermediate type usually have the long factor only with the grains zigzag, and here there is a segregation as to texture, the chalky kernels being scattered here and there among the flinty ones.

No weights and volumes have been taken of the two types of grains, but it seems evident, that the floury kind is larger and with a lower specific gravity than the flinty sort. A test for popability, among other studies of inheritance, is planned.

Hopi Upon Golden Tom Thumb. This is another extreme cross of a pop corn with Hopi the later in this instance being the pollen parent. In Plate II a portion of a Hopi ear is shown at 1 and the G. T. Thumb is represented at 2 with a long series of the offspring shown between and arranged somewhat in order from the ears that resemble the Hopi to those that most nearly represent the small pop corn parent. Something of the spiral of the rows of the Hopi is shown in several ears. Sixteen ears are with the grains all of a floury texture, and on the other hand an equal number have only flinty grains, and these are among the smaller ears three of which are shown near the parent they most resemble. There were 55 ears, that were of the mixed type.

It seems evident here, that, while the floury endosperm is a recessive, it is not fully expressed in some ears. In other words, in the F_1 there is a strong tendency for the plants to vary and to approach one or the other parent in several characters. These plants, that are large, like the Hopi tend to have the larger ears with grain characters of that parent, and a more full expression of the floury factor, while upon the other hand the smaller plants have the smaller ears, with the grains of the flinty type, that may pop, when brought to the test.

General Observations—From the above tests made in the breeding of corns with flinty and floury endosperm, it is evident, that the character of soft texture is inherited in the same manner, as the sugary quality, when the combination is with kinds bearing correous endosperm. It is further shown, that in the F_1 ears there is a wide range of variability in plant, ear and grains, and furthermore, there is a tendency for a linking of the characters of each parent, so that plants and their ears and grains resemble, as a whole, one parent much more, than another.

It follows from these studies, that it may be of prime importance to choose with exceeding care the F_1 plants that bear the most desirable ears and grains, and grow a stock from them under isolation, at the same time making the most of the segregation that is manifest in the grains as to the preferred type of kernel.

The Inheritance of Zigzag Grain Arrangement in Corn.

An opportunity was offered for a record of results in the breeding of zigzag-eared with straight eared kinds of corn.

GOLDEN QUEEN UPON COUNTRY GENTLEMAN F_1 EARS. There were sixty-five ears obtained in this lot, with the following record for disposition of the grain:—Completely zigzag 4, partly zigzag 16, and 45 the rows of which were easily counted. Plate III, upper row, shows a set of ears, placed between sample ears of the parental types, and so arranged, that the full measure of variability in the disposition of the grains may be seen from the ears, that most resemble the Golden Queen, (1), upon the left, to those with grains zigzag, near the Country Gentleman, to the extreme right (2). It seems apparent, that the alignment of the grains is most perfect near the base of the ear, and in some the zigzag arrangement is confined to a small portion of the middle of the ear.

BLACK POP UPON COUNTRY GENTLEMAN F_1 EARS. Here the amount of irregularity in the rows is less than in the above, but, as is shown in the second set in Plate III there are ears, that fully exhibit the zigzag arrangement. Such ears were all small, as compared with the Country Gentleman sample shown alongside. The two parents 3, 4, are of the same general shape, and the ears of the cross show their greatest variability in the size character.

NEW TOM THUMB UPON EARLIEST UPON EARTH F_1 EARS. The New Tom Thumb has a remarkably short broad ear, as shown at the left end (1) of the upper row in Plate IV. The other parent has a longer and more slender ear, with the grains regularly in rows. This cross produced several ears of the zigzag type, and all were short, as shown in the left portion of the row in the plate. A very large per cent of the largest ears, showed some displacement of the grains.

EIGHT-ROWED POP UPON COUNTRY GENTLEMAN F_1 EARS. This is a combination between a variety with a large, slender eight-rowed pop corn and the familiar Country Gentleman. Record was not made of the number of

PLATE III.

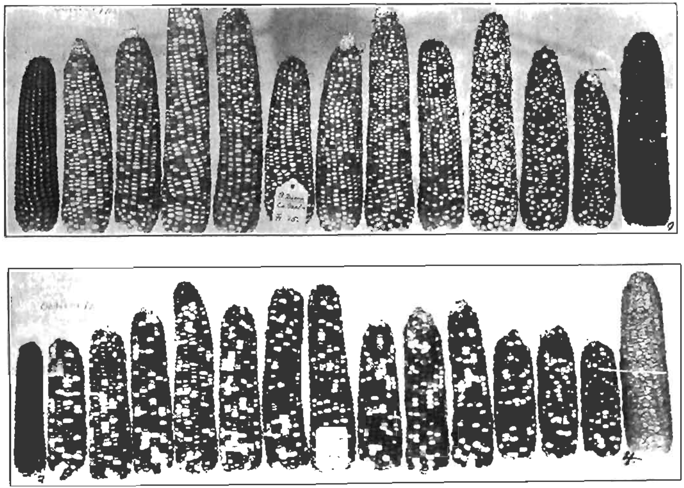


PLATE III:—CROSSED CORN: *Zigzag Inheritance.*

(Upper half) *Golden Queen* upon *Country Gentleman* F_1. The two parents are shown respectively by the ear *1* and *2*, and a set of intermediates are between.

(Lower half) *Black Pop* upon *Country Gentleman* F_1. The parents are at *3* and *4*, and a series of intermediates between them. In both sets the zigzag arrangement of the grains is much in evidence.

PLATE IV.

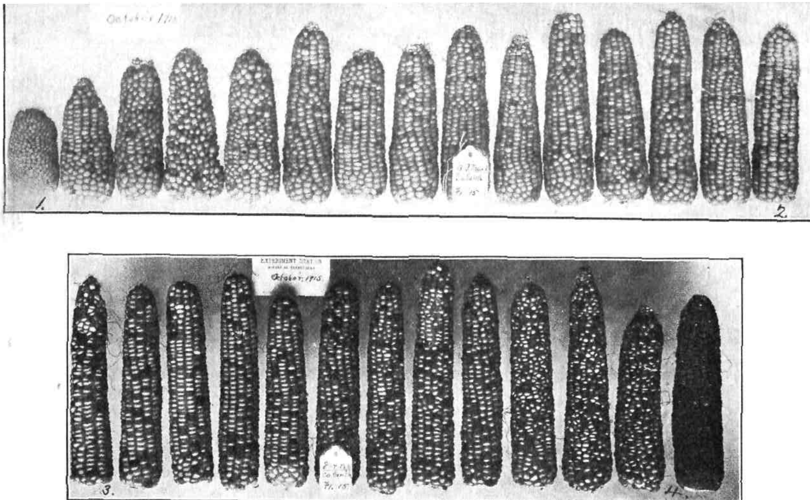


PLATE IV:—CROSSED CORN: *Zigzag Inheritance.*

(Upper row) *New Tom Thumb* upon *Earliest on Earth* F_1. The parental types are shown at *1* and *2*, with a set of intermediates between them.

(Lower row) *Eight Rowed Pop* upon *Country Gentleman* F_1, showing a set of ears ranging from the parental types *3* and *4*, some straight-rowed and others practically zigzag.

zigzag ears, but there were several, as indicated by the samples shown in the lower row of Plate IV, where a set of ears is given, extending from the one at the left (1) quite close to the pop type, but showing a little of grain displacement, through a series of intergrades to those next to the Country Gentleman (2) which are truly zigzag, excepting a small zone at the base.

NEW TOM THUMB UPON HOPI F_1 EARS. This cross, considered and figured elsewhere under Inheritance of Texture, etc., is a striking illustration of the immediate effect of a zigzag parent. Nearly all of the 87 ears that were measured, had some indications of the zigzag arrangement, and many were entirely so, particularly among the short broad ears, that in many ways most resembled the pop parent.

It is quite evident, that the amount of displacement of the grains varies greatly in the F_1 and depends somewhat upon the combination made.

GOLDEN QUEEN UPON IOWA SILVER MINE F_1 EARS. In this cross the case is quite different from the five preceding, in that both parents are straight-rowed varieties, but in the block of Silver Mine, upon which Golden Queen was openly bred under isolation in 1914 there was one zigzag ear. The grains from this ear were used for planting two rows (20 hills), and alongside of them an equal area was planted with grains from a normal ear.

There were no zigzag ears in the whole crop, but three ears from the zigzag mother ear showed a slight displacement of the grains. The two lots of corn differed in the amount of dentedness it being much greater for the straight-rowed parents.

GOLDEN QUEEN UPON TRIUMPH F_1 EARS. This lot is similar to the last in number of hills grown, both parents being straight-rowed kinds, one seed ear zigzag, the others normal, etc. All of the ears of the crop were with full alignment of the grains.

The results of these last two trials are in marked contrast with the five going before, and the chief differing condition seems to be that of fixity of type. In the first five trials either the Country Gentleman or the New Tom Thumb was represented, and these are kinds, that are normally and regularly with zigzag ears. In other words, the character for lack of alignment is varietal and therefore well-established. In both of the last two instances, the zigzag ears selected for seed were very exceptional from among those, normally straight-rowed, and nothing is known to the writer as to their particular history. In breeding it has been shown, that the grains of such ears have very different potency for zigzagness than those, from ears, that are normally zigzag.

There is much information lacking as to the origin of the zigzag ears. When such an ear is young, the ovlues are plainly seen in double rows. Only a fraction, one-half perhaps, of the ovlues regularly develop into grains, and this may bring about the lack of normal alignment.

Inheritance of Grain Isolation in Corn.

This subject is very closely associated with the preceding one of grain arrangement. In the Annual Report of the Station for last year, page 302, is given a description with plate, of ears with grains isolated, that is, entirely separated from each other or only partially touching their neighbors. During the past year certain rows were planted with grains from such ears, and alongside of them were rows, planted with grains of the same varieties of corn, but produced normally upon the cob.

The stalks and the ears have been measured, and the results await study. Attention now is called only to the apparent inheritance of the character for isolation of the grain.

There were six pairs of rows, involving three crosses in the F_2. With the exception of five ears, upon which the grains were in a few places somewhat separated from each other, the isolation was confined to the ears from rows planted with grains that in, the main were borne upon the cob far from their fellows. In these last rows ears like those used for seed, namely sparsely-set were frequent and in one case they were 50 per cent. of the whole. Plate V shows in the lower row, fourteen of the ears of the peculiar type in question, but none of them have the grains as widely separated as in the parental ear. The original parents Golden Queen at 1 and Hickory King at 2 are shown in the upper row, with a set of intergrades between them, all from the same row, as the set of ears shown below. By close inspection it is seen that the grains of the ears of the lower row are frequently dented, when they are borne somewhat normally, while those, that have more space, are smooth-tipped. Time as yet has not been taken, to study the nature of the origin of the rough, practically undesirable ears. One might write, that a factor for development of the ovules was inoperative in part, and that its influence extended over the whole ear, thus producing abortions with considerable uniformity.

Results, similar to the above were obtained with two other crosses, namely, Golden Queen upon Brazilian Flour and Champion White Pearl.

Inheritance in Row-Number in Corn.

From a cross made last year of the Golden Queen upon the Large White Flint a (1) four-rowed, (2) a six-rowed and (3) an eight-rowed ear were selected for seeding the present year. The following are the results in ear rows:

Mother Ear	*Row-Number.* 8	10	12	14	*Total*	*Average*
Four-Rowed	28	15	6	0	49	9.10
Six-Rowed	13	18	13	2	46	10.12
Eight-Rowed	4	19	18	1	42	11.00

The four-rowed parent did not have any offspring like itself in number, but as compared with the other mother ears in the test there was a tendence to materially reduce the row-number, as shown by the average. In

PLATE V.

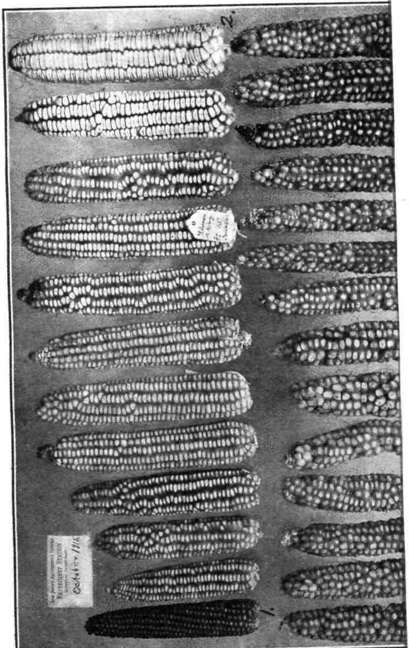
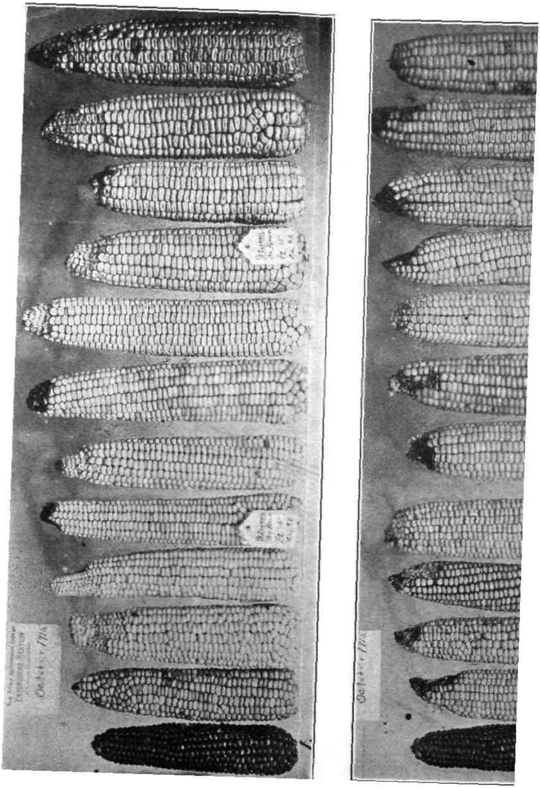


PLATE VI.



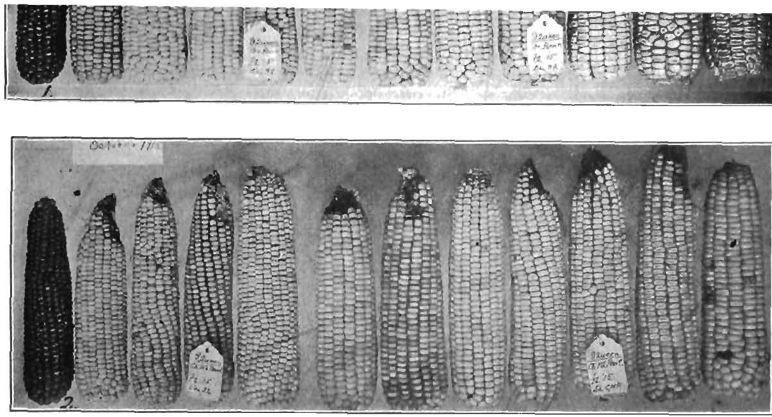


PLATE VI:—CROSSED CORN: *Inheritance with Selections in F_1 Ears.*

(Upper row) *Golden Queen* upon *Brazilian Flour* F_2. At *1* is a parental Golden Queen ear, and to its right five ears of crop from this type in F_1. The right half of row is made up of ears from crop of opposite extreme of F_1 ear, that is resembling Brazilian Flour.

(Lower row) *Golden Queen* upon *Champion White Pearl* F_2. Four ears at the right of the Queen ear, 2, are from the crop of ear like Queen, *the other seven ears are from an F_1 ear that resembled the Pearl.*

the same manner the six-rowed ear had its progeny quite midway between the other two in its average.

It goes without writing, that the four-rowed ear is an unusual one and one does not feel authorized in averaging its row-number with 14, namely that of the pollen plant, which would, by the way, give 9 or the six-rowed ear with the same 14 giving 10, and the eight-rowed ear in the same way, obtaining 11. The instances are too few for such rash conclusions. The indications, however, are strongly in favor of the opinion, that an unusually low row-number in the parental ear may be followed by a decrease in the average row-number of the offspring, as compared with that from normal seed ears, and therefore, unless the reduction is desired, care should be exercised in ear-selection, to secure the acceptable row-number in the seed ears.

A Study of Second Generation Corn Ears.

From several F_1 crosses of the previous year selections were made (1) of ears, that are most like one parent and (2) ears that approach the nearest in all respects to the other parent. From one of these extreme ears 20 hills were planted, and the same number alongside of the other, that is a block of 40 hills carried two rows of 10 hills each of one, and two similar rows of the other extreme.

At harvest time the stalks were measured for their height, etc., ears counted, measured for length and width, and the weight of the crop determined.

There was a marked difference in the appearance in the sets of rows from the time the plants came through the ground to the day of harvest. The measurements have not yet been arranged, and it is therefore not possible to give more than a general report of the test.

Golden Queen Upon Brazilian Flour, F_2 Ears. Only 8 ears formed upon the whole 20 hills (70 plants) planted from the ear most resembling the pollen parent, and these were in general appearence nearer to the Golden Queen than to Brazilian Flour. Five of these ears are shown at the left of upper row of Plate VI with a typical ear of the Golden Queen to their extreme left. The two rows, planted with grains from F_1 ear, resembling Brazilian Flour type gave a much better crop, and the ears were large, with the broad grains usually dented. Six samples are shown in the right portion of Plate VI.

Golden Queen Upon Champion White Pearl, F_2 Ears. Here the planting was the same as given above, and the striking results in the ears are shown in lower row of Plate VI where the only four ears produced from the twenty hills, planted from one ear, resembling the Golden Queen parent, are given to the right of the ear of the pollen parent. It is to be seen that in shape of ear and smallness of grain, these ears are repeating the type of the parent shown near them. The other extreme of parental ear yields a much better crop and the ears and grains adhered quite closely to the Champion type, as shown in the right portion of the Plate.

GOLDEN QUEEN UPON HICKORY KING, F_2 EARS. In this combination both parents are long-seasoned, and the ears were not fully mature. The difference in the size of the ears was not great, but the smaller had the grains small and round-topped, while the larger ears had broad, flat, dent grains. The 36 ears, representing the crop of the planting with Golden Queen-like grains weighed 7.1 pounds, while the 37 ears from the other extreme weighed 9.0 pounds.

GOLDEN QUEEN UPON EARLY ADAMS, F_2 EARS. The differences here are well shown in Plate VII where the upper row is made up of the largest twelve ears from the set from the F_1 grains of an ear, that most resembled the Black Pop while the lower row is composed of 12 ears from the set of plants, that grew from grains of an ear, that most nearly represented the Early Adams. A typical ear of the Black Pop is added at 1, and it is seen, that several ears approach it in size and shape and bear grains, that are smooth, small, and would probably pop fairly well. There are no ears in this row, that have dented grains, while in the lower row the majority are with large flat, dented kernels, true to Adams.

BLACK POP UPON SQUAW-COUNTRY GENTLEMAN, F_2 EARS. This cross is quite similar to the last, one parent being the same, while the other is a union of Squaw upon Country Gentleman. The seed planted for the upper row in Plate VIII was from an ear, that was the nearest of the lot to Black Pop, while that for the companion plot was from an ear, that was strongly marked with characters of the Squaw. The Black Pop parent is represented in ear 1 and the 13 ears to its right are the largest of the set, and, while with one exception, not very close to the pollen parent in width of ear and size of grain, they are very different from the set of only 11 ears in the lower row, where the larger size of the ear and grain of the Squaw is fully in evidence. The weight of ears from the Black Pop-like mother-ears was 6.50 pounds, while the other extreme in seed ear yielded 10.25 pounds, or a difference of 63.4 per cent. in favor of the larger mother-ear. This is nearly a duplicate of the previous test in gross commercial product.

General Observations—While opportunity has not been had for the study of the records of the measured length of each plant, and the length, width and number of rows of each ear, it seems quite evident, that there is a marked difference to be expected in the F_2 depending upon the selection, that may be made among the F_1 ears.

All through the growing season it was evident, that the plants resembled the parent nearest to which the seed ear approached, and when it came to the ears and grains, there was no exception to this rule. There is a strong correlation among the various plant characters, that is, an ear resembling the Golden Queen or the Black Pop, Early Adams, Brazilian Flour, Hickory King, etc., was produced by a plant, that in like manner resembled, more or less closely, the same variety.

These preliminary studies indicate, that it is of great importance, to make selections, so far as possible, for the qualities desired in the first

PLATE VII.

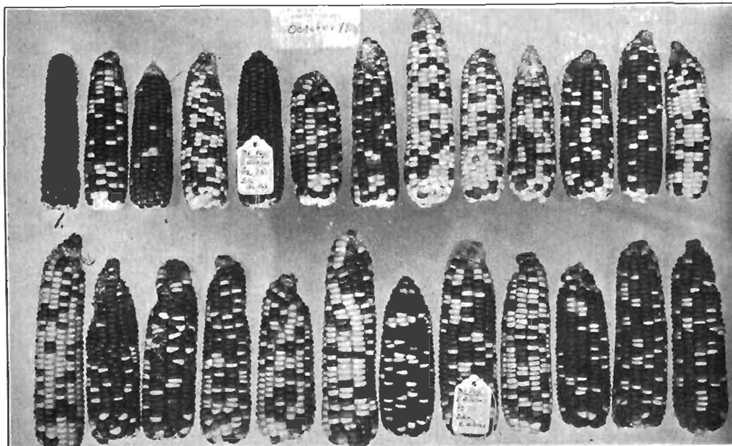


PLATE VII:—CROSSED CORN: *Inheritance with Selection in F_1.*

Black Pop upon *Early Adams* F_2 (Upper row) Showing a set of the largest twelve ears from the F_1 ear resembling the Black Pop. *1.* (Lower row) A set of twelve ears from the F_1 ear resembling the Adams parent is given.

year after the cross. In many kinds of plants there may be much less range of variation than in corn, but in the last named crop it is so evident, that there is ample opportunity for profitable segregation. In other words, the practical breeder should study the F_1 plants most intently, and gain as much time, as possible, by choosing the strains desired when they first manifast themselves.

Corn Reciprocals in Two Generations.

Reciprocal crosses between the Earliest on Earth sweet corn and the Golden Tom Thumb pop corn, both short-lived kinds, were grown the last season, making a block of 638 plants. From the time the plants were four inches high until fully grown, there was a marked difference in stature in favor of the F_1.

The stalks and the ears were all measured, but no averages are ready for this report. The following table shows the general results of the test:

Table of Results of F_1 and F_2 of Small Early Corns.

Cross.	No. Plants.	Average Weight.	Weight of Ears.	Weight of Corn Per Plant.
EOE. upon GTT. F_1	222	16.8 gm.	9349 gm.	42.0 gm.
GTT. upon EOE. F_1	87	20.6 gm.	3999 gm.	45.9 gm.
EOE. upon GTT. F_2	234	11.5 gm.	4615 gm.	19.7 gm.
GTT. upon EOE. F_2	140	5.7 gm.	2578 gm.	18.4 gm.

It is seen that the average weight of plant is very much more in the F_1, and the ears per plant far above double that of the F_2.

Both parents are small, and this cross did not offer any opportunity for a study of the effect upon the offspring of strongly contrasting varieties when bred reciprocally, the chief point being to show the superiority, if any, in crop production of one generation of a cross over another. This the test abundantly illustrates; and the results agree with that of many similar trials made with corn elsewhere. Strive to plant F_1 seed.

Crosses With Cuzco Corn.

A number of crosses in the F_2 of Cuzco corn have been grown the past season. These combinations were made by Dr. Groth in the greenhouse during the winter 1913-14 and the F_1 was grown out of doors, last year, and in the words of the originator: "The aim is, to get a large-grained, early dent corn with long ears, and more than eight rows."

Cuzco-Hickory King. This cross was remarkable for the very great size of the plants and the quite uniform lack of ear formation, 155 plants yielded only 26 ears, and all of them were very small and having many abortive ovules.

Figure 2, Plate IX, shows the best ear and a poor sample at 3, with one of the Hickory King. (1) grown alongside and in every way treated culturally in the same manner.

There is a tendency to produce the abortive ears in fan-like clusters, and sometimes nine feet above the earth, the plants often attaining a height of fifteen feet.

The lower portion of the stem naturally is very stout, usually of a green, glossy purple and with whorls of aerial roots produced from four to six nodes, and sometimes five feet from the base.

The chief end sought in the cross failed, namely to get unusually large, long grains upon exceptionally desirable ears, first, in the failure to produce any approach to a profitable yield, and further, the grains that were produced while large were borne upon short stout ears, with a tendency to form abortive clusters, as before stated.

From the standpoint of stover, there is nothing appealing to the practical grower because of the enormous size of the plants, which in the present instance were blown down three times and were set up with difficulty when ordinary corn recovered quite fully.

While the Cuzco corn is a product of a warm region, it can not be claimed that this year was too short, for the first frost to injure vegetation did not occur until the middle of October.

CUZCO-COKESBERRY. This cross of the Cuzco is with a very large kind, *and here, as with the Hickory King, the results were entirely unsatisfactory.* Figures 4 and 5, Plate IX, show samples of the crossed ears, *placed in comparison with those of the Cokesberry (3).* There were only 6 ears upon 46 plants, and, while the grains are large, the ears are small *and the yield very light. Here the plants, usually without any sign of* weakness and remarkably large, fell with the wind storms and held the puny ears often in clusters far above one's head.

CUZCO-MASTODON. Here again it was hoped, that a profitable combination might be secured when the crop grown is seeking for a large grain upon a suitable long ear. Only disappointment can be recorded, for from 89 plants grown, only 7 ears, and these very imperfect, were obtained. Figures 8 and 9, Plate IX, show samples of the cross alongside of the Mastodon ears (7) that were grown in an adjoining row.

Here were some of the very largest of plants, and it is not unlikely that somewhat of their bigness resulted from a failure to produce as a rule more than a semblance of ears.

CUZCO-EARLY YELLOW DENT. This cross of the Cuzco was less of a failure, than any of the other crosses, but here it is seen, that the fundamental of success was lacking, when it is stated, that out of 331 plants only 63 ears were produced. Figures 11 and 12, Plate IX, further testify to the inferiority of the crossed ears when compared with those of the Dent (10) parent, grown under the same circumstances in the adjoining row.

CUZCO-EIGHT-ROWED FLINT. This, *the last of the Cuzco* crosses grown this year, showed no marks of merit from the crucial point of corn growing, for, no matter how interesting special features of color of leaf, stem, tassel, cob or grain may be, and there were many, when the yield is low, and the husking of the nubbins difficult, the combination is a financial failure.

Figures 14 and 15, Plate IX, show sample ears of the Flint (13) parent.

It was not practicable to make any study of the pollen and embryo sacs, or determine in any other way the cause of the failures above enumerated.

If the Cuzco needed a moist season for its best performances, it was supplied, on the other hand, it is possible, that a dry summer might have been better for the production of fruit.

It would be of value, to test these same crosses in the native region of the Cuzco and get the expression of that environment upon them. An uncongenial surrounding may thwart one's efforts in the study of inheritance in such crosses, as the ones treated above.

Strong winds prostrated this corn worse than in the other block and the coarse stubble (stumps) needed to be removed before ploughing.

The five crosses above reported upon, all point in the same general direction, namely, the practical failure of the commercial breeding of Cuzco corn with the ordinary field types of this region. The enormous size of plant, the smallness of any ears, that do form, and the tendency to produce the group of thick-husked abortive ears are all disappointing. The inferior crop did show that grains of unusual size were realized, and, as before remarked, it would be a satisfaction to know how advantageous these crosses might prove in surroundings like those in the home of the Cuzco and learn how much of the present failure is due to environment.

Table of Results in the F_2 Cuzco Corn Crosses.

Cross	*Hills*	*Plants*	*Vi-ability*	*No. Ears*	*Yield Per Acre*
Cuzco—Hickory King....	70	155	73.8%	26	402 lbs.
Cuzco—Cokesberry	60	49	27.2%	6	132 "
Cuzco—Mastodon	40	89	74.2%	7	400 "
Cuzco—E. Yellow Dent...	160	331	69.0%	63	800 "
Cuzco—Eight-rowed Flint.	140	282	68.8%	57	760 "

The table shows low viability generally and particular for the Cokesberry cross. In yield there is nothing to be said in favor of any of the five crosses tested.

In the Early Yellow Dent cross there was a striking exhibition of albinism, there being 35 pale cream seedlings and 37 that were white with a pink tinge, the whole 72 plants shortly perishing, that is 15 per cent of the seeds planted produced chlorotic seedlings.

In the Eight-rowed Flint cross there were nine seedlings with very pale green color.

Plate X shows, in sections, a portion of a single stalk of the Cuzco upon Early Yellow Dent. The lower portion of the stem is large, woody, purplish, glossy, and had seven of the aerial nodes with rosettes of roots, six of which are shown. This particular stalk bore two small ears fully seven feet above the ground. In the lower right hand corner is shown a characteristic "hand" of imperfect ears that appeared upon many of the stalks in all the crosses, usually without grains, but with many stiff husks.

The ordinary corn-smut was much in evidence throughout this large block of corn.

III.

INHERITANCE IN PEPPERS.

In 1914 there were 678 plants grown on the F_2 of the cross of the "Golden Queen" upon "Red Cluster" and from the records the following deductions are made:

In Table I it is shown, that by comparing a set of one hundred of the largest plants with a like number of the smallest, both being of the "single leaved" type, there are certain associations made apparent.

In the first place, the larger plants have the longer leaves. Secondly, the positive correlation is great between the size of plant and that of the fruits. In color the large plants have a much greater number of yellow fruits than the theoretical number, and among the smaller plants the number is somewhat less. In flavor there is a close positive correlation of large size of plant, and sweet flavor while pungency is associated with the small plants. *A similar association holds with the thickness of wall.*

In Table II, which deals with fascicled plants, it is seen that the larger set, (only 69 plants) is positively correlated with (1) the larger leaves (2) larger fruit (3) almost the absence of yellow fruits (4) a much smaller percentage of mild fruits, and (5) a strong positive correlation between the larger plants and thickness of wall.

From the two tables it is observed, that the "Golden Queen" size of plant carries with it its own type of leaf, fruit size, color, flavor and thickness of wall, while the "Red Cluster" has its several characters here under consideration, more or less linked together, namely, long, narrow leaf, small red, pungent, thin-walled fruit.

For example, more than a third of the large "single-leaved" plants have yellow fruits, while of the fascicled plants there are only 2 per cent.

The relation of the size of fruit to other characters is made the subject of Table III. The index of the largest and smallest plants is even 3 for weight; for plant size it is 1.41, leaf size 1.21 and width 1.32 in favor of the large groups of fruits. That is, the larger fruits are associated with larger plant and leaves. In the matter of color the yellow is associated with the larger fruits, four-fifths of the smaller set being red. There are three times as many sweet fruits in the large set, as in the small, and the former have a very high percentage of thick walls.

Table I.
Relation of Size of Plants (Single Leaved) to Other Characters.

	Plant Length	Leaf Length	FRUIT												
			Position			Size		Color		Flavor			Walls		
			Pend.	Up.	Int.	Wght.	Length	Red	Yellow	Hot	Sweet	Int.	Thick	Thin	Int.
Largest 100...	61.7cm	113.6cm	39	27	34	80.4	72 36	66	34	11	15	74	64	23	13
Smallest 100...	27.6cm	89.3cm	39	28	32	59.0	67.60	71	29	22	6	72	30	43	27
Index	2.23	1.27	......	......	......	1.36	1.07								

Table II.
Relation of Size of Plants (Fascicled) to Other Characters.

	Plant Length	Leaf Length	FRUIT												
			Position					Color		Flavor			Walls		
			Pend.	Up.	Int.	Wght.	Lgth.	Red	Yellow	Hot	Sweet	Int.	Thick	Thin	Int.
Largest, 69 ...	37.7cm	138.5cm	28 (41)	26 (38)	15 (21)	78	68.7	68 (99)	1 (1)	11 (16)	3 (4)	55 (80)	31 (45)	23 (33)	5 (22)
Smallest, 100	22.3cm	104.7cm	31	39	30	44	62.4	97	3	26	9	65	23	67	10
Index	1.7	1.32				1.77	1.07								

Table III.
Relation of Size of Fruit to Other Characters of the Plant.

	Fruit Wght.	Plant Lgth.	Leaf Arrangement			Lgth.	FRUIT												
							Position			Fruit Lgth.	Color		Flavor			Walls		
			Single	Fasc.	Int.		Pend.	Up.	Int.		Red	Yel.	Hot	Swt	Int.	Thick.	Thin	Int.
Largest, 100..	105	48.4	82	15	3	113.6	49	24	27	76.9	68	32	15	9	76	70	18	12
Smallest, 100..	35	34.6	32	65	3	94	25	40	35	64.2	80	20	29	3	68	18	14	68
Index	3.00	1.41				1.21				1.19								

The conclusion is evident, that, so far as this test goes, and it deals with a large number of instances (697)—there is a decided association of several characters. This result is quite contrary to the opinion, that the characetrs are inherited independently. For example from a study of the size of the plant and color of the fruit the following results obtain:

Red Fruited	487	71.94%
Yellow Fruited	190	28.06%
Total	677	100.00%

Average length of plants..............................41.1 cm.
Average length of red fruited plants...................39.8 cm.
Average length of yellow fruited plants.... ... .44.5 cm.
Excess of length of yellow over red fruited plants 4.7 cm. or 11.2%.

The following table shows the plants arranged, as to their height in five-centimeter groups, and the number of yellow and red-fruited individuals under each group. It is seen, that the greater frequency for the yellow fruited is at 55 cm. and the red-fruited at 35 cm.

Table Showing Relation of Size of Plants to Color of Fruit.

Centimeters	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Yellow Fruited	0	1	5	14	27	24	31	24	35	13	5	5	5	0	1
Red Fruited	11	24	53	51	70	55	46	57	42	32	17	10	13	2	3

The association of size and color in another cross between a large yellow and a small variety of pepper was brought out with a plate in the Annual Report for 1912.*

The Relationship Between the Height of Plant and Length of Leaf.

Four hundred and eighty-nine plants of the F_2 of the Golden Queen upon Red Cluster were used in the study, the samples being taken only from plants of the normal type, and not with fascicled leaved.

It is to be remembered, that the plants were all of the same age and average matured leaves, ten in number, were taken from each plant for measurement.

There is displayed to the eye in Table IV an evident positive correlation, that is, the shorter plants have the smaller leaves, and the larger plants the larger foliage. *There is a great range in variation and therefore the population is broadly scattered along the mean diagonal reaching across the table from the short stemmed-leaved corner to the long stemmed-leaved corner.*

*N. J. Agricultural Experiment Station, Annual Report, 1912, pp. 347–416.

Table IV.

Correlation of Height of Plant and Length of Leaf in "Single-Leaved" Plants of 15/21 F_2.

Leaf mm \ Stem cm	14–16	16–18	18–20	20–22	22–24	24–26	26–28	28–30	30–32	32–34	34–36	36–38	38–40	40–42	42–44	44–46	46–48	48–50	50–52	52–54	54–56	56–58	58–60	60–62	62–64	64–66	66–68	68–70	70–72	Totals
56–60					1		1																							2
60–65				1																										1
65–70	1			1		1		1	1	1																				6
70–75		1		1	2		2	2	2		2	1			1		1													15
75–80	1	1		1	2	3	2	1		1	2	1	2				1		3	1										24
80–85				3	1	1	1	4	3	3	2	3	1	6	1	2		1	1	1	1		1							36
85–90			1	1	1		2	2	3	2	1	6	6	4	4	1	2		4	2	1	1			1					45
90–95			1			1		1	2	5	3		4	4	2	2	6	4	3	4	1	1	2	1	1					48
95–100						3	1	3	5	2	1	4	4	5	4	4	2	3	5	3	2	2	1	1	1		1	1		58
100–105			1				1	2		2	1	3	6	6	4	6	6	5	2		3	4	4	1				1		58
105–110					1		1		2	2		2	5	2	2		4	3	4	4		1	1	1	1		1	1		38
110–115									2	1	4	1	2	2	4	3	3	3	2	4	1	2	4		1	1	2			42
115–120									1		4	2			1	1	4	9	1	4		2		1	1		1	1		33
120–125								3	1	1					2	2	1	2	1	5	1	2	1	3		1	1			27
125–130							1				1		1	2	2	2	1		3		1	3	2	2	1	1		1		24
130–135										1						2			1	1		1	1	1	1	1	1		1	12
135–140														1			2	2	1				1							7
140–145																						2	1		1		1			5
145–150																		2						1					1	4
150–155																									1			1		2
155–160																		1												1
Totals	2	2	3	8	8	9	12	19	22	22	21	23	31	32	27	25	31	33	35	30	11	21	19	12	10	4	8	7	2	489

The Correlation of Length and Width of Pepper Leaves.

The subject of the relation between the length and width of pepper leaves has been under consideration in the study of the F_2 cross of the Golden Queen upon Red Cluster. Only plants with the ordinary phyllotoxy (not fascicled) were employed, and ten average leaves taken from each of five hundred normal plants were used.

The accompanying display of these plants, selected at random is presented in Table V. For convenience the lengths are given in five mm. units, while the width are in single mm. It is seen, that the population occupies a comparatively close belt from the short-and-narrow, extreme to the large-and-broad end of the series along the diagonal of the table.

Table V.

Correlation of Length of Leaf and Width of Leaf in "Single-Leaved" Plants 15/21 F_2.

Length mm. \ Width mm.	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	30	40	41	42	43	44	45	46	47	48	49	50	51	Tota
50–60	1																																	1
60–65		1																																1
65–70		2	1		1	1																												5
70–75		3	3		6	2	2																											16
75–80		1	1	6		2	4	3	4	2																								23
80–85			1	1	3	4	11	8	4	2																								34
85–90					1	1	6	10	12	6	2	4	2	1																				45
90–95					1		5	2	10	9	5	7	4	4	1																			49
95–100							1	6	5	8	9	9	6	4	4	1	3	2																58
100–105							2	1	3	4	8	10	4	11	6	2	1	1	1	1														55
105–110									4	2	4	3	7	6	4	1	2	3	3															39
110–115									1	1	2	3	4	4	8	7	11	2	2		1			1										47
115–120										1	1	2	3	6	4	6	4	3	4	1	1			1										37
120–125														1	3	3	4	2	2	5	5	1	1											27
125–130														1	2	5	3	2	1	4	3	2		2		1	1							27
130–135																1		1	3	4	2	1				1								13
135–140																				1	2		1			2			1				1	8
140–145																					1		1	1	3			1						7
145–150																					1		1	1										3
150–155																										2			1					3
155–160																									1					1				2
Totals	2	7	7	7	12	10	31	30	43	35	31	38	30	38	32	26	28	16	16	15	16	4	4	6	14	6	1	1	2	1	0	0	1	500

It is evident that there is a great variability in the length and width of the leaves in a cross of the kind used. The results here shown, may be obtained with leaves of any well-established variety of pepper.

A somewhat different expression would have been secured for correlation with the fascicled-leaved plants of this cross, and a still different one for the cross as a whole, had both types of leaf position been involved.

Furthermore, a conflcting result might have been obtained had the leaves in various stages of growth been used, instead of mature samples. Pepper leaves increase the ratio between length and width, as they pass from their early stages to full development.

Correlation Between the Size (Weight) of Fruits and the Size (Length) of Their Seeds. 15/21 F_2.

One hundred seeds (less in a few instances, where the full number was lacking) were measured from each of 200 fruits, each representing a separate plant, taken at random (in succession from the set of "Golden Queen" upon "Red Cluster" F_2 peppers.* Measured by tens and computed by hundreds, it is seen in the population table, that the range in seed length is from 31 mm. to 42 mm.

On account of the wide difference in the size of the fruits of the two parents, and the included tip of the larger kind, it was found best, to use the weight of the peppers. Furthermore, the weight of ten sample fruits was employed instead of a single specimen and for convenience of expression the weighings are placed in five-gram groups.

As shown in the population Table VI the ten fruit groups range in weight from 10 to 155 grams, a far greater difference than found in the units of length of the seeds.

The table shows a very strong positive correlation between the two characters brought into comparison. That is, the general trend of the population units is to the right and downward, that is, from the small-fruited, small-seeded extreme to the large-fruited, large-seeded end of the series.

A peculiarity is met with in this study, namely; the presence of nine fruits that from their great size are disassociated and are the only ones that weigh over a hundred grams. The seeds of these are generally large, two of the fruits have extremely large seeds, one has seeds that are among the smallest, and this unit stands in an isolated place in the table and has therefore a very marked effect upon the otherwise strongly positive correlation.

These measurements, and many others of this study were made by Mr. S. A. Waksman, Senior in the Agricultural College.

*The seeds were placed 10 in a row, against a micrometric rule upon a glass plate with a black background. Ten measurements of 10 seeds each constituted the records for length for each set, that is, there were 2000 combined measurements, and 20,000 seeds are represented in the population display. *The absolute length of any particular seed is not secured and* therefore no basis was recorded for the determination of the variability of the seeds in any fruit.

Table VI.

Correlation Between Size of Fruit and Size of Seeds.

Seeds mm \ Fruit grams	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150	155
31		1																												
32		1																												
33	2		3	1			2				2																			
34	1	2	1				1	1	3	2				1													1			
35		1	2	2	2	3	5	1	4	4	5	1	1	1	1															
36			2	1	1	1	9	1	2		1	4	5			2	1								1					
37	1				2	1		2	2	3	4	3	4	5	3	2		1	2					1		1				
38					1	3	2		5	4	5	5	1	2	3	3	2													
39						1	1		2	2		3	2	1	4		1	1							1					
40								1	2	1			1		1		1	1	3							1	1			
41														2																1
42																	1								1					
Totals	4	5	8	4	6	9	20	8	19	13	17	17	14	14	12	7	6	3	5					1	3	2	2			1

The results given above are in close accord with those that are obtained from a corresponding study of commercial peppers. For example, the very large seeded kinds have comparatively large fruits, and the small fruited sorts are closely associated with the small size of seeds. It is only when the intermediates are considered, that the close correlation fails. Thus two kinds with the size of seeds nearly the same, may have a decided difference in size of fruit and contrariwise, two kinds having size of fruit practically the same, differ considerably in that of the seeds.

Golden Queen Upon Red Cluster Peppers F_3.

There are many factors at work in the above cross of two strongly contrasted varieties of pepper, and in the third generation now being studied, the range of differences among plants is great.

SIZE OF PLANT. The Golden Queen being standard has a majority of its offspring in the cross following this parent as to tallness. Many rows are with all the plants tall, and also a large number of rows have only a few dwarfs. There are some rows, that are entirely dwarf. The Golden Queen is not as tall, as many other kinds of pepper, and may be classed among the kinds of medium height. However, it is a standard and is far above the Red Cluster. Measurements show, that there are great differences among the standard plants, as to size, some rows being larger, than the parents, while others are smaller.

LEAF ARRANGEMENT. There is a very marked difference in the leaf arrangement between the Golden Queen and Red Cluster for in the former the internodes are of a length that separates the leaves for a considerable distance from each other, while the latter, after the plants have made from seven to ten internodes, have them very short, and thereby the leaves and fruits are brought close together. It is this failure of internodal growth, that gives the clustered or fascicled type of leaf arrangement in the dwarf parent, and its offspring in the cross may have the same inactive factors for internodal growth. It follows therefore, that there is an expected causal linking of dwarfness and fascicled leaves on the one hand, and standardness and leaves borne singly on the other.

There is also another associated character that aids in the distinguishing of the plants, namely, the size, form and color of the foliage. While the seedlings are young, it is perhaps not possible to recognize the dwarf plants, for, until they have formed several leaves there are no signs of the fascicled character, and the foilage is of the common type in all respects. But at or near the time when the flower-buds begin to form, the internodes fail to elongate, and this brings the leaf and flower buds close together and differences in the foliage gradually arise. The first distinction of the fascicled foliage is the length of the petiole, which become much longer than in the previous leaves, and the blades lengthen more rapidly than they broaden. This change is followed by a deepening of the green of the foliage that is now forming a dense, leafy top to the plant, through which the fruits are beginning to show. Usually there is no further elongation of the stems of the plant and without the formation of new leaves, the old ones thicken and develop a very large number of chlorophyll granules, thus producing the dark green color before mentioned. A similar change can be brought about in almost any plant by removing the new growth, thus limiting the photosynthesis to a comparatively few leaves, or even to the cotyledons which may enlarge and thicken greatly, when they alone are left upon the seedling. When the leaves are few in a fascicled pepper, they may become so thick as to be quite brittle.

Among the crossed F_3 fascicled peppers, plants frequently occur that send up stems above the leafy tops, previously described, that is, the extremely abbreviated internodes may be succeeded by one or more of considerable length, after which the fascicled type is again followed, making a sort of "second story," and in some instances a "third story" is produced. In short, the seedling first shows single leaves, then as the flowering time approaches the internodes shorten, and this may be followed by a vegetative period with long internodes and again flowers and leaves are borne in clusters.

THE LEAF. In the Queen the leaves are large, and at least very broad for their length, while in the Cluster they are long and slender. A study of the inheritance in these characters is rendered difficult by the marked influence that is had upon them by the character of the internode, that is, there is not only the blending of characters in the simple phyllotoxy, but a great change is wrought by the internodal development. For example, there are all the intergradings of large and small in the different types of leaf arrangement upon the stem. That is, there are, to mention extremes, both standard and dwarf plants with large leaves like those of the Queen, but the foliage of the tall plant with single leaf arrangement is quite unlike those borne upon the dwarf fascicled plant. In like manner a tall plant may have its leaves small, both short and narrow, which are to be compared with those upon the dwarf, where the petiole is very much longer, made so, it may be contended, because of the crowding and consequent shading of them while growing, a result that is shown in other kinds of plants for similar physical reasons.

THE FLOWER. The Queen has a much larger flower, than the Cluster with a high average of lobes to the calyx and corolla, and stamens and locules to the pistil. These differences have all appeared in various combinations, but time has not permitted of their adequate study. It seems, however, a fact that the flower forecasts with much certainty the character of the fruit, whether large or small, that is to follow. In other words, a flower that has above five lobes to calyx and corrolla and stamens, is a forerunner of a correspondingly large fruit.

There is a decided positive correlation between the size of the flower, and that of the leaves, that is, in this cross, a large leaved plant, whether standard or dwarf, may be expected to bear large flowers. It therefore follows that one may predict somewhat as to the output of the fruit of a plant when noting the character of the foliage. A large mass of data is being gathered upon this point, in order to determine as to the rule governing this correlation.

THE FRUIT POSITION. The Queen has its fruits pendent, that is, the peduncle, soon after the flowers open—which in all peppers is generally with the face lateral—begins to bend and continues until the point is brought to a pendent position. This hanging of the fruit is not a matter of size, for small fruited kinds may be pendent, and some of the largest commercial sorts are upright.

In the cross under consideration, the seed parent has its fruit upright, and here the peduncle, after the lateral flower has fallen, bends upward at the blossom end, thus bringing the fruit to an upright position.

The position of the fruit, whether it be of the pendent or upright type, may be much modified by circumstances, as when held by the two stems in the angle between which the fruit is borne. Again the peduncle may be long, slender and the fruit large, when gravity brings the point downward, but an inspection of the young fruits of the same plant will usually answer the question that may have arisen as to the fruit's normal position.

The F_3 cross of the Queen and the Cluster show plants, that are with the fruits in all of the positions, namely, upright, pendent and intermediate. There is a large number of the plants, having the fruits pointing laterally or varying greatly in direction; they are not of the upright type, and may be classed with the pendent because partially so. Some rows have the plants all of one or the other of the three types, and others show a mixture of the two or three, and through the study of the immediate parent it may be determined as to the inheritance of the character of the fruit position.

So far as a general inspection goes, it indicates that the upright fruits are the smaller and borne upon the lower plants.

THE FRUIT COLOR. There are widely speaking only two colors in pepper fruits, the red and the yellow. Certain kinds, however, show a pale lemon as they pass from the green to the yellow. So far as the counts have been made, it is evident that in color inheritance the Mendelian rule is followed and the red is dominant. Thus in the Queen-Cluster cross the fruits are all red in the F_1 and three-quarters in the F_2.

It is too soon, to give exact data as to any association of the color, but it seems likely, that the large fruits are more apt to be yellow than the small ones. This, taken with the other correlations mentioned, indicates that in this cross there is a tendency for the characters of either parent to hold together.

THE FRUIT SHAPE AND SIZE. Fruit shape in peppers is a most difficult subject whenever the ribbed exterior and obtuse tip enter into the cross. These were introduced by the Queen and the offspring show all possible expressions of the factors for shape that were brought together. In no case in the 3000 plants has the exact size and shape of either parent been extracted, and there is no special intermediate type that includes a majority of the individuals.

The one thing that is most impressive is the greater size of a large nnmber of the offspring than that of their parents. It is as if the factor, for example, for length in the Queen was modified by one that prevented the free elongation of the fruit, and as a result the tip is held back while the sidewalls grow and produce the deep pit or depression at the tip. In other words, the fruit is much larger than it seems, because the sides extend around the mistaken end and into the pit to the true end like the letter "C." In the crossing this restraint may be removed and the length factor is permitted to act freely, and there results a fruit much longer than the large parent, even when the true length is actually measured.

In Plate XI an attempt is made, to show the range of variability in the F_3 fruits. The upper row shows a set of upright red fruits ranging from the nearest to the larger parent, given at 1 to the smallest and most slender placed at the extreme right. In row 2 is shown a corresponding set of upright yellow fruits, with a similar set of pendent red in row 3, and of pendent yellow in row 4. Two samples of Red Cluster fruits are shown at the lower right hand corner (2).

It is seen, that neither parent is extracted, but the smaller is more nearly reproduced. The following table presents some of the facts, drawn from the sets shown in the photograph:

Color	*Position*	*No. Fruits*	*Average Weight*
Red	upright	24	2.78 gm.
Yellow	"	24	4.42 "
Red	pendent	24	5.44 "
Yellow	"	23	5.20 "

The average for red fruits is 4.11gr.; for yellow fruits, 4.81gr.; for upright fruits, 3.60gm.; for pendent, 5.32gm. The red upright are much the smallest fruits, but the yellow pendent is slightly below the pendent red. The position seems to have more influence upon size, than color.

The variability of pepper fruits in the F_3 is brought to the eye in Plate XII, where there are nine rows of fruits shown, together with a sample of the parents as seen at (1) Golden Queen and (2) Red Cluster. Each row is made up of a typical fruit from each of the ten plants of that row. Somewhat different types of fruits were selected, and the upper five rows represent sets in which the variability is the least, while the lower four rows were selected to show the extreme of variableness. The uppermost rows have yellow fruits, the next two red, and the lower four are mixed in color, position and other characters of the fruits.

The records that have been made will furnish data for many things, and here only an attempt is made to record some of the general results. From Plate XII it goes without writing that within the rows the plants adhere quite closely to a type, and the fruits may be the same in color and position. In size and form some rows are with long, slender pointed fruits, others broad with a blunt tip, and again both of the types are mixed.

Kind Row	1	2	3	4	5	6	7	8	9	10	11	12	
Cherry	2	0	0	1	0	2	9	1	4	5	0	1	25
Procopps	2	1	6	3	2	3	0	4	0	2	8	5	36
Interm'te	5	9	3	5	8	6	1	5	2	3	0	4	50
													111

In a general way the 111 fruits may be grouped, as shown in the above table, from which it is gathered, that rather more than a quarter of the fruits are Cherry-like, somewhat more resemble the Procopps in outline, while nearly a half are intermediate.

PLATE XI.

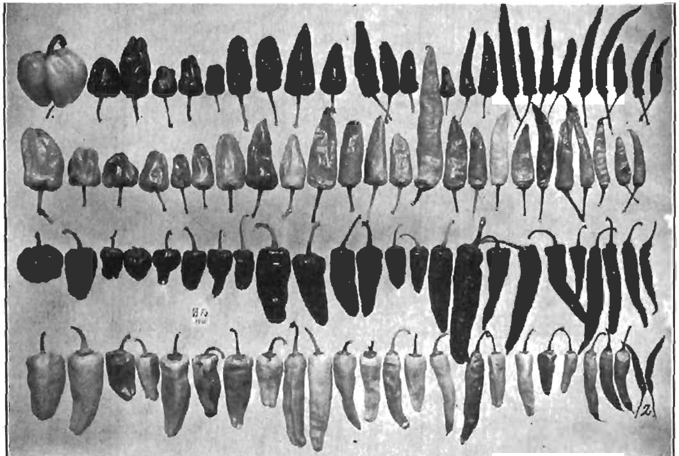


PLATE XI:—CROSSED PEPPERS: *Golden Queen upon Red Cluster F_1.*

The upper row shows the range in size and shape of red upright fruits: the second row of yellow upright; the third, red pendent, and the fourth yellow pendent fruits. Samples of parents are shown at *1* and *2*.

PLATE XII.

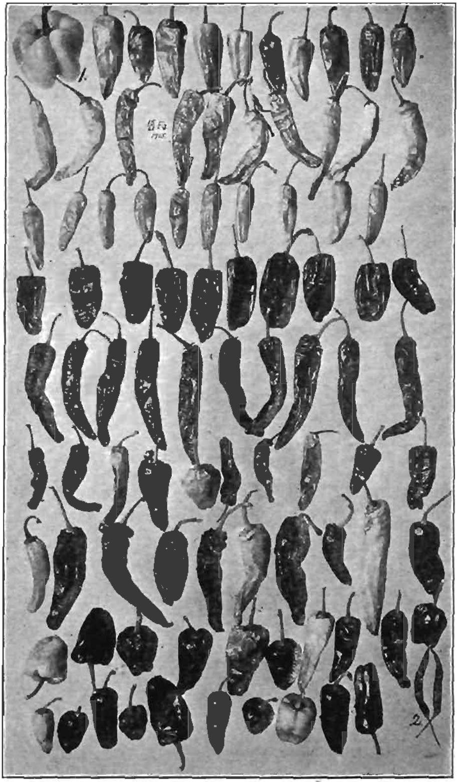
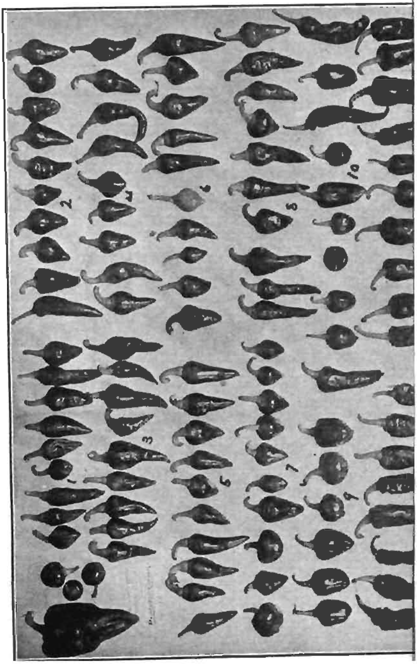


PLATE XII:—CROSSED PEPPERS: *Golden Queen upon Red Cluster* F_3.

The parents are shown at *1* and 2. Each of the nine rows is made up of a typical fruit from a plant in that row, and all from the same F_2 parent. The upper five rows show much uniformity within the row, the last four indicate great variability.

PLATE XIII.



It is further shown, that in no instance is the size of the larger parent nearly approached. The length may be attained, but also such fruits lack much in width and consequently are very much less in size and weight. On the other hand, there are fully 15 plants that bear fruits that might be mistaken for the Cherry; that is, the smaller parent, so far as this test goes, is much more nearly extracted than the larger.

Pepper Crosses in the Fourth Generation.

Some crosses of peppers were grown in the F_4 during the past season, particular attention being paid to the matter of variability. Measurements were made of the height of the plants; length and breadth of the leaf, using five average samples from each plant; the length and width of the fruits, again using five samples; and the total weight of each lot of five fruits.

In a comparison of the results with records of the same characters in previous generations, it may be possible to draw some conclusions as to variability.

PROCOPPS-CHERRY. This cross is one between two very different kinds of peppers, the Procopps Giant being a large fruited kind, as the name suggests, while the Cherry is small and round.

A display of the F_4 is made in Plate XIII where the parent types are shown in the upper left hand corner, one sample of the Procopps and three of the Cherry, the remaining portion of the plate being occupied with twelve sets of fruits, as numbered. Thus at 1 is shown a single sample fruit from each of nine plants, grown from the seeds of the same selfed fruit of the F_3. Both parents are red and there is no appearance of yellow, one parent has pendent and the other upright fruit, one is mild, the other hot, etc., but no attempt is heing made now to give more than a preliminary report upon the variability in size and form of the fruits.

At a glance it is noted that the size and form vary greatly from row to row, as for example No. 9 with its six fruits of the short, broad, thick-walled (plump) type is in strong contrast with No. 11 just below, where the eight fruits are long, curved, taper-pointed and thin-walled (wrinkled). Other sets of fruits are less uniform, as for example No. 1, where two of the fruits are Cherry-like, two long-pointed as in the Procopps and five that are intermediate. A more variable set is shown at 10, where five are more or less Cherry-like, two almost a reproduction of the parent in size and form and five approach the Procopps, two of them fully in length but not in width. Numbers 2, 3, 5 and 12 conform somewhat closely to a tapering type of fruit, but these sets differ somewhat among themselves particularly in size.

IV.

SOME NEW BREEDING WORK.

During the year some space in the breeding ground has been devoted to new subjects or older ones for special problems.

NASTURTIUMS. A beginning has been made during the past season in the breeding of the nasturtium (*Tropaeolum majus* L.). This is in particular for a study of the inheritance of the stature of the plant, the size and variegation of the leaves, and various flower characters.

For this work it was found of special value to have the plants in hills at least 40 inches apart, with two plants to the hill, and excepting dwarf sorts, trained closely to stakes so that the blooms were brought two or more feet from the earth. After many attempts no selfed seeds were produced, and it was soon evident that the work of pollinating needed to be done with extreme care. It was further noted, that certain combinations can be made with great difficulty if at all, while between other kinds crossing is comparatively easy, but even here a single seed was the usual result, and three (3) was exceptional for a single flower.

The leaf colors may in a general way be divided into: (1) the ordinary more or less pale green (2) the dark green, in which a purple is much in evidence (3) a fresh pale green and (4) a variegated type of the normal green. It is the inheritance of this factor for variegation, that will command particular attention, together with a possible study of the combinations that may give rise to the mottled foliage.

It has been noted, that the variegation, while not apparent in the first two leaves, begins in the third and continues throughout the natural life of the plant. Some plants of a mottled strain may bear leaves, that show more of the light areas, than others, and likewise the variegation is far from uniformly distributed throughout the leaves of a plant. The areas of normal green in the leaf are usually quite angular, due to the border being associated with the larger veins. For example, a leaf may be half green, and half light, the dividing line across being two of the veins that radiate from the base of the peltate blade. At other times the line of separation is theoretically that of the union of the two basal lobes to form the shield-shaped blade.

It seems evident that the variegated kinds of nasturtiums are the weaker and those plants, that have the least green were puny and unfruitful, thus adding to the difficulty of breeding with these specimens that, for some reasons, are most desirable for study.

SQUASHES AND GOURDS. Three plots were devoted to the breeding of squashes and gourds among which as leading subjects were the bush squashes, represented by (1) the Long Island and (2) the Mammoth Scallop and (3) the Strickler's Crookneck. The Cocoanut was used as a vine sort, while among the gourds there were several represented from the small Egg to the Knob Kerry with its slender neck nearly a yard long. For a study of the inheritance of size and color the Apple and the Mock Orange received special attention.

A study was made of the relative size and color of the fruit as related to its position upon the vine; that is, for example, whether the fruit nearest to the root in the long viney Cocoanut is of the same appearance as those produced elsewhere.

RADISHES. One of the chief difficulties in the breeding of radishes is the securing of pure line parents. To this end a plot of radishes was grown the past season with six representative types. This crop gave material for work upon the influence of position in the pod upon the vigor of seedlings. Two kinds having many contrasting characters were selected for breeding in the greenhouse, namely: (1) the Icicle, a long, white-rooted variety, with the plants tall and the pods long and (2) the Deep Scarlet, a turnip-rooted sort with short plants and pods.

It is of interest to record that in radishes there is more or less positive correlation between the length of root and that of fruiting top and the seed-vessels.

DATURAS. During the past season breeding was begun with four species of Daturas, namely, (1) *D. Tatula* L. (2) *D. Stramonium* L. (3) *D. Cornucopiaoides* and (4) *D. Meteloides*. The first two are comparatively common weeds under the name of Thorn Apple and the other two species are ornamental plants of that coarse type, that fits them for a conspicuous place in the flower beds in large grounds. The first two differ chiefly in the presence or absence of a purple color. That in the *D. Tatula* colors nearly all the parts, even to the large corolla, and to the eye makes this species very distinct from the *D. Stramonium*. The latter is nearly the same excepting that the purple color is absent, the plants being green, excepting the corollas which are white. The capsules of both are upright, dehisce uniformly, and are produced in profusion. The *D. Cornucopiaoides* is easily recognized among the fonr by its less spreading habit of growth, and very large purple flowers, which have the corolla doubled, associated with which are weak sexual organs and a consequent low productiveness. The capsules, small, fleshy, somewhat pendent, and with the outside roughened but not strictly spinose, as in the other species.

The *D. Meteloides* is a distinct stout, wide spreading species, with ashy green leaves, large, beautiful white flowers and drooping, spiny nearly spherical pods, that break open irregularly.

It is found, that the *D. Tatula* and *D. Stramonium* breed with extreme ease while the *D. Cornucopiaoides* is quite the opposite and after repeated trials no crosses were obtained of it with any of the three species. *D. Meteloides* takes a medium position, for with it some breeding work was done with the first two named.

It is quite evident, that in the present instance the genetic relationship determined by the systematic test is reenforced by the behavior of the species in the breeding grounds, that is, the color difference between the *D. Tatula* and the *D. Stramonium* does not inhibit breeding and may be considered simply a present and absent character that does not affect the structure or the apparent healthy functioning of all its other characters.

The *D. Meteloides* because of its green color and white flowers, broad top, copious bloom of white flowers, spiny pods, etc., is nearer to *D. Stramonium* than the others, but with this and *D. Totula* it breeds equally well, but not as fully and freely as found for *D. Tatula* with *D. Stramonium*. The most widely separated species in the group is the *D. Cornucopiaoides*, as evidenced by the upright habit feebleness of the whole plant, the character of the blossom and capsules and the lack of seed production. It is apparent that the breeding of this species will be a matter of much moment.

Much of the new work in heredity is in the hands of Mr. Orville C. Schultz, Research Assistant in Plant Breeding.

ABORTIVENESS, AS RELATED TO POSITION IN THE POD.

1. Mohawk Bush Beans.

FIRST CROP. This was grown at the usual season for an early crop, and the harvest consisted in first separating the pods into four sets upon the number of ovules that formed, namely, the six-, five-, four-, and three-ovuled pods.

Table VII.

Percentage of Abortiveness in the First Crop.

No ovules per pod	Number pods	Base	2nd	3rd	4th	5th	Tip	Averages
6	121	23.10%	6.60%	7.45%	6.60%	3.3%	1.65%	8.12%
5	253	13.14%	5.92%	4.35%	3.95%	....	2.77%	6.08%
4	158	13.90%	8.21%	10.10%	....	....	6.35%	9.64%
3	13	5.38%	....	....	....	....	....	1.79%
Totals and Averages	545	13.39%	6.91%	7.30%	5.26%	3.30%	3.59%	

It is seen, that a very large portion of the abortiveness is in the basal position, with the least at the tip, and no great difference among themselves in the positions between the base and tip.

SECOND CROP. This crop was harvested August 14th.

Table VIII.

Percentage of Abortiveness in the Second Crop.

No ovules per pod	*Number* pods	Base	2nd	3rd	4th	5th	Tip	Totals
6	264	15.9%	000%	6.8%	3.10%	000%	6.80%	5.43%
5	1,480	20.2%	6.44%	5.4%	5.4%	....	7.75%	9.05%
4	984	21.5%	6.10%	6.5%	....	....	4.00%	9.55%
Totals and averages........	2,728	19.5%	4.14%	6.2%	4.25%	000%	6.25%	....

Here again the abortiveness is chiefly in the basal position, but the tip averages no less than the intermediates.

THIRD CROP. This crop planted July 7th was harvested October 11th.

Table IX.

Percentage of Abortiveness in Third Crop.

No ovules per pod	Number pods	Base	2nd	3rd	4th	5th	Tip	Totals
6	9	55.5%	0000	15.4%	0000	0000	0000	11.8%
5	68	41.2%	13.2%	14.7%	16.2%	000	14.7%	20.0%
4	195	4 30%	16.9%	12.3%	....	....	10.8%	20.8%
3	79	35 5%	13.9%	. .	....	. . . .	11.4%	20.3%
Totals and averages	*351*	*43.8%*	*11.0%*	*14.1%*	*8.1%*	....	*9.22%*	*9.2%*

Here again the abortiveness is chiefly in the basal position and somewhat less at the tip than in the intermediate positions.

The number of ovules per pod produced diminishes and the average percentage of abortiveness increases as the season advances, as the following sets of averages from these tests show:

	Number of pods	Average number of ovules	Average abortiveness
Early crop..............................	545	4.97	6.55%
Middle crop..............................	2,728	4.73	7.35%
Late crop	351	4.02	16.03%

The large increase in abortiveness is in the basal position as the full table of averages for the several positions show:

	Base	2nd	3rd	4th	5th	Tip
Larly crop...............	13.95%	6.91%	7.30%	5.26%	3.30%	3.59%
Middle crop..............	19.2%	4.18%	6.2,%	4.25%	0000	6.25%
Eate crop	43.80%	11.00%	14.10%	8.10%	0000	9.22%
Average	25.65%	7.36%	9.20%	5.87%	1.10%	6.35%

From the averages it is noted that the smallest amount of abortiveness is in the 5th place from the base of six-ovuled pods and the next in 4th place and of course only in five- and six-ovuled pods.

The details of this study are in the hands of Miss Mathilde Groth, along with those of other subjects in abortiveness not ready for print.

V.

THE INFLUENCE OF VARIOUS SALTS ON THE GROWTH OF SOYBEANS.[1]

JOHN W. SHIVE, PH. D.

An experiment conducted by Dr. Groth, the object of which was to test the effect of various salts on the growth of soybeans (*Glycine hispida*) and prairie berries (*Solanum nigrum*), was terminated in May of this year. During the summer this experiment was repeated in part, the same pots of soil again being employed without alteration. In preparation for the repeated experiment, the soil in each pot was thoroughly mixed and a sufficient quantity of tap water added to each culture to restore approximately its original water content. The series of pots from which a crop of soybeans had been harvested were again planted with soybeans. The series of cultures which had yielded a crop of prairie berries were again planted with prairie berry seeds. The latter, however, failed to germinate and this series of cultures was discontinued.

The soil used in the original experiment and also employed in the repeated experiment, consisted of a mixture of equal parts by weight of air-dry, white sea-shore sand, and rich garden soil. Each pot contained 4.5 kg. of this mixture.

In the original experiment, the salts added to the soil-sand mixture comprised the carbonates, chlorides, nitrates, phosphates, and sulphates of sodium, potassium, calcium, and ammonium, each used singly. The soluble salts were added to the soil in the form of solutions. The amount of salt in question required for a culture was dissolved in 500 cc. of water and this solution was then added to 4.5 kg. of the soil and thoroughly mixed with it. The difficulty soluble salts were added to the soil in the powdered form. To 4.5 kg. of the soil was added the required amount of salt in question and to the whole was then added 500 cc. of water with thorough mixing.

Each salt was employed at different concentrations, each of which represents a definite percentage value for all the salt radicals (theoretical atomic groups), Na_2O, K_2O, CaO, and NH_4 for the carbonates, and NO_3, PO_4, SO_3, and Cl for the nitrates, phosphates, sulphates, and chlorides, respectively. These five different concentrations of the salt radicals are 0.05, 0.10, 0.15, 0.20, and 0.30 per cent of the weight of the air dry soil (4.5 kg. to each culture).

The cultures of this experiment may be divided into four groups with reference to the class of salts employed. The cultures containing the sodium, potassium, calcium, and ammonium salts, respectively, comprising the four groups. Each group of cultures employed five salts (carbonates, chlorides, nitrates, phosphates, and sulphates) at five different concentrations, making a total number of twenty-five cultures in each

[1]This paper appeared in Soil Science, v. 1, no. 2, p. 163-170, February, 1916.

group. In addition to these, each group contained a control culture consisting of the same soil-sand mixture as the other cultures, but containing no salt.

Table X gives the chemical formulæ of the salts employed in each group of cultures, also the radicals upon which the concentration calculations are based, and the actual weight in grams of the salts in each culture required to produce the various concentrations of these radicals.

Table X.

Actual weight in grams of the salts employed in each culture, calculated from the percentage values of the salt radical concentrations.

Formulæ of salts	Salts radicals	0.05% concentration	0.10% concentration	0.15% concentration	0.20% concentration	0.30% concentration
		gm	gm	gm	gm	gm
Na_2CO_3	Na_2O	4.518	9 035	13.553	18.070	27 105
NaCl	Cl	3 710	7.420	11.130	14.840	22.260
$NaNO_3$	NO_3	3.083	6.165	9.248	12.330	18.495
Na_3PO_4	PO_4	9.005	18.009	27.014	36.018	54.027
Na_2SO_4	SO_3	3.950	7 900	11.850	15.800	23.700
K_2CO_3	K_2O	3.310	6.620	9 930	13.241	19.860
KCl	Cl	4.733	9.465	14.198	18.930	28.395
KNO_3	NO_3	3.670	7.340	11.010	14.680	22.020
K_3PO_4	PO_4	5.023	10.045	15.068	20.090	30.135
K_2SO_4	SO_3	4.845	9.690	14 535	19.380	29.070
$CaCO_3$	CaO	4.020	8.040	12.060	16 080	24.120
$CaCl_2$	Cl	3.525	7 050	10.575	14 100	21.150
$Ca(NO_3)_2$	NO_3	4.288	8.575	12.863	17.150	25.725
$Ca_3(PO_4)_2$	PO_4	3.666	7.332	10.998	14.664	21.996
$CaSO_4$	SO_3	4.838	9.675	14.513	19.350	29.025
$(NH_4)_2CO_3$	NH_4	6.185	12.370	18.555	24.740	37.110
NH_4Cl	Cl	3.393	6.785	10.178	13.570	20.355
NH_4NO_3	NO_3	2.905	5.810	8.715	11.620	17.430
$(NH_4)_2HPO_4$	PO_4	3.125	6.250	9.375	12.500	18.750
$(NH_4)_2SO_4$	SO_3	3.710	7.420	11.130	14.840	22.260

The seed used in this experiment was raised on the experiment grounds of this Station, and under favorable conditions yielded 96 per cent strong germination. The seeds were planted directly in the soil, ten seeds to each pot, at a depth of from two to three centimeters. Only five plants, however, were allowed to grow in each culture. In the higher concentrations, the seeds in a number of cultures failed to germinate and such cultures were discontinued.

The cultures were conducted in the experiment greenhouse during the time period from August 3, to September 20, 1915. The water lost from each culture by transpiration and by evaporation from the soil surface was restored every second day by the method of weighing. The water added to the cultures was, in each case, poured through a test tube open at both ends and placed vertically in the soil so as to extend about half way to the bottom of the pot. This prevented flooding of the surface of the soil. At the end of the time period of 48 days the plants were harvested. The tops were severed from the roots at the surface of the soil, placed in weighing bottles and dried for two days at a temperature of about 98°C and from four to five hours longer at a temperature of from

102°C to 104°C. The dry weights of the tops were then obtained in the usual way.

The numerical data of the yields of tops are presented in Table XI. The dry weights of tops are given in this table relative to the average dry weights of tops of the control cultures taken as 1.00. The actual average dry weight, in grams, of these controls is given in parenthesis in the table heading for the dry weight columns. The actual weight of any culture may be obtained by multiplying its relative weight by the actual weight of the average control culture. The blank spaces in the table indicate either failure of the seeds to germinate or failure of the seedlings to develop after germination had taken place.

Table XI.

Relative dry weights of soybeans grown 48 days in soil-sand mixture with five different concentrations of the salt radicals.

Formulæ of salts.	Salt radicals.	Dry weight of tops relative to the average dry weight of the controls (5.48 grams) taken as 1.00.				
		0.05% concentration.	0.10% concentration.	0.15% concentration.	0.20% concentration.	0.30% concentration.
Na_2CO_3	Na_2O	1.02	.93	....	....	....
$NaCl$	Cl	.49	.50	....	....	....
$NaNO_3$	NO_3	.84	.82	.98	....	....
Na_3PO_4	PO_4	.63	.64	....	....	....
Na_2SO_4	SO_3	.51	.45	.73	.52	....
K_2CO_3	K_2O	.98	.91	.47	....	....
KCl	Cl	.64	.55	....	....	....
KNO_3	NO_3	.80	.78	....	....	....
K_3PO_4	PO_4	.74	.52	....	....	....
K_2SO_4	SO_3	.54	.54	.62	.58	....
$CaCo_3$	CaO	1.28	1.33	1.35	1.20	.80
$CaCl_2$	Cl	.60	.57	....	....	....
$Ca(NO_3)_2$	NO_3	.73	.78	.69	.97	....
$Ca_3(PO_4)_2$	PO_4	.67	.62	.35	.30	.35
$CaSO_4$	SO_3	.56	.42	.68	.57	.32
$(NH_4)_2CO_3$	NH_4	.76	.72	.44	.65	....
NH_4Cl	Cl	.43	.34	....	....	....
NH_4NO_3	NO_3	.54	.43	....	....	....
$(NH_4)_2HPO_4$	PO_4	.51	.43	.33	.40	....
$(NH_4)_2SO_4$	SO_3	.62	.39	.41	....	....

From Table XI it will be observed that only with 0.05 and 0.10 per cent concentrations did germination and development take place in all the cultures. With 0.15, 0.20, and 0.30 per cent concentrations the number of cultures which failed were 9, 12, and 17, respectively, out of a possible total of 20 cultures for each concentration. On the one hand, the failure in the germination or development of these cultures is undoubtedly related to the concentration of the salts in the soil solution, which in the high concentrations here employed, act osmotically to offer resistance to water entrance into the seeds and young roots, and as might be expected, the number of failures increased as the concentration increased. On the other hand, the toxic action of the salts in each of these cultures may be a factor in the prevention or retardation of development. The former is an effect of the physical properties of the soil solution; the latter an effect of its chemical properties. It is, of course, entirely possible, and indeed probable, that these two factors acting at the same time are responsible for the results noted. To what extent failure or retardation in development of these cultures is due to one or the other of these two factors has not been determined.

Further inspection of Table XI brings out the fact that only five cultures produced yields of tops superior to the average yield of the four control cultures. One each of these occurred with the 0.05, 0.10, 0.15, and 0.20 per cent concentrations of CaO, and the remaining one with the 0.05 per cent concentration of Na_2O. All other cultures produced yields inferior to the average yield of the control cultures. This retardation in the growth of the plants must be regarded as directly related to the unfavorable influence of the salts employed in these cultures, either by a toxic action affecting the life processes of the plants in a chemical way, or by giving rise to osmotic activities in the soil solutions resulting in too great resistance to water entrance into the roots in quantities adequate to supply the loss by transpiration and that used in the metabolic processes of the plant.

The relative toxic influences of the salts upon the growth of soybeans may be studied from the standpoint of relative dry weights as a criterion. With this point in view the dry weights of the tops (relative to the average control) of the plants grown in the cultures containing the sodium salts, at the 0.05 per cent concentration, were arranged in the order of their magnitudes, beginning with the highest. These form a rather uniformly decreasing series of numbers which were next plotted to form a graph shown as the heavy black line in Plate XIV (lower group of graphs). Here the abscissas were chosen arbitrarily to represent the different salts of the same base, the acid radicals of which are placed below. These acid radicals are the same for each group of salts. The ordinates represent the relative dry weight values. With the same abscissas the corresponding dry weight values for the three remaining groups of cultures (potassium, calcium, and ammonium salts), at the 0.05 per cent concentration, were plotted, using the same scale for the ordinates, thus forming four graphs, each graph representing a single group of five cultures. The relative dry weight values for the four groups of cultures, all at the 0.10 per cent concentration, were plotted in a similar manner on the same sheet, using the same abscissas and the same ordinates. Curves of the dry weight values for the higher concentrations are not here represented since none of the groups is complete.

From Plate XIV it is at once clear that at the 0.05 and 0.10 per cent concentrations, all the carbonates agree in showing higher dry weight yields than do any of the other salts in their respective groups. The dry weight values, arranged in the order of their magnitudes from the highest to the lowest yields, occur with the carbonates, nitrates, phosphates, sulphates, and chlorides, respectively. At the 0.05 per cent concentration, however, ammonium sulphate produced a higher yield of tops than did the corresponding phosphate, and both calcium and potassium chlorides yielded higher dry weights of tops than did the corresponding sulphates. At the 0.10 per cent concentration, potassium sulphate yielded a slightly higher dry weight value than did the corresponding phosphate, and the chlorides of sodium, potassium, and calcium produced somewhat higher yields than did the corresponding sulphates, potassium chloride yielding also a slightly higher dry weight value than did the corresponding phosphate. The yields from cultures containing ammonium salts, in every instance are lower in value than the yields from the corresponding cultures of each of the other groups, excepting the yield from the culture containing ammonium sulphate at the 0.05 per cent concentration, already noted.

With the 0.05 and 0.10 per cent concentrations, the cultures containing calcium carbonate show a markedly higher dry weight yield than does the average control. The culture containing sodium carbonate with the 0.05 per cent concentration also shows a slight improvement over the average control. The remaining cultures containing carbonates show yields somewhat lower than the average yield from the controls, and this becomes marked in the case of the cultures containing ammonium carbonate. The dry weight yields of all the other cultures with the 0.05 and 0.10 per cent concentrations here considered, fall far below the average dry weight of the controls. The relative differences in the degree of the toxic influence of the various salts employed, manifesting itself in retarded growth, are indicated by the gradual downward slope of all the graphs in Figure 1. It will be observed that the ammonium salts, judging from the criterion of dry weight yields, exert a markedly greater toxic influence upon the growth of soybeans than do any of the corresponding salts of sodium, potassium, or calcium. There is, however, one notable exception in the case of ammonium sulphate with the 0.05 per cent concentration. Here the toxic influence, as indicated by the dry weight values, is somewhat less than that of the corresponding salts of the other basic elements (sodium, potassium, calcium). With the 0.10 per cent concentration, however, this condition is reversed.

No marked differences excepting those of size occurred in the tops of the soybeans during the first twelve days of growth. At the end of this time, however, evidences of disturbed growth began to appear in certain cultures, first in the calcium phosphate cultures and later in all phosphate cultures excepting those with the 0.05 per cent concentration. This disturbance manifested itself first in injury to the cotyledons. It consisted of a reddish-brown discoloration around the margin of these organs, gradually spreading toward the center. In severe cases the entire cotyledon became discolored and the death of the organ quickly ensued. In case of slight injury to the cotyledons, in addition to the marginal discoloration, reddish-brown spots also appeared at irregular intervals over the surface. In many cases the cotyledons completely recovered from this form of the injury, continuing normal during the remainer of the growth period. Usually an interval of several days elapsed between the time when the injury first manifested itself on the cotyledons and its appearance on the foliage leaves. The injury spread, in severe cases, to include all the

PLATE XIV.

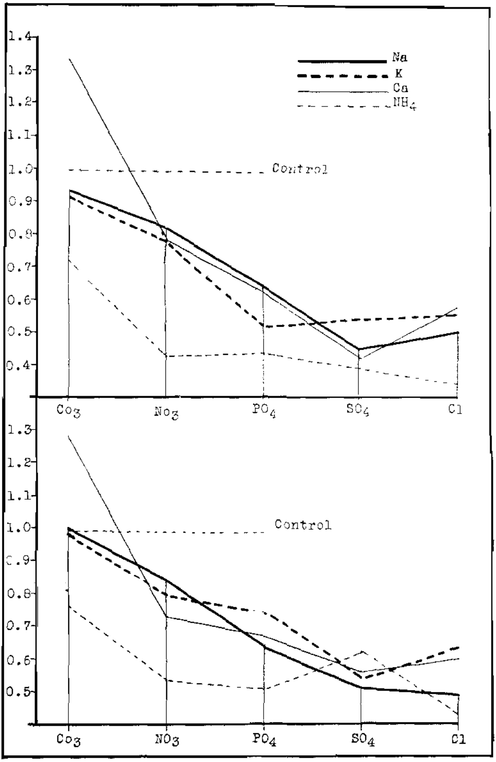


PLATE XIV:—Graphs showing the relative dry weight values of soybeans grown in various cultures containing different salts.

(Plate used by courtesy of *Soil Science*.)

leaves of the plant. In the leaves, the disturbance appeared first as small, yellowish, translucent spots, which quickly took on the characteristic reddish-brown hue. These spots first appeared near the margin of the leaf and gradually increased in size and spread to cover the entire leaf, when death and falling of the leaf quickly followed. A foliage leaf once injured never completely recovered, however slight the injury may have been.

This injury occurred only with the cultures containing the phosphates and was most severe in the calcium phosphate cultures, all of which were dead at the time of harvesting. With the sodium, potassium, and ammonium cultures, no injury occurred at the 0.05 per cent concentration, although at the 0.10 per cent concentration all the plants were severely injured, and with the higher concentrations all the sodium and potassium phosphate cultures failed, while with 0.15 and 0.20 per cent concentrations of ammonium phosphate the plants were dead at the time of harvesting.

The injury here described seems to be related directly to the phosphate salts. However, not sufficient data are at hand to warrant any definite conclusions. The reaction of soybean plants toward the phosphate salts here dealt with, singly and in combination with other salts, is at the present time the subject of further investigation.

Further evidences of disturbed growth appeared in the plants grown in the soil-sand mixture containing the ammonium salts. These plants as a whole were characterized by an unusually dark green coloration of the leaves, which may have been the result of an over-abundant supply of nitrogen, but here, at least, it is by no means an indication of a healthy condition. Not only had the plants grown in the lowest concentration (0.05 per cent) of the ammonium salts a decidedly deeper green coloration than had the plants from cultures containing the salts of sodium, potassium, or calcium, but the intensity of this coloration was correspondingly more pronounced as the concentration of the salts in the cultures was greater and the dry weight yields correspondingly less. The plants from cultures containing ammonium salts were further characterized by exceedingly short leaf petioles, which gave the plants a stunted appearance.

The present experiments, as well as similar experiments immediately preceding, have yielded little that might be construed as conclusive with respect to the toxic or beneficial influences of the salts here employed, upon plant reactions. Nevertheless, these experiments have been a fruitful source of suggestions for constructive investigation.

VI.

INHERITANCE STUDIES IN GARDEN PLANTS.

Earle J. Owen, M. Sc.

This work as reported last year has continued with the subjects—beans, eggplants, okra, and limitation studies on beans and peas.

The bean experiments were concerned with three generations of the Scarlet Runner hybrids (F_1, F_3, F_4), bush bean crosses (F_1) and certain varieties of *Phaseolus vulgaris* grown for reciprocal breeding attempts.

Scarlet Runner Hybrids.

Only one of three F_1 combinations reached maturity. The hybrid with Kentucky Wonder as the female parent gave one sterile undeveloped plant about four inches high when cut down by frost, while the normal individual met an untimely death.

SCARLET RUNNER—REFUGE WAX (63—132 F_1). In this hybrid six thrifty, climbing plants resulted, all with crimson blooms, striped green pods mottled purple seeds. They average 46 pods to the plant, many containing but one seed, and few more than two.

Three hundred eighty-six plants of Scarlet Runner, White Marrowfat (63, 29, F_3) and Scarlet Runner, Black Valentine (63, 45, F_4) were grown mainly as the Prolific and Non-Prolific set, 21 individuals being recorded as sterile, 10 in the Prolific and 11 in the Non-Prolific group. A very narrow-leaved type (filiform) occurred, being as a rule, associated with sterility. Many roots exceeded those of *Phaseolus vulgaris* but none approached the spindle-shaped, tuberous type of Scarlet Runner. A test of these roots is being made as to their perennial character.

Bush Bean Crosses (F_1).

Six of these were grown as a result of last year's breeding, the reciprocal between Hodson Wax and Kentucky Wonder being of chief importance. All six plants (Kentucky Wonder, Hodson Wax) like the climbing parent required poles, averaging 165 pods, which were quite uniformly long, flat, curved and green. Unlike Kentucky Wonder, these pods did not shrivel at maturity while the medium-sized seeds were mottled. Pod measurements, seed weights and other data are on record.

Eggplants.

Under their respective headings some results of the season's work are tabulated below. Three hundred thirty plants, exclusive of the Prolific and Non-Prolific set, were under observation and many attemps were made to obtain true reciprocals. Much valuable data not available for this report, as leaf and fruit measurements, are in reserve for a later publication.

Foremost in interest among twenty-four F_1 crosses is the reciprocal hybrid, Dwarf Purple, Scarlet Chinese (6—25, 25—6), striking differences are seen in respect to height and bearing quality. Plants of 6—25 began fruiting first and failed to make the growth of 25—6. The fruits in form, size and color show little difference, both having ridged, striped green surfaces which, at maturity, turn to orange.

The reciprocal Dwarf Purple Egg (6—40, 40—6) shows 22 gm. difference in weight of fruit but otherwise there are no striking contrasts. Plants of the hybrid Scarlet Chinese, Round White (25—29 F_1), fourteen in number, were uniform in general appearance and made an enormous growth, but yielded only a limited number of late, few seeded fruits, which were even smaller than those of the hybrid with Dwarf Purple,

Table XII.
Records of Experiments With Varieties of Eggplants.

VARIETY OR CROSS.	Plants grown.	Height of plant. cm.	Fruits per plant.	Color of Fruit.	Weight of one fruit gm.	Per cent. decay Oct. 20.	Spines.
4 Black Beauty	5	61.	2.0	Purple.	812.	10	Medium.
6 Dwarf Purple	5	49.	4.4	Dull Purple.	156.8	13	Few.
8 Florida High Bush	5	77.	3.2	Violet Purple.	543.2	0	Medium.
9-a N. Y. *Improved Spineless*	5	48.	2.6	Purple.	812.0	30	Few.
11 Long White	5	44.	3.6	White.	92.0	33	Medium.
12 Long Purple	6	57.	2.6	Purple.	119.0	37	Medium.
21 Striped	16	63.	5.0	Striped Purple.	210.8	16	Medium.
25 Scarlet Chinese	9	98.	100.	Dark Green to Light Green.	20.2	25	None too many.
29 Round White	6	50.	6.0	White.	119.2	8	Medium.
34 Round Purple	5	63.	6.8	Dull Purple Shading to Green.	302.4	8	None too few.
40 Egg	6	47.	20.8	White.	30.6	0	Few.
41 Hybrid	13	78.	6.0	Purple Shading to Violet.	403.2	11	Many.
4 29 F_1	10	81.	7.5	Purple.	537.6	21	Many.
4 41 F_1	9	75.	7.0	Purple.	678.4	14	Many.
6 25 F_1	6	93.	46.5	Striped Green.	16.1	11	None.
25 6 F_1	20	116.	10.5	Striped Green.	11.5	9	None.
6 40 F_1	7	43.	5.7	Dull Purple.	67.2	33	Few.
40 6 F_1	11	40.	5.8	Dull Purple.	89.6	37	Few.
6 29 F_1	9	62.	10.4	Violet Purple.	134.4	12	Medium.
6 41 F_1	10	64.	7.1	Dull Purple.	316.4	10	Many.
8 11 F_1	10	68.	7.6	Light Purple.	495.6	15	Medium.
8 29 F_1	10	63.	5.8	Light Purple.	324.8	46	Medium.
11 9 F_1	10	53.	4.5	Purple.	369.6	40	Medium.
11 29 F_1	9	53.	9.0	White.	148.7	8	Medium.
12 29 F_1	10	47.	8.9	Violet.	63.7	38	Medium.
19 40 F_1	10	43.	7.1	Purple Shading to Green	164.7	44	Medium.
21 6 F_1	10	65.	12.1	Purple.	199.3	3	Medium.
21 41 F_1	9	68.	6.6	Purple	305.0	26	Medium.
25 29 F_1	14	169	3.0	Striped Green.	9.7	0	None
26 6 F_1	10	76.	8.1	Purple	232.4	25	Many
26 41 F_1	10	78.	12.0	Pale Violet	337.2	12	Many
34 6 F_1	10	61.	7.3	Dull Purple.	252.2	10	Medium
34 29 F_1	10	58.	7.9	Pink	243.7	10	Medium
34 40 F_1	10	45.	4.3	Green Striped	126.0	51	Few
34 41 F_1	10	71.	7.3	Lilac	268.8	19	Few
40 11 F_1	10	60.	7.6	White	145.6	26	Medium

Okra.

As indicated in Table XIII, the three varieties grown in 1914 were continued for breeding material together with the two F_1 crosses, a group of the hybrid plants (*Hibiscus Manihot—Hibiscus esculentus*) now in the sixth generation, and the Golden Bowl (*Hibiscus Manihot*), plants of which were kept in six-inch pots (in the open) with the hope of hastening their period of bloom. Further attempts were made to breed reciprocally *H. Africanus* with the wild *H. Trionum*, but the capsules dropped before maturing.

Table XIII.

Record of Experiments With Okra.

Variety or Cross	Plants grown	Height of plant cm.	Diameter of flower mm.	Pods per plant	Length of pods mm.
1 Dwarf Prolific (standard)	24	104.7	76.3	8.0	132.1
1 Dwarf Prolific (dwarf)	6	66.6	74.0	13.0	109.5
8 White velvet	6	84.6	91.3	11.0	165.9
15 Hall's Prolific Dwarf, Early Green	20	64.2	77.4	10.3	188.4
White Velvet-D Early Green, 8-15 F_1	8	73.6	74.7	12.7	195.6
D Early Green—D. Prolific, 15-1 F_1	8	82.5	69.9	9.2	120.8
Hybrid Okra	10	180.0	112.3	21.8	131.0
Golden Bowl	7	147.6	137.2	....	....

Limitation Studies.

This year beans and peas have been the only subjects in hand, the former giving results from five season's work while the latter is carried to the second generation only.

Table XIV.

Record of Limitation Studies With Beans and Peas.

Subject	Plants grown	Blooms per plant	Fruits per plant	Weight of One Seed 1912 gm	1913 gm	1914 gm	1915 gm
Black Valentine:							
Full crop	9	22.5	10.3	.27	.34	.30	.27
One pod	9	253.0	1.0	.36	.41	.45	.44
No pods	10	256.7	0.	......	......	......	......
Davis' Wax:							
Full crop	10	27.7	20.1	.33	.34	.45	.38
One pod	9	229.3	1.0	.36	.50	.55	.61
No pods	10	268.4	0.	......	......	......	......
Alaska Pea:							
Full crop	5	11.4	8.2	......	......	......	.18
One pod	5	26.0	1.0	......	......	......	.19
No pods	5	39.8	0.	......	......	......	......
American Wonder:							
Full crop	5	12.2	10.2	......	......	......	.24
One pod	5	75.8	1.0	......	......	......	.30
No pods	5	81.0	0.	......	......	......	......

Since the weight of the seed is being made the principal test a four years' record of the beans is given by way of comparison.

REPORT OF THE DEPARTMENT OF ENTOMOLOGY

Department of Entomology

THOMAS J. HEADLEE, PH.D., *Entomologist.*

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*On State Station.

CONTENTS.

Report of the Department of Entomology

THOMAS J. HEADLEE.

I.

INTRODUCTORY.

The personnel of the staff has remained unchanged and continuity of the work has been thereby greatly promoted. Miss Augusta E. Meske has continued her satisfactory service as stenographer and clerk. Mr. Charles H. Richardson has continued his studies of the typhoid fly and its associates. The results obtained will appear at a later date in a bulletin of the Experiment Station. He has rendered very satisfactory service in the identification of insects, accession collection, and correspondence. Until recently all his time has been devoted to Experiment Station work. With the beginning of the present college year he entered upon his duties as Instructor in Entomology and will devote approximately eight hours a week to that work. Mr. Charles S. Beckwith has continued his work of mosquito control planning the cutting of 715,000 feet of 10 by 30 inch ditching or its equivalent on the marshes of Bergen, Cape May and Ocean Counties. In addition to this he took charge of the salt marsh ditch cleaning and extending, and of the salt marsh patrol for the Ocean County Mosquito Extermination Commission, affording that section of the county from Toms River north a degree of protection which it has not hitherto known. All these duties he performed in a highly creditable manner. Mr. Henry H. Brehme has continued his work as a mosquito inspector spending most of his time along the shore of Raritan Bay, Newark Bay and the Hackensack River. A certain amount of temporary assistance, particularly in mosquito work, has been rendered by various persons, the chief of whom is Dr. Floyd E. Chidester, Associate Professor of Zoology in Rutgers College. Dr. Chidester's time was devoted to that phase of salt marsh work concerned with the natural enemies of mosquito larvæ and with the effect of varying salinities on mosquito development. The results of his investigations will be published as technical bulletins of the Experiment Station.

The time of the Entomologist and his assistants has been devoted to attending to correspondence, to investigating certain phases of the effect of climatic factors on insect economy, certain phases of nicotine as an insecticide, anti-peach borer coatings, potato flea beetle control, potato spraying and dusting, strawberry weevil control, typhoid fly, white grubs, and miscellaneous species, and to the work of mosquito control.

Correspondence.

During the past season not far from an average of 30 letters each working day have been handled, involving a correspondence of 9000 letters a year. Not more than ten of these letters pertained to work of the State Board of Agriculture and its seems fair to say that this department has handled an Experiment Station correspondence of 6000 letters. Requests for information on 180 species of insects and their near relatives of which 17 were mosquitoes, have been attended to. In addition about 1000 circular letters have been mailed.

II.

INSECTS AND OTHER ANIMALS ABOUT WHICH OUR CORRESPONDENTS HAVE WRITTEN.

ARACHNIDA

Latin Name.	Common Name.	Locality.	Date.
Bryobia pratensis Garman	Clover Mite	Plainfield	April 29.
Eriophyes quadripes Shimer	Maple pouch gall mite	Middletown	June 3.
" " "	" " " "	Florham Park	June 16.
Tetranychus sp.	Red Spider	Rahway	March 5.
" "	" "	Haddonfi ld	June 14.
" "	" "	Red Bank	June 21.
" "	" "	Rutherford	June 23.
" "	" "	Mendham	June 28.
" "	" "	New Brunswick	July 9.
" "	" "	Petersburg	July 10.
" "	" "	Newark	July 31.

INSECTA.

ISOPTERA.

Termes flavipes Koll.	White Ant	South Orange	April 27.
" " "	" "	Egg Harbor	May 18.

ODONATA.

Odonata sp.	Dragon flies	Morristown	Oct. 21.

THYSANOPTERA.

Thrips tabaci L n.	Onion Thrips	Bridgeton	May 17.
" " "	" "	Philadelphia, Pa.	May 21.
" " "	" "	Cedarville	May 21.
" " "	" "	Newport	May 31.
" " "	" "	E. Moriches, L. I.	July 16.
Thysanoptera	Thrips	Great Meadows	March 5.
"	"	Moorestown	Sept. 20.

HOMOPTERA.

Aphis forbesi Weed	Strawberry Root Louse	Cologne	March 26.
" gossypi Glover	Melon Aphis	Berlin	March 6.
" maidi-radicis Forbes	Corn Root Aphis	Cape May Court House	July 8.
" mali Fabr.	Green Apple Aphis	Atlantic Hig lands	March 16.
" "	" " "	Bordentown	July 14.
" "	" " "	Watchung	Aug. 24.
" sorbi Kalt.	Rosy Apple Aphis	Summit	May 24.
Aphididæ	Plant Lice	Little Falls	Nov. 2, '14.
"	Green Plant Oice	Washington	April 5.
"	Plant Lice	Montclair	April 12.
"	Potato Plant Lice	Clifton	May 5.
"	Plant Lice	Shenandoah, Ia.	May 6.
"	" "	Berlin	May 8.
"	" "	Paterson	May 24.
"	" "	Cape May Court House	May 26.
"	" "	Summit	May 28.
"	" "	Oxford	May 28.
"	" "	Passaic	May 31.
"	Aphid Galls	Montclair	May 31.
"	Plant Lice	Haddon Heights	June 1.
"	" "	Jersey City	June 3.
"	Black Plant Lice	Madison	June 9.
"	Plant Lice	Pitman	June 12.
"	" "	Somerville	June 12.
"	" "	Wayne	June 18.
"	" "	Rutherford	June 22.
"	" "	Mount Holly	June 29.
"	Root Louse	Englewood	June 29.
"	Green Plant Lice	Irvington	June 30.
"	Plant Lice	South Orange	July 1.
"	" "	Idlewood	July 5.
"	" "	Riegelsville	July 6.
"	Green Plant Lice	Pattenburg	July 8.
"	Plant Lice	Hackettstown	July 10.
"	" "	Brookdale	July 10.
"	" "	Rutherford	July 10.
"	" "	Sewell	July 12.
"	" "	Lewiston	July 12.
"	Red Plant Lice	Cross Keys	July 14.
"	Plant Lice	Irvington	July 14.
"	" "	Cream Ridge	July 16.
"	Green Plant Lice	Keyport	July 16.
"	Plant Lice	Franklin Park	July 20.
"	" "	Montclair	July 20.

HOMOPTERA—Continued

Latin Name.	Common Name.	Locality.	Date.
Aphididæ	Plant Lice	Downer	July 21.
"	" "	*Audubon*	July 23.
"	Black Plant Lice	Bronx Park	Aug. 9.
"	" " "	Eatontown	Aug. 15.
"	Plant Lice	Somerville	Sept. 20.
Aspipiotus forbesi Johns.	Cherry Scale	Union Hill	Sept. 20.
" perniciosus Comst.	San Jose Scale	Chatham	Jan. 25.
" " "	" " "	Paulsboro	Jan. 29.
" " "	" " "	Titusville	Feb. 6.
" " "	" " "	Chatham	Feb. 11.
" " "	" " "	Trenton	March 26.
" " "	" " "	Ridgewood	June 28.
" " "	" " "	Elizabeth	Sept. 13.
Asterolecanium quercicola Bouche	Golden Oak Scale	Rutherford	Aug. 12.
Aulacaspis rosæ Bouche	Rose Scale	Lakewood	Feb. 24.
" "	" "	Mays Landing	March 19.
Ceresa bulbalus Fabr.	Buffalo Tree Hopper	Hopewell	Jan. 27.
Chermes sp.		Metuchen	Aug. 13.
Chermes abietis L.	Spruce Gall Louse	Newfoundland	May 19.
Chionaspis euonymi Comst.	Euonymus Scale	Haddonfield	April 24.
" " "	" "	Cape May Court House	July 31.
Chionaspis furfurus Fitch	Scurfy Scale	Chatham	Jan. 25.
" " "	" "	Titusville	Feb. 6.
" " "	" "	Trenton	Feb. 24.
" " "	" "	*Cape May Court House*	May 26.
" pinifoliæ Fitch	Pine Leaf Scale	Summit	Nov. 9, '14
" " "	" " "	New York City	Dec. 3, '14
" " "	" " "	Cos Cob, Conn.	Jan. 28.
" " "	" " "	Summit	May 10.
" " "	" " "	Summit	Sept. 29.
Chrysomphalus aonidum L.	Circular Scale	Englewood	April 10.
Coccidæ	Soft Scale	Princeton	Dec 7, '14.
"	" "	Woodbine	June 17.
Colopha ulimicola Fitch	Coxcomb Gall Louse	Camden	May 28.
" " "	" " "	Montclair	June 21.
Eulecanium nigrofasciatum Perg.	Terrapin Scale	Bloomfield	May 13.
" tulipiferæ Cook.	Tulip Soft Scale	Mays Landing	Sept. 22.
Gossyparia spuria Mod.	*Elm Scale*	*Mt. Holly*	April 5.
Lachnus quercifoliæ Fitch		New York City	Sept. 22.
Lepidosaphes ulmi L.	Oyster Shell Scale	Westmont	Nov. 15, '14
" " "	" " "	Moorestown	Feb. 2.
" " "	" " "	Titusville	Feb. 6.
" " "	" " "	New York City	Feb. 11.
" " "	" " "	Oradell	Mar. 8.
" " "	" " "	Trenton	Mar. 26.
" " "	" " "	Mullica Hill	Mar. 30.
" " "	" " "	Hillsdale	April 1.
" " "	" " "	Washington	April 5.
" " "	" " "	New York City	April 12.
" " "	" " "	Englewood	July 3.
" " "	" " "	*Englewood*	July 7.
" " "	" " "	Newark	Aug. 12.
" " "	" " "	Eatontown	Aug. 15.
Lygidea mendax Reut.	False Apple Red Bug	Summit	May 24.
" " "	" " " "	Dunellen	June 12.
Myzus cerasi Fabr.	Cherry Plant Louse	Washington	April 5.
" " "	" " "	Cream Ridge	June 16.
" " "	" " "	Plainfield	June 19.
Myzus ribis L.	Currant Plant Louse	Montclair	June 9.
" "	" " "	Sussex	July 13.
Nectarophora pisi Kalt.	Pea Louse	*Williamstown*	April 30.
" " "	" "	Westwood	June 10.
" " "	" "	New Egypt	June 29.
Nectarophora rosæ L.	Rose Louse	Lawrenceville	June 8.
" " "	" "	New Brunswick	July 9.
Pemphigus sp.		Ridgewood	July 31.
Phenacoccus acericola King.	Maple Pseudococcus	Hawthorne	Jan. 14.
" " "	" "	Hoboken	July 12.
Phylloxera vastatrix Planch	Grape Phylloxera	Roselle Park	July 21.
Pseudococcus sp.	Mealy Bug	Glen Ridge	Sept. 27.
Psylla pyricola Forst.	Pear Psylla	*Phalanx*	March 3.
" " "	" "	Riverton	June 28.
" " "	" "	Vineland	June 28.
" " "	" "	Riverton	July 2.
Saissetia hemisphærica Targ.	Hemispherical Scale	East Orange	Sept. 23.
Schizoneura sp.	Plant Louse	Hoboken	July 12.

HOMOPTERA—Continued

Latin Name.	Common Name.	Locality.	Date.
Schizoneura lanigera Housm.	Wooly Apple Louse.	Elizabeth.	March 6.
" " "	" " "	Pattenburg.	July 8.
Tibicem septendecim L.	Periodical Cicada.	Dover.	June 5.
" " "	" "	Princeton.	June 26.
Typhlocyba rosæ L.	Rose Leaf Hopper	Sussex.	June 5.
HEMIPTERA.			
Anasa tris is De G.	Squash Bug.	Dover.	Mar. 25.
Cicada sayi Grossb.	*Cicada.*	*Freehold.*	Aug. 2.
Cimex lectularius L.	*Bed Bug.*	*Englishtown.*	*April* 21
" " "	" "	Marlboro	Aug. 14.
Leptobyrsa explanata Heid.	*Rhododendron Lace Bug.*	*Somerville.*	*April* 24.
" " "	" " " "	Morristown.	Aug. 28.
Pentatomidæ Sp.	Stink Bug.	Hackensack.	April 23.
" "	" "	*New York City.*	Sept. 2.
Phymata erosa L.	Ambush Bug	Crosswicks.	Oct. 20.
Reduviidæ sp.	Assassin Bug.	New Monmouth	Aug. 19.
ORTHOPTERA			
Acrididæ sp.	Grasshoppers.	Sewell.	May 5.
" "	"	Newark.	July 24.
Blattidæ sp.	Cockroach	Newark.	July 10.
" "	"	Freehold.	July 23.
Paratenodera sinensis Sauss.	Chinese Mantis.	Moorestown.	Oct. 25.
Periplaneta americana L.	American Cockroach.	Phillipsburg.	Mar. 25.
" " "	" "	Elizabeth.	April 15.
Microcentrum sp.	Katydid.	New York City.	Nov. 28.
" "	"	Hopewell.	Jan. 27.
" "	"	Vineland.	Feb. 3.
" "	"	Garwood.	Feb. 18.
" "	"	Titusville.	Mar. 6.
" "	"	Titusville.	April 14.
" "	"	Three Bridges.	Oct. 20.
COLEOPTERA.			
Anthonomus signatus Say.	Strawberry Weevil.	Port Norris.	Mar. 19.
" " "	" "	Moorestown.	April 29.
" " "	" "	Clifton.	May 5.
" " "	" "	New Brunswick.	May 10.
" " "	" "	Federalsburg, Md.	May 15.
" " "	" "	Moorestown.	June 10.
" " "	" "	Louisville, Ky.	June 16.
" " "	" "	Gordon Head, Brit. Col.	Oct. 28.
Anthrenus scrophulariæ L.	Buffalo Beetle.	Collingswood.	July 5.
Attagenus piceus Oliv.	Black Carpet Beetle.	Bloomfield.	May 5.
Bruchus pisorum L.	Pea Weevil.	New Brunswick.	June 11.
Bruchidæ sp.	Weevil	Fanwood	Dec. 8.
Carabidæ.	Ground Beetle.	Plainfield.	July 30.
Chrysomelidæ.	*Leaf Beetle*	*Moorestown.*	April 29.
Coccinellidæ.	Lady Bug.	Moorestown.	April 29.
"	" "	Summit.	May 24.
Conotrachelus nenuphar Hbst.	*Plum Curculio.*	*Glassboro.*	Mar. 2
" " "	" "	Berlin.	Mar. 6.
" " "	" "	Somerville.	June 10.
" " "	" "	*Dunellen.*	*June* 12.
" " "	" "	Maplewood.	June 18.
" " "	" "	Somerville.	July 3.
Crioceris asparagi L.	Asparagus Beetle.	*Bridgeport.*	*April* 28.
" " "	" "	Titusville.	June 9.
Cyllene robiniæ Forst.	Locust Borer.	Summit.	May 24.
Dermestes lardarius L.	Larder Beetle.	Millington.	May 7.
Diabrotica 12-punctata Oliv.	12-spot'd Cucumber Beetle	Berlin.	Mar. 6.
" vittata Fab.	Striped Cucumber Beetle.	Marlton.	June 3.
" " "	" " "	Asbury Park.	Aug. 6.
" " "	" " "	Paulsboro.	Sept. 2.
Drasterius elegans Fabr.	Wire Worm.	Newton.	June 25.
Elateridæ sp.	Wire Worm.	Elmer.	Jan. 26.
" "	" "	Trenton.	May. 8.
" "	" "	No. Caldwell.	Oct. 5.
Epitrix cucumeris Harris.	Potato Flea Beetle.	Montclair.	July 20.
" sp.	Flea Beetle.	Berlin.	Mar. 3.
Galarucella luteola Mull.	*Elm Leaf Beetle.*	Toms River.	Feb. 22.
" " "	" " "	Bridgeton.	May 14.
" " "	" " "	Elizabeth.	May 15.
" " "	" " "	New Egypt.	Aug. 31.

COLEOPTERA—Continued

Latin Name.	Common Name.	Locality.	Date.
Ithycerus novaboracensis Forst.		Newfield.	May 27.
Leptinotarsa 10-lineata Say.	Colorado Potato Beetle.	Bridgeport.	May 13.
" " "	" " "	Englishtown.	June 16.
" " "	" " "	Boonton.	June 24.
Macrodactylus subspinosus Fabr.	Rose Chafer.	Bridgeport.	May 3.
" " "	" "	Mt. Holly.	May 4.
" " "	" "	Silverton.	May 10.
" " "	" "	Cape May Court House.	May 26.
" " "	" "	Lakewood.	June 8.
" " "	" "	Sicklerville.	June 14.
" " "	" "	Englewood.	June 16.
" " "	" "	Ridgewood.	June 16.
" " "	" "	Deal.	June 18.
" " "	" "	Upper Montclair.	June 30.
Nodonota puncticollis Say.		Millington.	June 16.
Odontata hornii Sm.		Bernardsville.	Sept. 3.
Phytonomus punctatus Fabr.	Clover Leaf Weevil.	Lakehurst.	April 30.
Pissodes strobi *Peck*.	*White Pine Weevil.*	*Oakhurst.*	*July* 28.
Prionus laticollis Dru.	Giant Root Borer.	Spottswood.	Dec. 16, '1
Saperda candida Fab.	Round Headed Apple Tree Borer.	Bedford.	Oct. 12.
Scarabæidæ sp. (mostly *Lachnosterna fusca* Froehl. and *L. crcuta* Sm.).	White Grubs	Vincentown.	Feb. 15.
" "	" "	Marlton.	Mar. 20.
" "	" "	New York City.	April 26.
" "	" "	Cape May Court Honse.	April 29.
" "	" "	Tenafly.	May 12.
" "	" "	Englewood.	May 20.
" "	" "	Elizabeth.	July 23.
" "	" "	Hackettstown.	July 27.
" "	" "	Scotch Plains.	July 27.
" "	" "	East Orange.	July 28
" "	" "	Stockton.	Aug. 21.
" "	" "	Rutherford.	Aug. 30.
Cyclocephala immaculata Oliv.	" "	Merchantville.	Sept. 7.
Scarabæidæ sp.	" "	Trenton.	Sept. 16.
" "	" "	Rahway.	Sept. 18.
" "	" "	Newton.	Sept. 21.
" "	" "	Rahway.	Sept. 28.
" "	" "	Deal.	Oct. 6.
" "	" "	Passaic.	Oct. 7.
" "	" "	Paterson.	Oct. 10.
" "	" "	Norma.	Oct. 18.
" "	" "	New Brunswick.	Oct. 21.
Scolytus rugulosus Ratz.	Fruit Bark Beetle.	Glen Rock.	Jan. 11.
" " "	" " "	Roselle.	Aug. 14.
" *quadrispinosus Say.*	*Hickory Bark Beetle.*	*Pottersville.*	*July* 16.
" " "	" " "	Oakhurst.	Aug. 13.
" " "	" " "	Englewood.	Sept 26.
Scolytidæ sp	Bark Beetles.	Freehold.	July 21.
Silvanus surinamensis L.	Saw-toothed Grain Beetle.	Red Bank.	Aug. 11.
" " "	" " " "	Trenton.	Oct. 13.
Tenebrioides mauretanica L.	Cadelle.	Camden.	Oct. 28.
Xyleborus saxeseni.		Tuckahoe.	Oct. 5.

LEPIDOPTERA.

Latin Name.	Common Name.	Locality.	Date.
Archips argyrospila Wlk.	Fruit Tree Leaf Roller.	Flanders.	Mar. 17.
" sp.	Leaf Roller.	Oakland.	May 18.
" "	" "	Summit.	May 24.
Arctiidæ sp.	" "	Lembe tville.	May 18.
Autographa brassicæ Riley.	Cabbage Looper.	Millburn.	Nov. 8, '1
Carpocarpsa pomonella L.	Coddling Moth.	Plainfield.	April 10.
" " "	" "	Merchantville.	April 22.
" " "	" "	Delawanna.	Sept. 19.
" " "	" "	Elizabeth.	Oct. 13.
Citheronia regalis Fabr.	Hickory Horned Devil.	Trenton.	Aug. 16.
Crambus caliginosellus Clem	Corn-root Web-worm.	Newton.	June 25.
Datana integerrima G. & R.	Black Walnut Caterpillar.	Port Monmouth.	May 6.
" " "	" " "	Tenafly.	Sept. 16.
Desmia funeralis Hubner.	Grape Leaf Folder.	Plainfield.	May 25.
Eulia pinatubana Kearf.	Pine-tube Builder.	Bernardsville.	July 10.
" " "	" " "	Far Hills.	Oct. 18.
Halisidota caryæ Harris.	Hickory Tussock Moth.	Bernardsville.	July 12.

LEPIDOPTERA—Continued.

Latin Name.	Common Name.	Locality.	Date.
Heliothis obsoleta Fab.	Corn Ear Worm.	Dorchester, Mass.	Nov. 25, '14.
" " "	" " "	Shelton, Conn.	Mar. 17.
" " "	" " "	Pemberton.	May 18.
" " "	" " "	Cape May Court House.	July 24.
" " "	" " "	Fairton.	Sept. 8.
" " "	" " "	*Boston, Mass.*	Oct. 19.
Hemerocampa leucostigma S. & A	White-marked Tussock Moth.	Mendham.	Nov. 30, '14
" " "	White-marked Tussock *Moth*	*Woodcliff-on-Hudson*	Mar. 7.
" " "	White-marked Tussock Moth.	Trenton	Mar 15.
" " "	White-marked Tussock	Freehold.	Oct. 14.
Hyphantria cunea Dru.	Fall Web Worm.	Jersey City.	Sept. 21.
Laphygma frugiperda S. & A	Fall Army Worm.	Asbury Park	Aug. 6.
Leucania albilinea Hbn.	Wheat-head Army Worm.	New Brunswick.	July 6.
Loxostege similalis Gn.	Garden Web Worm.	New Brunswick.	Sept. 21.
Macronoctua onusta Grote.	Iris Borer.	Passaic.	July 16.
" " "	" "	Plainfield.	July 27.
Malacosoma americana Fab.	Apple-tree Tent-Caterpillar	Hackensack.	April 23.
" " "	" " "	Hackettstown.	April 26.
" " "	" " "	Allendale.	April 28.
" " "	" " "	Peapack.	April 31.
" " "	" " "	Pemberton.	May 3.
" " "	" " "	Trenton.	May 3.
" " "	" " "	Park Ridge	May 11.
" " "	" " "	Woodcliff Lake.	May 11.
" " "	" " "	Millville.	May 12.
" " "	" " "	Whippany.	May 12.
" " "	" " "	Philadelphia, Pa.	May 19.
" " "	" " "	Cookstown.	May 20.
" " "	" " "	Summit.	May 24.
" " "	" " "	Passaic.	May 24.
" " "	" " "	New York City.	May 25.
" " "	" " "	*Morristown.*	May 26.
" " "	" " "	Riverton.	May 28.
" " "	" " "	Elizabeth.	June 1.
" " "	" " "	Mil ington.	June 2.
" " "	" " "	New York City.	June 3.
" " "	" " "	East Orange.	June 8.
" " "	" " "	Brooklyn, N. Y.	June 8.
" " "	" " "	New York City.	June 9.
" " "	" " "	Basking Ridge.	June 13.
" " "	" " "	Peapack.	June 15.
" " "	" " "	Allendale.	June 16.
" " "	" " "	Cranbury.	July 14.
" " "	" " "	Andover.	July 21.
" " "	" " "	Rutherford.	Sept. 21.
" " "	" " "	*Hackensack.*	Oct. 6.
Melalopha inclusa Hbn.	Poplar Tent Maker.	Springfield.	Sept. 21.
Melittia satyriniformis Hbn.	Squash-vine Borer.	Berlin.	Mar. 6.
" " "	" "	Woodbury.	April 28.
" " "	" "	Freehold.	Aug. 13.
" " "	" "	Mickleton.	Sept. 6.
Nepticular pomivorella Pack.	Serpentine Leaf Miner.	Oceanic.	Nov. 4, '14.
Noctuidæ sp.	Cut Worms	Pemberton.	Feb. 19.
" "	" "	Newark.	April 13.
" "	" "	Ringoes.	May 21.
" "	" "	Elberon.	May 24.
" "	" "	*Ancora.*	May 28.
Oxyptilus periscelidactylus Fitch	Grape Plume Moth.	Westfield.	May 27.
" " "	" " "	Madison.	June 8.
Paleacrita vernata Peck.	Spring Canker Worm.	Newton.	Mar. 29.
Papaipema nitella Gn.	*Stalk Borer.*	Mt. Holly.	Dec. 10, '14
" " "	" "	Rahway.	July 26.
" " "	" "	New York City.	Aug. 10.
Phlegethontius celeus Hbn.	Potato Hawk Moth	Maywood.	Aug. 25.
Phlyctænia rubigalis Guen.	Greenhouse Leaf Tyer.	Rutherford.	May 25.
Samia cecropia L.	Cecropia Moth.	Hoboken.	July 29.
Sanninoidea exitiosa Say.	Peach Borer.	Lovettsville, Va	Jan. 13.
" " "	" "	Bloomfield.	Jan. 25.
" " "	" "	Paulsboro.	Jan. 29.
" " "	" "	Ashland.	Feb. 11.
" " "	" "	Burlington.	Feb. 11.
" " "	" "	Paterson.	Feb. 23.

HYMENOPTERA—Continued.

Latin Name.	Common Name.	Locality.	Date.
Sanninoidea exitiosa Say	Peach Borer	Berlin	Mar. 6.
" " "	" "	Ridgewood	Mar. 28.
" " "	" "	*Taylorsville, Pa.*	*April 16.*
" " "	" "	Haddonfield	April 29.
" " "	" "	Irvington	May 18.
" " "	" "	Sewell	June 10.
" " "	" "	Kingston	July 9.
" " "	" "	Newark	Sept. 7.
" " "	" "	Sicklerville	Sept 18.
" " "	" "	Newark	Oct. 6.
" " "	" "	Annandale	Oct. 18.
" " "	" "	Riegelsville	Oct. 27.
Sibine stimulea Clem.	Saddle-back Caterpillar	Orange	Aug. 9.
" " "	" "	Hanover	Sept. 18.
" " "	" "	Freehold	Oct. 14.
Sitotroga cerealella Oliv.	Angumois Grain Moth	Riverton	Sept. 11.
" " "	" " "	Riverton	Sept. 13.
" " "	" " "	Swedesboro	Sept. 21.
" " "	" " "	Camden	Oct. 28.
Sphingidæ sp.	Sphinx Moth	Freehold	Oct. 14.
Thyridopteryx ephemeræformis Steph.	Bag Worm	Toms River	Mar. 8.
" " "	" "	Cranbury	June 15.
" " "	" "	*Elizabeth*	*July 10.*
" " "	" "	Elizabeth	July 19.
" " "	" "	Westwood	July 23.
" " "	" "	Newark	Aug 12.
" " "	" "	Pennington	Oct 12.
Tischeria malifoliella Clem	*Trumpet Leaf Miner*	*Oceanic*	*Nov. 4, '14.*
Zeuzera pyrina L.	Wood Leopard Moth	Jamaica Plains, Mass.	Mar. 17.
" " "	" " "	Cambridge, Mass.	Mar. 23.
" " "	" " "	Hackensack	Aug. 11.
	HYMENOPTERA		
Apis mellifera L.	*Honey Bee*	*Whippany*	*Nov. 4, '14.*
" " "	" "	Bridgeport	May 13.
" " "	" "	Washington	June 28.
" " "	" "	Clinton	Aug. 7.
" " "	" "	Bloomsbury	Sept. 6.
Callirhytis operator O. S.		Montclair	April 21.
Dolerus collaris Say	Wheat Saw Fly	Hackensack	April 28.
Formicidæ sp.	Ants	Berlin	Mar. 6.
" "	"	Bogota	April 17.
" "	"	Plainfield	April 20.
" "	"	Bordentown	April 29.
" "	"	Roselle	May 8.
" "	"	Bloomfield	May 26.
" "	"	Merchantville	May 21.
" "	"	Plainfield	June 1.
" "	"	Tuckahoe	June 2.
" "	"	New York City	June 3.
" "	"	Ocean Grove	June 8.
" "	"	Westfield	June 28.
" "	"	Newark	June 29
" "	"	Rutherford	July 10.
" "	"	New York City	July 28.
" "	"	Cranford	Aug. 2.
" "	"	Paterson	Aug. 4.
" "	"	New Rochelle	Oct. 12.
" "	"	Chatham	Aug 3.
Lophyrus leconti Fitch	*Le Conte's Saw Fly*	*Bernardsville*	*July 10.*
Megarhyssa atrata Fab.		Hasbrouck Heights	July 24.
" lunator Fab.	Long-tailed Ichneumon	Salem	June 15.
Neuroterus batatus Fitch		Hoboken	July 12.
Priophorus acericaulis MacGillivray	*Maple Petiole Borer*	*Tenafly*	*June 1.*
Priophorus acericaulis MacGillivray	" " "	New York City	June 8.
Tenthridinidæ sp.	Saw Fly	Ridgewood	May 29.
" "	" "	New Brunswick	July 9.
" "	" "	Petersburg	July 10.
Vespa crabro L.	European Hornet	Montclair	Sept. 26.
	SIPHONOPTERA.		
Ctenocephalus canis Curt.	Cat and Dog Flea	Chatham	July 27.
" " "	" " " "	Plainfield	July 29.
" " "	" " " "	Freehold	Oct. 7.

DIPTERA

Latin Name.	Common Name	Locality.	Date.
Acidia suavis Loew (?)		Haddonfield.	Oct. 5, '14.
" " "		Vineland	Mar. 1.
Cecidomyia caryæ, O. S.		*Metuchen.*	*Aug. 13.*
" caryæcola O.S.		Bernardsville	June 2.
" pilulæ Walsh.		Oceanic	Nov. 4, '14.
" tubicola O. S.		Metuchen.	Aug 13.
" oxycoccana Johns.	Cranberry Tip Worm	Hammonton.	June 13.
" viticola O. S.		Bridgeton	July 6.
Cecidomyia sp		Newton	June 8
Culicidæ sp.	Mosquitoes	Bayonne	Nov. 10, '14.
" "	"	Bayonne.	Nov. 10, '14.
" "	"	Bayonne.	Nov. 10, '14.
" "	"	Erie.	Nov. 11, '14.
" "	"	Bayonne.	Nov. 12, '14.
" "	"	Boston, Mass.	Feb. 27.
" "	"	*Burlington.*	*April 16.*
" "	"	Burlington.	June 2.
" "	"	Hinsdale, Ill.	June 26.
" "	"	Manchester, Mass.	June 29.
" "	"	New Egypt.	July 1.
" "	"	DeKalb, Ill	July 9.
" "	"	Cleveland, O.	July 10.
" "	"	Blackshear.	July 15.
" "	"	New York City.	July 22.
" "	"	Prout's Neck, Me.	Aug. 6.
" "	"	Orange	Aug. 13.
" "	"	Elizabeth.	Aug. 14.
" "	"	Rutherford.	Aug. 16.
" "	"	Newark.	Sept. 4.
" "	"	Raleigh, N. C.	Sept. 9.
" "	"	Vineland.	Sept. 14.
" "	"	New York City.	Sept. 17.
Eri talis tenax L.	*Drone Fly.*	*Bordentown.*	July 14.
Homalomyia sp		South Orange	Mar. 9.
Lasioptera vitis O. S.	Potato Gall on Grape.	Woodbine.	May 31.
" " "	" " "	*Roselle Park*	*July 21.*
" " "	" " "	*Lakewood.*	*July 22.*
Lyperosia irritans L.	Horn Fly.	Newton	Sept. 7.
Monarthropalpus buxi Lab.	Box Leaf Miner.	Far Hills.	Oct. 18.
Musca domestica L.	House Fly.	Bayonne.	Nov. 10, '14.
" " "	" "	Bayonne.	Nov. 10, '14.
" " "	" "	Bayonne.	Nov. 10, '14.
" " "	" "	Detroit, Mich.	May 6.
" " "	" "	Passaic.	June 18.
" " "	" "	Martinsville.	June 23.
" " "	" "	Franklin.	Aug. 5.
" " "	" "	Rutherford	Aug. 13.
" " "	" "	New York City.	Sept. 21.
" " "	" "	Franklinville.	Oct. 11.
Phorbia brassicæ Bouche.	Cabbage Maggot.	*Middle Village, N. Y.*	*Dec. 2, '14.*
" " "	" "	Matawan	May 16.
" " "	" "	Rahway.	May 25.
" " "	" "	Weston.	May 25.
" " "	" "	Cape May Court House.	May 26.
" " "	" "	Woodbine.	May 26.
" " "	" "	Paterson.	May 27.
" " "	" "	Riverton.	May 28.
" " "	" "	Elizabeth.	June 4.
" " "	" "	Boonton.	June 5.
" " "	" "	Trenton.	June 6.
" " "	" "	Hackettstown.	June 8.
Phorbia sp.	Onion Maggot.	Leesburg.	Feb. 12.
" "	" "	Newark.	July 18.
Pollenia rudis Fab.	*Cluster Fly.*	*Lebanon.*	Nov. 29, '14.
" " "	" "	Chester.	Sept. 12.
Tabanus sp.	Horse Fly.	Elmer	June 28.

III.

INSECTS OF THE YEAR.

This record includes all species except mosquitoes (they are treated in a special section of this report) that have appeared in sufficient numbers to excite serious attention.

American Tent Caterpillar.

(*Malacosoma americana* Harr.)

Dark brown egg mass about 3/4 of an inch long surrounding a small twig of apple, wild cherry and other trees during the dormant season or a white web of varying size built in a crotch and sheltering brown hairy caterpillars in the spring and early summer.

The season of 1915 started off with a tremendous outbreak of this species. Centering in northeast New Jersey the outbreak included all the northern half of the State and the species appeared in small numbers throughout the southern half. The danger of outbreak was forecasted by scouting the State for egg masses and testing their health in the insectary. Warnings were issued and citizens given opportunity to avail themselves of the State's anti-insect laws.

The warnings were heeded to the extent that many persons cleaned up their own properties.

In Bergen County where much of the land has been given over to urban development large acreages grown up to wild cherry are interspersed with or lie adjacent to built-up sections. On this wild cherry a tremendous brood of caterpillars developed and after consuming the available foliage migrated into the built-up sections consuming the foliage of apple, peach and garden truck. Under such conditions as these the efforts of the small individual land holder to protect his property adequately were set at naught. Fortunately, such conditions did not obtain in a large number of cases.

The outbreaks of 1914 and 1915 have shown that under conditions where food is exhausted before maturity has been reached the caterpillars will migrate considerable distances in search of food and that at such periods they will consume foliage which at other times they would refuse. The general life history and habits of the species are so well understood that they will be omitted from this report.

An enormous number of egg masses have been deposited and unless natural enemies or weather intervenes an outbreak may be expected next season.

Waging a successful fight against this insect involves education and organization; education of the people in the infested territory in the methods which the individual can use to protect his plantings, organization of people in the infested territory in such a fashion that the enforcement of law against the careless and recalcitrant can be carried out.

Where such action is practicable, children's organization, such as the boy scouts, should be utilized to remove the egg masses before the next growing season opens. If, however, the prevention of an outbreak is to be the work of paid mature labor the hatching of the caterpillars should be awaited for there are many chances that the eggs or caterpillars which hatch from them may be destroyed by natural forces before the webs reach the size of a man's hand.

Depending upon which is the more practicable under local conditions the webs with their caterpillar contents should be cut out and burned up or simply crushed where they hang or the foliage round about them sprayed with arsenate of lead or dusted with powdered arsenate of lead in such a fashion that the leaves will be covered with small closely set spots of the poison. The best results are likely to follow the application of the measures of control throughout a continuous area, permitting no nests to remain within its limits. Organized community action is the only type of action certain to bring about these results.

Apple Plant Lice.

Small dark-green to light and rosy colored lice covering the opening buds and flower stems and later found on the undersides of the leaves and upon the apples causing the foliage to curl and the apples to grow knotted and gnarled.

The American tent caterpillar had barely made a good start when various species of plant lice had begun to work. The season was cold and the lice throve while their principal parasitic enemies did not. Soon the apple foliage began to curl and later the young apples to shrivel and grow knotted and gnarled.

Contrary to previous experience the principal species was the rosy apple louse (*Aphis sorbi* Kaltenbach) and again contrary to previous experience with apple lice they proved very difficult to kill.

The life history of the rosy apple louse is much like that of the green species except that instead of staying on the apple tree the year round it migrates probably to certain species of plantains and returns to the apple in the fall. All species of apple plant lice (except the wooly) pass the winter in the egg state on the smaller branches and twigs of the trees and hatch about the time the buds open. Until recently it was held that the best time to destroy the young lice lay between the opening of the buds and the opening of the blossoms.

As the result of careful and rather conclusive studies Parrott and Hodgkiss of the experiment station at Geneva, New York, reached the conclusion that best results follow the treatment which is applied just as the buds are beginning to show green. These workers hold that nicotine solutions, oil emulsions, and soap preparations are the most effective sprays. They advise a combination of winter strength lime sulphur and 40 per cent nicotine at the rate of 3/4 of a pint of nicotine to 100 gallons of the lime sulphur. By this combination both the scale and the plant lice are hit.

In the 1913 report of the Entomologist the writer called attention to the fact that winter-strength lime-sulphur treatment for San Jose scale when delayed until the buds were swelling would destroy the green apple aphis (*Aphis mali* Fabr.) provided the lice had hatched and the buds had not yet opened sufficiently for them to find shelter under the scales.

It would seem that this stage is the most auspicious for apple lice control because of their tender condition, providing all the lice are hatched before the buds open sufficiently for them to crawl under the scales. The complete success of the method hinges directly upon this phase of their life history.

Assuming that not all the lice do hatch before the buds open sufficiently to allow them to seek shelter the following facts remain: (1) some and perhaps the large majority do hatch before shelter can be had; (2) from 95 to 98 per cent of those which do hatch may be destroyed by the combined winter-strength lime-sulphur and 40 per cent nicotine combination, which treatment also controls the San Jose scale; (3) such lice as are left may be hit by later sprays with just as good chances of success as if no treatment whatever had been given when buds began to show green.

If the grower desires to take every possible precaution to destroy the lice he should treat the trees when they are beginning to show a little green with winter-strength lime-sulphur to which 40 per cent nicotine has been added at the rate of 1 part of the nicotine to 1000 parts of the lime-sulphur. The mixture should be applied with sufficient care to cover all parts of the tree, particularly the twigs and smaller branches. Of course this treatment will serve for the scale as well as the lice. Then he should keep a sharp lookout for the presence of lice by examining many specimens of opening buds from different parts of the orchard. If the lice appear between the opening of the buds and opening of the blossoms the orchard should be promptly treated with a mixture composed of 40 per cent nicotine, water and soap. Contrary to the recommendation emanating from other sources the writer believes that the nicotine should be used at the rate of 1 part to 500 parts of water and should have soap added at the rate of 2 pounds to fifty gallons. It is likely that the 40 per cent nicotine added to the scab spray at this time would give satisfactory results. The most complete success will follow only that type of treatment which thoroughly wets all the lice.

From certain work done several years ago against the melon louse (*Aphis gossypii* Glover) the writer has felt that best results in spraying lice, which are somewhat protected by foliage, follow the use of stronger nicotine mixtures than those which are usually recommended. His belief that stronger mixtures are better has been strengthened by the present season's experience.

Other Plant Lice.

The cherry louse (*Myzus cerasi* Fabr.) occurred practically everywhere the domestic cherry was grown and curled the leaves badly. There were very few instances in which the pest was combatted at all. This inactivity was probably due to the slight importance of the cherry crop.

Both shade and forest tree lice were far from being as abundant this year as last. The same reduction was seen in the species infesting bush fruits, but the lice on truck crops were much worse than usual.

Potato lice were very abundant but did little damage. Tomatoes were tremendously infested with *Aphis rumicis* Linn., and were probably weakened in such a fashion as to render them susceptible to the mosaic disease which followed.

Practically no spraying for control of the potato lice was undertaken but some successful work with 40 per cent nicotine, water and soap was carried out against the aphis on tomatoes. The most practical machine used has been the field potato sprayer. Thorough treatment with a mixture composed of 40 per cent nicotine (1 part), water (500 parts) and soap at the rate of 2 pounds to 50 gallons has seemed satisfactory.

The gooseberries at Mr. Edward Mechling's place near Moorestown have exhibited both this season and last a most remarkable malformation, which is apparently due to the work of plant lice of the species *Aphis houghtonensis* Troop[1]. This species[2] of aphis was brought to attention by Mr. James Troop who found it in the summer of 1904 on Houghton gooseberries near the city of Indianapolis, Indiana. Mr. Troop does not attempt to describe its life history but states that it does not colonize on other varieties of gooseberry.

Observations made by the writer have served to confirm the pest's reported fondness for the Houghton. Thus far the life history has proved a puzzle.

[1]The writer's thanks are due to Mr. John J. Davis for identification of specimens.
[2]*Entomological News*, Feb. 1906, pp. 59-60.

Pear Psylla.

(*Psylla pyricola* Forst.)

Small (1/10 of an in. long) reddish brown fly-like creatures found on the trunks and branches during warm days in late fall and early spring; small (1/80 of an inch+) yellow nymphs congregating in axils of leaf and fruit stalks, and later spreading over the undersides of the leaves causing the tree to drip honey-dew and later to take on a dark sooty color.

The pear psylla has recently thrust itself into notice by troubling in a very serious manner several pear growers and by refusing to succumb to the usual treatments. Briefly stated, the pear psylla winters as an adult in the cracks and crevices of the bark, moves about more or less during the warm spells of the dormant season, lays its eggs just before the blossoms open, feeds first as a nymph in the axils of the leaf and fruit stalks, then spreads over the under-sides of the leaves, and reaches maturity. It is thought there are at least four broods a season.

The damage is done by the insect robbing the tree of sap and food and by the growing of a black mould which lives upon the honey-dew produced by the psylla.

Successful control seems to involve the following operations:

1. The rough bark should be scraped off during the fall and winter, taking care not to injure the live tissue. The scrapings should be gathered and burned, in order that all hibernating psylla sheltering in it may be destroyed.

2. During warm days in late fall and early winter or late winter and early spring many of the adult psylla are crawling about over the bark. Thoroughly spraying the whole tree before leaving it for another at this time with winter-strength soluble oil or with 40 per cent nicotine, soap and water (1 pint nicotine to 800 parts of water with soap at the rate of 1 ounce to the gallon) will destroy many. The liquid must not freeze on the trees.

3. Thoroughly spraying with winter-strength lime-sulphur just before the blossom buds open will destroy many, perhaps most of the eggs.

4. Thoroughly spraying with 40 per cent nicotine, soap and water will destroy all the nymphs that are well wetted. Use here 1 part of nicotine to 1000 parts of water and add soap at the rate of 1 ounce to the gallon.

During the last two years in the experience of the writer no one of the methods has by itself been successful. A combination of the first three has been eminently so.

White Grubs.

Large fleshy white grubs with dark-brown heads, brown sprawlly legs, enlarged abdomen and bodies that curl into a semi-circle; found in the soil about the roots of plants.

Three or more species of white grubs have been concerned in the injury which has taken place. Collections from north and central New Jersey show *Lachnosterna fusca* Froehl and possibly *L. arcuata* Smith while those from the southern portiton show *Cyclocephala immaculata* Oliv. and *Polyphylla varilosa* Hentz[1]. Doubtless the first species is the one which has wrought most of the harm.

Injury by white grubs, the young of the June bug and to some extent of the rose bug has been very noticeable in lawns, golf courses, and strawberry fields. In some instances the sod has been entirely cut loose from the soil beneath. In most cases the injury has appeared in spots only. Strawberry patches in many instances have lost more than 50 per cent of their plants.

[1]*The species were determined by Mr. John J. Davis.*

Brown patches in lawns and golf courses during the past season have been excellent signs of grub trouble. Reddening and browning of strawberry foliage have been indication of the work of white grubs. If the spots and plants thus showing injury are dug up and carefully examined, the root system will be seen to be partly or wholly destroyed and white grubs will usually be found in the soil.

In some places in the red shale soil where the land has been in grass and weeds for several years the grubs average one for each two square foot of surface.

The infestation by white grubs is such, especially in view of their large size, as is not likely to give serious trouble next season, for these almost mature grubs will do only a little feeding next summer and then pupate. In the summer of 1917 there ought to be a large emergence of adults and in 1918 grub injury should again be troublesome. Natural enemies or unfavorable weather may, of course, prevent the beetles from appearing in large numbers or may destroy their progeny.

While methods of controlling white grubs under field cropping conditions have been fairly well worked out, practically nothing has been discovered to prevent their work on lawns and golf courses. With a view of supplying this lack of information studies of control measures adapted to these conditions have been undertaken. An account of the study and its result is given under the head of "White Grub Remedies."

Rosebug.

(*Marcodactylus subspinosus* Fabr.)

Light-brown beetles (1/2 in. in length) with long spiny sprawly legs appearing in early summer and feeding voraciously upon roses, sassafras, apple, and many other trees and shrubs.

While the young of this insect, which resembles a white grub, has done a considerable amount of harm to lawns in South Jersey, the adults seemed to have done still more harm. At times during the rose bug season the beetles fairly filled the air. Rose bushes, sassafras, apple trees, grape vines and berry bushes have suffered most of the damage but corn in some cases has been partly destroyed.

The southern part of the State suffered most but the bugs were present in sufficient numbers to occasion complaint throughout the central portion. Practically no reports were received from the northern part of the State.

On the farm of Mr. John H. Barclay near Cranbury the pest assumed serious proportions on a variety of apple known as Duchess. Curiously enough none of the other varieties, which were McIntosh Red, Twenty Ounce Pippin, Stayman Winesap, Rome Beauty, Greening, and Fall Pippin, were touched. There were three rows of Duchess—two on one side of the orchard and one on the other. There were scattering trees of this variety mixed through rows of other varieties. In every instance the beetles picked out the Duchess. Some studies of control measures were made in the course of which the carbolic acid-whale oil soap mixture, powdered arsenate of lead and sulphur, and self-boiled lime-sulphur were tried. An account of the results is given under the head of "Rosebug Remedies."

Flea Beetles.

(*Epitrix sp.*)

Small (size of a pin head) black beetles found on potatoes, tomatoes and various solanaceae; they jump like fleas and fill the leaves with small irregular holes.

Never in the writer's experience have the flea beetles (*Epitrix cucumeris* Harr.) been so abundant. The potato foliage was filled with holes before the plants were six inches high and on at least two other periods the amount of fenestration was large. Tomato foliage suffered severely.

Treatments of various sorts as will be set forth in the section devoted to the investigation of this insect showed that home-made Bordeaux mixture eliminated about 50 per cent of the injury.

Army Worm.

(*Leucania unipuncta* Harv.)

Dark-gray to dingy-black plump caterpillars with three narrow yellowish stripes above and a slightly broader and darker one at each side; usually occurring in large numbers in grass lands, cultivated fields and lawns; feeds almost entirely at night except when food becomes exhausted then migrates in armies and feeds in broad day destroying grass and similar vegetation as it goes.

The army worm has this year been practically absent. Absolutely no complaints of serious injury were received and no cases were observed. Both the moths and the larvæ were occasionally found. This is quite in accord with the common experience with this insect—a year of great abundance is usually followed by a year of scarcity.

Angoumois Grain Moth.

(*Sitotroga cerealella* Oliv.)

Small (1/4 in. long) clay colored moths almost totally without color markings, found flying about or resting on the walls and grain of bins and granaries or small (1/5 in. or less) white larvæ enclosed in corn or wheat grains.

For the first time in several years the angoumois grain moth, locally known as the "fly weevil," appeared in sufficient numbers to occasion complaint. The damage seems to have occurred mostly along the Delaware River from Trenton south and the principal crop suffering harm has been corn, although some damage to wheat has been reported. Doubtless the limiting of injury mainly to corn is connected with the fact that comparatively very little wheat is grown in that section.

As might be expected from a knowledge of the angoumois grain moth's habits the seed corn stored in warm places and that part of the 1914 crop held over during the summer of 1915 have been the grain damaged. The fact, which by the way, is borne out by this year's experience, that corn is not seriously attacked until the summer following the one in which it is grown, except when stored in heated buildings, narrows the problem of protection in a highly satisfactory fashion.

To prevent injury to hold-over corn it is necessary to store the new crop in an uninfested place considerably removed from possible sources of infestation or to provide means of regular fnmigation. To prevent injury to corn stored in heated buildings adequate provision for fumigation must be made.

To carry out the first method it is necessary to prepare a new crib or to clean out the old one together with the surrounding sources of infestation. Cleaning out the old crib is a matter of removing all grain and thoroughly freeing all cracks and crevices from grain accumulations and dusts about 30 days before the new crop is to be stored. Cleaning out other sources of infestation refers to other grain accumulations in the same building or other near-by structures in the same manner as that prescribed for the crib itself. As a matter of fact, it is likely under ordinary farm conditions to prove difficult if not impracticable to clear up the crib and other sources of infestation.

To carry out the fumigation it would be necessary to have the crib sufficiently separate from other buildings to permit its complete enclosure by a tarpaulin. With this sort of arrangement the farmer has merely to cover his crib and fumigate whenever the weevils appear in sufficiently numbers to render the treatment necessary. Corn stored in heated buildings is usually small in quantity and can therefore be easily enclosed in a tight box and fumigated whenever infestation appears.

The best fumigant is carbon bisulphide. Details concerning its use are published in the Station circulars and may be obtained on request.

European Pine-Shoot Moth.

(*Evetria buoliana* Schiff.)

Dark brown larvæ with deep black head and thoracic shield found inside dead and dying terminal shoots of pine; presence indicated by sickly look of shoot and mass of gum.

This insect which was first observed by the writer in the early summer of 1913 on pine shoots sent in from Long Island, has appeared in large numbers on imported nursery stock. In the course of his duties the assistant to the State Entomologist, Mr. Harry B. Weiss, found a surprising infestation on seven shipments from Holland. As many as ten infested buds were found on a single small plant. Unfortunately, the species seems to have been established in the State for several years.

The pine-shoot moth is a well known pest of the pine in Europe and annually causes serious damage by eating out and destroying the terminal buds. This results in a distortion of the tree's growth, preventing the formation of good straight trunks. The insect confines its attention to conifers and the problem of its control in North Jersey is therefore comparatively simple, being merely a question of protecting pines growing under cultivation. In South Jersey, however, the question of control may prove to be very different. While the common species of pine in South Jersey are not listed among its food plants, no one can say whether it will under our conditions attack them successfully.

Pruning off the infested buds in the spring when they are easily seen and still contain the larvæ, and destroying them with fire is the best method of control thus far discovered. Cutting in the fall is effective but is attended with more difficulty for the infested buds are harder to detect at that season than they are in the spring.

The European Mole Cricket.

(*Gryllotalpa gryllotalpa* Linn.)

Large (2 in. in length) cricket-like creatures found in the soil and tunnelling hither and thither cutting off the stems and roots of plants.

For several years at Rutherford tunnelling by some creature other than moles and mice has been noted. The tunnels range from 1/4 to 1 inch in diameter and perforate the soil in every direction. This season the agent was discovered by Mr. Weiss to be a large mole cricket, which was later determined by Mr. J. A. G. Rehn as the European mole cricket.

It is interesting to note that this species is regarded by Curtis and others as a serious pest in many parts of Europe where it appears in early summer "in myriads" and "nothing in the herbaceous way is proof against its ravages."

The life history of this mole cricket has been well known for many years. At the beginning of summer the female constructs in the neighborhood of her burrows a nest about 6 inches below the surface. It is shaped like a bottle with a curved neck, 2 inches long and 1 inch wide. The neck of the bottle communicates with the surface, 300 to 400 eggs are laid in it and the entrance closed. The oval brownish-yellow eggs hatch in July and August, about one month after they are laid, and the young mole crickets begin to feed on the tender roots of plants whether grass or vegetables. At the end of about one month after hatching the group disperses.

Maturity is reached the following spring after which they pair and lay eggs. Winter is passed in the soil.

Many measures of control have been suggested by various European students, among which may be mentioned that of digging in September three or four pits per 500 to 600 square yards, each two or three feet deep and a foot wide, filling them with horse dung and covering them with soil. The mole crickets apparently attracted by the warmth congregate in these pits on the first frost and may be easily destroyed.

Whether the life history or measures of control will be the same in this country as in Europe is a question which only time and investigation can answer.

Lawn Ants.

Ants that infest lawns and golf courses have been unusually troublesome this season. Many cases in which the grass has been destroyed have come to our notice. The species principally concerned is a small reddish brown ant (*Tetramorium cespitum* Linn.) which constructs small hills ranging from 1 to 2 inches at their bases, each of which centers at a burrow about 1/4 of an inch in diameter. In some cases 6 to 10 of these ant hills could be counted on a square foot. The damage did not stop with the destruction of the grass, but the species made its way into houses and infested such sweet materials as it could find. The sugar syrup and tartar emetic described in the last edition of Bulletin No. 203 proved very successful in repelling house invasions.

Onion Thrips.

(*Thrips tabaci* Linden.)

Very small (1/25 in. long) slender, dark-colored, slowly-moving creatures that appear when the onion leaves are pulled away from the stem; usually quite distinct against the white back ground of the separated stem or leaf; presence indicated by small whitening spots in the leaves.

This insect is playing a large part in onion culture. It was stated to the writer by Mr. Frank H. Hall of the Campbell Soup Co., that the growing of onions from seed had been practically eliminated by the thrips. Everywhere throughout the southwestern part of the State evidence of its work on onions grown from sets could be detected. It seems obvious that either the measures of control worked out for this insect are inadequate or that the grower's utilization of them is very unsatisfactory.

From the writer's observation he is inclined to believe that the trouble lies primarily in the use of measures of control in the proper fashion.

Cabbage Maggot.

(*Phorbia brassicæ* Bouche.)

Small (3/16 in. long) white maggots either tunnelling in the roots of cabbage or engaged in skinning them; indication of presence is lack of growth, wilting and death; best test for presence is careful examination of the roots of the injured plant.

This year the cabbage maggot appeared in exceptionally large numbers and did much harm. It seemed as if the growers have had so little difficulty in recent years that they have ceased to trouble themselves about measures of control. As a consequence the first intimation of trouble came after the plants were well along and the maggots buried in the roots. Unfortunately all studies of the subject have shown that remedies at this stage are practically useless.

Carbon bisulphide fumigation of the soil about the roots followed by the use of quick acting fertilizer was tried but with slight success. The carbolic acid emulsion was also tried but without encouragement.

It should be remembered by cabbage and cauliflower growers that successful treatments begin shortly after the plant is set out.

Garden Webworm.

(*Loxostege similalis* Gn.)

Black-dotted, slightly-hairy caterpillars varying in color from pale through greenish yellow to dark-yellow, feeding upon pigweed (Amaranthus Spp.), alfalfa and various kinds of garden truck.

In the latter part of the season this insect appeared in the guise of an alfalfa pest. In most instances it was present in ever widening patches scattered over the field. The plants were defoliated and threatened with destruction. The extent of territory covered was such as to forhid local work. Accordingly, the infested fields were sprayed with potato sprayers, using 3 pounds of lead arsenate of 50 gallons of water and using about 100 gallons to the acre. The worms were promptly destroyed by this treatment.

Maple Leaf Stem Miner.

(*Priophorus acericaulis* MacGillivray.)

Small white larva found mining out the petiole of maple and causing the leaf with the infested petiole to fall from the tree.

This injurious saw fly appears to be on the increase, two new localities being found. It has now been taken at Hackensack, Bloomfield, Montclair, and Englewood. Kerosene emulsion was applied to the soil as the larvæ were entering it in 1914 and the past summer has shown no appreciable effect.

Wheat-Head Army-Worm.

(*Leucania albilinea* Hbn.)

Smooth greenish or brownish striped caterpillar, an inch or more in length, feeding upon the heads of wheat and timothy.

This species was reported from two localities—Newton and New Brunswick—not as working upon wheat but timothy. Parts of the field examined showed the heads completely stripped. Damage by this insect is unusual and ordinarily accomplished before the grower becomes aware of its presence.

Periodical Cicada.

Brood No. VI of the periodical cicada which is listed as occurring in small numbers in the State was represented by very small numbers, specimens being taken at Cranford, Upper Monclair, Oak Ridge and Princeton.

Pitted Ambrosia Beetle.

(*Corthylus punctalissimus* Zimm.)

This ambrosia beetle, which has been recorded from Eagle Rock and Cape May County, being taken at the later place in the roots of huckleberries has this year been found by Mr. Weiss in rhododendrons *Kalmia latifolia* and *Azalea mollis* at Somerville.

The work of the insect is indicated by a yellowing of the leaves. The yellowed leaves wilt and drop off the plant. The dead stems break off near the surface of the ground where the tunnelling occurs.

This beetle's attacks appear to be confined to shaded localities where there is an abundance of mulch. The species is known to attack sugar maple, sassafras, dogwood, hazel, huckleberry, water beech, ironwood and rhododendrons.

The only remedy seems to be that of cutting and burning the infested stems taking care to see that the whole stem is secured and a part not left in the ground.

Miscellaneous.

To a certain extent the tabulated list of insect correspondence seems to give a notion of the miscellaneous species. Many species, however, do a type of work which is so common in character or so small in amount that no one will write in concerning it. The list which follows is based on direct observation both of the writer and Mr. Harry B. Weiss.

Tetranychus bimaculatus, Harvey, the red spider was scarce, probably because extraordinary amount of rainfall.

Eulecanium tulipiferae Cook, the tulip soft scale, seems to be decreasing, being less abundant this year than last.

Lepidosaphes ulmi Linn., the oyster shell scale has continued to increase, especially in the nurseries where it was found on cornus, snowberry and spirea as well as its usual food plants.

Leptobyrsa explanata Heid., the rhododendron lace bug, was plentiful on rhododendrons throughout the State. A related species was taken at Palmyra, Arlington, Rutherford and Nutley. It has not yet been determined.

Phenacoccus acericola King, the maple false scale, has been scarce during the present season.

Pulvinaria innumerabilis Rathv., the cottony maple scale was rarely seen.

Toumeyella pini King, a species of scale new to New Jersey, was found on pine in the woods at Asbury Park on July 26th, seriously damaging a few trees. The needles badly infested by the scale drop off.

Trioza tripunctata Fitch, the bramble flea louse, was found on July 7th seriously damaging blackberries of black diamond variety at Cologne and Hammonton.

Galerucella luteola Mull., the elm leaf beetle was seen at Plainfield, July 14th, Princeton July 12th, Rahway July 13th, Summit June 21st, and Hackettstown July 6th. The damage in most cases was slight but the species was generally present.

Gastroidea cyanea Mels., one of the leaf beetles, has this year been on the increase on poplar and willow at Rutherford, Irvington and other points in North Jersey.

Molasoma scripta Fabr., a leaf beetle on poplar was found July 23rd and later at Merchantville, Pensauken, Camden, Rutherford and Bridgeton.

Saperda candida Fabr., the round headed apple tree borer, was taken in small numbers in an orchard at Freehold on June 24th.

Trichobaris trinotata Say, potato stalk borer, was reported by Benj. Barrett as injuring tomatoes.

Alypia octomaculata Fabr., was numerous on grape vines at Secaucus, Homestead and Jersey City.

Anisota senatoria Sm. & Abb., occurred in small numbers on oak in South Jersey.

Hemileuca maia Dru., was seen in large numbers on oak at Alloway, May 31st.

Ceratomia catalpa Bdv., the catalpa sphinx, has been fairly abundant. This species was chiefly interesting because it seemed almost totally free from parasitism.

Crambus vulvivagellus Clem., corn-root web-worm, was found at work on July 15th at Oak Ridge. The infested land had been in sod for several years just preceding the planting of corn. Similar conditions obtained on a farm near Newton.

Macronoctua onusta Grt., was found rarely this season.

Rhagoletis pomonella Walsh, the apple maggot, was observed on the farm of Mr. Harold Hornor at Mount Holly. The infestation was sligbt.

IV.

INVESTIGATIONS.

Mushroom Spring-tail.

Early in December, 1914, our attention was called to trouble Mr. Jacobi of Irvington was having with the mushroom spring-tail (*Achoreutes armatum* Nicolet et al.), and were requested to see what could be done towards remedying the condition.

Although the best way of avoiding the work of the insect is found in the practice of sterilizing the soil and manure and the securing of clean spawn, the fact that the insect was already establisbed in made-up beds and likely to do much harm, led us to try out a soil treatment with carbon bisulphide.

On December 12th a preliminary experiment was set by the writer on a badly infested bed. Two of the plots were approximately a square yard each and the otber about 4 square feet. The small plot was designated as A and bad numerous mushrooms on its surface; the others designated as B and C respectively showed no growth above the soil.

Plot A was treated with the carbon bisulphide at the rate of 1 ounce to the cubic foot. Holes 2½ inches deep were made at points 12 in. apart and the liquid poured into eacb of tbem closing eacb as soon as its charge was introduced.

Plot B was treated with carhon bisulphide at the rate of 1/2 ounce to the cubic foot and plot C with 1 ounce to the cubic foot.

Check plots were interpolated between the treatments.

The temperature of the air in this cellar ranged from 50 to 55°F and the moisture of the soil was high.

On December 14th the treatments were examined by Mr. Richardson with the following results:

Plot A. All spring-tails dead; mushrooms softened.

Check between A & B. All spring-tails alive.

Plot B. All spring-tails dead.

Check between B & C. All spring-tails alive.

Plot C. All spring-tails dead.

On December 18th the treatments were again examined and with the following results:

Plot A. All spring-tails dead; no mushroom growth; cellar 45°F.

Check, all spring-tails alive; no mushroom growth.

Plot B. All spring-tails dead; no mushroom growth.

Check, all spring-tails alive; no mushroom growth.

Plot C. All spring-tails dead; no mushrooms.

On December 21st the treatments were again examined and with the following results:

Plot A.	Not examined for spring-tails;	no mushrooms.
Check	" " " "	two "
Plot B.	Spring-tails all dead;	three "
Check,	not examined for spring-tails;	two "
Plot C	" " " "	no "
Check between C and the wall		no "

Thus it appeared that 1/2 ounce of carbon bisulphide to the cubic foot kills the spring-tails and does not damage the mushrooms. It also appeared that 1 ounce to the cubic foot is injurious to the mushrooms.

The examination of the 14th served to demonstrate that the minimum dosage for the spring-tail had not been found. Accordingly a new set of experiments was set by Mr. Richardson on December 15th. Three plots, each 7.7 square feet, were treated, the first with 1 ounce to the cubic foot, the second with 1/2 ounce to the cubic foot, the third with 1/4 ounce to the cubic foot, the fourth with 1/8 of an ounce, and the fifth with 1/10 of an ounce. A check plot was interpolated between each pair of treated plots. The carbon bisulphide was placed in holes 5 to 7 inches deep. The plots were examined on December 16th with the following results:

Plot No. 1.	All spring-tails	dead.
Check No. 1.	" "	alive.
Plot No. 2.	" "	dead.
Check No. 2.	" "	alive.

Plot No. 3. Many spring-tails dead in compost; many alive in surface soil; not as many present as in Plot No. 2.

Check No. 3. All spring-tails alive.

Plot No. 4. Some spring-tails dead in compost; some alive in surface soil.

Check No. 4. All spring-tails alive.

Plot No. 5. Some dead; some alive.

Check No. 5. All alive.

On December 18th the treatments were again examined, and with the following results:

Plot No. 1.	All spring-tails	dead;	no	mushroom growth.	
Check No. 1.	" "	alive;	"	" "	
Plot No. 2.	" "	dead;	4	"	to the sq. ft.
Check No. 2.	" "	alive;	5-1/2	"	" " " "
Plot No. 3.	" "	dead;	1	"	" " " "
Check No. 3.	" "	alive;	1/2	"	" " " "
Plot No. 4.	" "	"	7	"	" " " "
Check No. 4.	" "	"	4	"	" " " "

Plot No. 5. Some alive; some dead; no mushrooms.

Check No. 5. All alive; 2-1/2 mushrooms to the sq. ft.

On December 21st the following results were obtained:

Plot No. 1.	5	mushrooms to the sq. ft.
Check No. 1.	2	" " " " "
Plot No. 2.	6	" " " " "
Check No. 2.	12	" " " " "
Plot No. 3.	0	" " " " "
Check No. 3.	7	" " " " "
Plot No. 4.	8	" " " " "
Check No. 4.	11-1/2	" " " " "
Plot No. 5.	1	" " " " "
Check No. 5.	7-1/2	" " " " "

On December 26th the following results were obtained:

Plot No. 1.	6	mushrooms to the sq. ft.
Check No. 1.	4-1/2	" " " " "
Plot No. 2.	3	" " " " "
Check No. 2.	15	" " " " "
Plot No. 3.	2	" " " " "
Check No. 3.	26	" " " " "
Plot No. 4.	12	" " " " "
Check No. 4.	20	" " " " "
Plot No. 5.	5	" " " " "
Check No. 5.	25	" " " " "

Desiring further evidence of the effect of treatment on mushrooms above the surface, a small bed covered with growing stock was treated in the usual way with 1/2 ounce to the cubic foot. The mushrooms were softened and practically ruined.

Desiring a notion of the soil temperature, tests were made with the following results:

Dec. 15th	2.15 P.M.	52.7°F and 52.5°F.
	5.00 P.M.	53.6°F and 52.7°F.
Dec. 16th	8.30 A.M.	52.7°F and 53.6°F.
	9.40 A.M.	51.8°F and 52.7°F.

It thus appears that while carbon bisulphide offers a ready means of destroying the mushroom spring-tails, its use is attended with such serious injury to the mushrooms that it cannot be considered as a remedy.

White Grub Remedies.

The problem of controlling white grubs has been mainly attacked from the standpoint of a field crop pest and comparatively little has been done with it as a garden, lawn and golf green problem. Yet in this guise the insect has recently done more damage and occasioned more complaint than it has as a field pest.

The measures of control as set forth in Circular No. 26 of the Experiment Station seem satisfactory from the standpoint of field crops, but without doubt leave much to be desired for protection of gardens, lawns and golf greens.

With the purpose of devising some practicable method of meeting this phase of the problem a study of soil disinfection has been undertaken.

At the outset it was plain that a study of soil treatment would have to take into consideration the minimum dosage for each particular insect form, the maximum dosage for the useful organisms growing in and on the soil, and the relation of these dosages to soil texture, chemistry, temperature and moisture.

Carbon bisulphide, having been extensively considered in Europe, occurred to us as the substance that should be first examined. Accordingly an effort was made to determine roughly the minimum dosage in the red shale soil common at New Brunswick.

Three areas were laid out in a garden on red shale soil where grubs of *Lachonsterna fusca* Froehl. had been abundant all summer. Plot No. 1 contained 18 square feet and later counts showed grubs at the rate of 1 to each 2.5 square feet. Plot No. 2 contained 80 square feet and showed grubs at the rate of 1 to each 2.5 square feet. Plot No. 3 contained 27 square feet, showed grubs at the rate of 1 to each 2.7 square feet. The temperature of the soil at a point three inches below the surface at mid-day averaged about 76°F throughout the first five or six days of the experiment. The soil was just moist enough for good working, not wet enough to ball and not dry enough to clod. Plot No. 1 received 1 ounce of carbon bisulphide per square foot. Holes 3 inches deep were made at points 12 inches apart throughout the plot and 1 ounce of the fluid poured carefully into each hole, which was at once closed by pressing the heel upon it. Plot No. 2 received 7 c. c. of liquid per square foot applied in the same way. Plot No. 3 received 15 c. c. per square foot applied in the same way. The application was made in the afternoon of September 6th, 1915.

On September 11th the whole of plot No. 1 was dug up and seven dead grubs were found. A part of plot No. 2, amounting to 32.25 square feet, was examined and seventeen grubs were found eleven of which were alive. On September 25th the balance of plot No. 2, amounting to 47.75 square feet, was examined and sixteen grubs, thirteen of which were alive were found. Plot No. 3 was also examined on this date and eight grubs, two of which were alive were found.

It thus seems that the minimum dosage for the conditions under which the test was carried out was not far from 3/4 of an ounce to the square foot.

As the growing season was drawing to a close and the experiments must soon be transferred to the laboratory it seemed well to see how the same charge would under outdoor conditions affect the plants which had suffered so much from the ravages of the grubs. Accordingly three areas, each one square yard in extent, were laid off in the yard within fifty feet of the other plots. A mixture of first year blue grass and white clover formed a vigorous sod over these plots. The soil was identical with that of the garden with only such difference as the surface cultivation of a garden through the growing season could produce. The temperature three inches below the surface averaged about 70°F for the first ten days of the experiment. The soil moisture was approximately the same as in the other experiment, perhaps a little greater. The experiment was set September 27th, 1915.

Plot No. 1 received 1 ounce of the carbon bisulphide per square foot applied as outlined in the previous experiment. Plot No. 2 received 15 c. c. per square foot and plot No. 3, 7 c. c. per square foot.

Up to November 1st there was no trace of injury to either the blue grass or the clover on any of the plots. It seems, therefore, that the minimum dosage for the grub is probably well below the maximum dosage for the blue grass and white clover.

Rosebug Remedies.

The rosebugs appeared in Mr. John H. Barclay's young apple orchard in sufficient numbers to threaten defoliation of the Duchess variety. This peculiar varietal preference, which has been mentioned under the heading "Insects of the Year" has been characteristic of rosebug injury at Mr. Barclay's place for the last four or five outbreaks.

The abundance of the bugs and the willingness of Mr. Barclay to cooperate offered a good opportunity to test out some measures of control. Accordingly it was planned to test a new mixture (consisting of 16 pounds of whale oil soap, 1 pint of crude carbolic acid in 100 gallons of water), powdered arsenate of lead and sulphur (made up in proportions in one case 1 part to 1 part and in the other one part of lead arsenate to 5 parts of sulphur), commercial lime sulphur plus arsenate of lead, and self-boiled lime-sulphur plus arsenate of lead.

The tree rows extended east and west and this infestation came in from the western end and progressed eastward. Beginning at the western end of a Duchess row on June 16th, the first tree was coated with powdered arsenate of lead and sulphur (1 to 1) the second tree with the carbolic-whale-oil-soap mixture, the third with powdered arsenate of lead and sulphur (1 to 5), the fourth with powdered arsenate of lead and sulphur (1 to 1), the fifth with carbolic-acid-whale-oil-soap mixture, the sixth (another variety, Stayman Winesap) untreated, the seventh with powdered arsenate of lead and sulphur (1 to 5) and the balance of the row with carbolic acid-whale-oil-soap mixture. The east half of two Duchess rows on the north side of the orchard were sprayed with self-boiled lime-sulphur to which arsenate of lead had been added at the rate of 2 pounds to 50 gallons. The west half of the same two rows were treated with commercial lime-sulphur to which arsenate of lead had been added at the rate of 2 pounds to 50 gallons. The lime-sulphurs had been applied on June 15th.

On June 16th the trees were kept under observation for two hours. The powdered lead and sulphur treatment showed no effect except that perhaps a few more beetles were found on the ground than under the untreated trees. The carbolic-acid-whale-oil-soap mixture knocked about 50 per cent of the beetles off the trees, seemed partly to paralyze many, and to kill some. After the first few minutes the mortality did not seem to increase and in fact of the 10 paralyzed beetles which were placed in a paste-board box and carried to the laboratory, not one died.

The trees treated with the self-boiled and commercial lime-sulphurs showed a few bugs, nothing like the numbers on the untreated trees. There were decidedly fewer bugs and absolutely no new feeding on the trees treated with the former.

On June 17th Mr. Richardson examined the conditions at the Barclay orchard and found them as follows:

Tree No. 1. Powdered lead arsenate and sulphur (1 to 1), 55 dead beetles under the tree; many beetles on the tree, some of which were feeding.

Tree No. 2. Carbolic-acid-whale-oil-soap mixture, 6 dead beetles under the tree; same conditions on tree as in No. 1.

Tree No. 3. Powdered lead arsenate and sulphur (1 to 5), none dead under the tree; same conditions on tree as in No. 1.

Tree No. 4. Powdered lead arsenate and sulphur (1 to 1), 11 dead beetles under tree, fewer beetles and less feeding than in 1, 2, or 3; not perfect control however.

Tree No. 5. Carholic-acid-whale-oil-soap mixture, 2 dead beetles under tree; beetles on tree about as No. 1.

Tree No. 6. Other variety, (Stayman Winesap), no treatment. Only one beetle found on this tree; no signs of feeding; leaves are stiffer than those of Duchess variety.

Tree No. 7. Powdered lead arsenate and sulphur (1 to 5), no dead beetles under tree; fewer beetles, and less fresh feeding than in No. 1; not perfect control however.

Trees 8 and so on to end of row, carbolic-acid-whale-oil-soap mixture.

Practically no dead beetles under trees, many beetles on trees but not as many as at west end of orchard; considerable fresh feeding; odor of soap still strong.

Trees treated with commercial lime-sulphur plus arsenate of lead average 5 to 6 dead beetles under each tree; not as many beetles or anything like the amount of fresh feeding found on trees of plots 1, 2, 3, 4, 5, 7, and 8.

Trees treated with self-boiled lime-sulphur and arsenate of lead; no dead beetles under tree; few beetles on trees; no fresh feeding.

All later observations served only to confirm the evidence gathered on the 17th that of all treatments used the self-boiled lime-sulphur plus lead arsenate was most effective, giving in fact almost perfect protection. In view of the fact that no dead beetles were found under the trees treated with self-boiled lime-sulphur, it seems likely that the mixture acted purely as a repellent and that the lead arsenate had little or nothing to do with the result.

Potato Flee Beetle.

The prevalent species this year was *Epitrix cucumeris* Harris., and its abundance was much greater than usual, attacking seriously both potato and tomato.

The mixture recommended by Mr. Cameron[1] consisting of one pound of pyrethrum, 10 gallons of water with enough soap to insure that a film of the spray will adhere to the leaves after spraying, was given a field trial. When the early planted potatoes on Mr. J. Harry Kandle's place were about four inches high they were heavily infested with the flea beetle. Two rows were sprayed with a mixture composed of 1 pound of pyrethrum, 10 ounces of whale oil soap and 10 gallons of water and two other rows with a combination of 10 ounces of whale oil soap and 10 gallons of water. The mixtures were applied under a pressure of about 100 pounds and about 100 gallons per acre were used.

The potatoes treated with pyrethrum, soap and water were freed from beetles and kept free for fully ten days, and exhibited no traces of spraying injury. The potatoes treated with the soap and water alone were freed from the beetles for a very short time and were stunted. By the former large numbers of the insects were destroyed; by the latter very few were killed.

Although the pyrethrum, soap and water mixture was effective the cost of the operation is practically prohibitive. Pyrethrum costs under present conditions 50 cents a pound at retail, which means about five dollars an acre for 10 days' protection.

The tests with Bordeaux mixture on a field scale showed this year as last a 50 per cent reduction of the beetles' work on plants given four treatments with home-mixed 5-5-50 Bordeaux. The protection afforded by Bordeaux was better than that given by the dust mixture, apparently because of its greater adhesiveness and consequent longer period of repellency.

Strawberry Weevil.

The life history, habits and methods of controlling this insect are set forth in New Jersey Bulletin No. 225 and no attempt will be made to review them in this account. The past season has brought out what appears to be a new method of hibernating. Many of the patches in southern New Jersey lie adjacent to woodlands in which popular opinion says that the beetles pass the winter. In company with Mr. Elwood Douglass on August 12th the writer searched the field in which the studies had been made when the weevils were very abundant and was unable in the course of an hour to find any traces of them. Examination of the golden rod blooming along the edge of an adjacent woodland revealed a few specimens at work on the blossoms. Search of the woodland itself was then undertaken. The forest floor was examined leaf by leaf, needle by needle, and stick by stick without finding a trace of the insect. The patches of moss growing on the soil about the bases of the tree trunks and scattered over the soil between were then examined. Here on the moss stems, about 1/4 of an inch below the summits, the beetles were found in abundance indicating that this type of wintering place was preferred to that which lies prone. The species of moss thus being utilized for winter quarters proved to be *Dicranum scoparium* (L)

[1] N. J. Station Report for 1[illegible], pp. 377-378.

Hedw. There is a curious and interesting resemblance between the place selected by this insect for winter quarters and that used by the chinch bugs on the plains. The close standing stems of the moss like those of the bunch grass serve to prevent the insects from experiencing the large changes of temperature which take place in unprotected places. The upstanding stems of the moss, again like those of the bunch grass, enable the insect by moving up and down to regulate at least to some degree its relation to soil moisture. Approximately every two weeks since the beetles were found in the moss they have been examined. No changes have taken place except that they seem slowly to be migrating down the stems.

A study of the methods of control was undertaken because many of the growers were losing about 50 per cent of the buds and none of the measures of control usually advocated appealed to them as practicable. A summary of the measures of control hitherto proposed shows that the methods fall into three groups: first, measures intended to prevent the insect from reaching the plants to be protected; second, measures intended to render the protected plants distasteful; third, measures intended to destroy the insect.

Under the first head comes the practice of covering the beds with muslin or other similar material; a proceeding which is practicable in a garden but hardly to be considered on a field scale. Cultivating pistillate varieties is a most effective method of circumventing the pest but one which has few followers because the berries produced by such varieties are thought not to meet the market conditions well. The planting of profusely blooming varieties is not adopted by the growers because the varieties in question are not thought to equal in returns the ones now in use.

Trap crops in this as in most insect problems is largely an impracticable solution because of the additional labor involved all of which a change in the weather or the increase of the weevil's natural enemies may set at naught.

Under the second head come various sprays and dusts such as crude carbolic acid, Bordeaux mixture, lime, ashes, etc. None of these substances or any others tried appear to afford a really satisfactory degree of protection.

Under the third head are included the arsenical treatments. In the season of 1913 several growers were advised that it might be worth while to try the arsenate of lead applying it thoroughly with an undershot nozzle, just before the buds opened. Satisfactory control by this means was not obtained.

The damage done by the strawberry weevil is practically all accomplished between the opening of the earliest buds and the opening of the latest and the problem of its control is thereby limited to preventing its work during that period which is between two and three weeks in extent. If a treatment could be found by means of which the plants could be protected either by destroying the beetles or repelling them during this period the problem of preventing serious harm to the strawberry crop would be solved. The experiments of 1915 were laid out with a view to finding this type of remedy.

The fact that Cameron[1] had been able to destroy the potato flea beetle (*Epitrix cucumeris* Harr.) with a mixture of pyrethrum, soap and water, lead us to include this mixture among those to be tested. The recent development in the production of exceedingly finely divided dry arsenate of lead and sulphur led to a test of them alone and in combination. The well known repellent and insecticidal action of tobacco dust and decoction led us to include tests of these substances. For the sake of comparison powdered lime and powdered arsenite of zinc and arsenate of lead spray were included.

The place selected for the work was a three- to four-acre sand field on the farm of Mr. Oeser—near Cologne. A woodland bordered the southern and western aspects. All of the work was done on Heritage and the limited number of rows prevented the interpolation of checks.

The northeast corner of the field was set aside for experimental work and the blocks were outlined as shown in the following diagram. The standard length of block was 40 feet. It was planned to start the treatments as soon as the beetles began to work and to maintain the coating until the maximum bloom was past.

Table of Treatments and Results.

Plot No.	Treatment.		Percentage of Buds Cut		Effects in Plants.
	Nature.	Dates of	5/5, 1915.	5/14, 1915	
Check at beginning	Nothing........	....	20	48	
1	Whale oil soap and water, 1 oz. to 1 gal..........	4/30	6	52	Scorched slightly.
2	Whale oil soap (10 oz.) Pyrethrum (1 lb.) and water (10 gals.)	4/27	6	42	Scorched slightly.
3	Arsenate of lead (3 lbs.) and water (50 gals.)........	4/28	10	25	None.
4	Arsenate of lead (1 lb.) and sulphur (1 lb.) dust........	4/30, 5/6.	7	8	None.
5	Arsenate of lead (1 lb.) and sulphur (5 lbs.) dust........	4/28, 5/6	6	12	None.
6	Home-mixed Bordeaux (5–5–50).	4/28	20	49	None.
7	Tobacco dust........	4/30	12	51	None.
8	Powdered arsenate of lead........	4/30, 5/6	7	19	None.
9	Powdered arsen te of zinc........	4/30	Badly	burned.	Burned bad'y.
10	Hydrated lime........	4/30, 5/6	7	41	None.
11	Whale oil soap (500 ozs.) black leaf 40 (1 gal.) aud water (500 gals.)........	4/30	6	42	Scorched slightly.
12	Dry pryethrum........	4/30.....	11	41	None.
13	Pyrethrum (1 lb.) whale oil soap (10 oz.) and water 10 gals.....	4/30	14	53	Scorched slightly
Check at end	Nothing........	....	38	60	.

[1]Report N. J. Agl. Expt. Sta., pp. 378-380, 1914.

Limited application of the two mixtures of arsenate of lead and sulphur made on May 18th when the strawberries were in full bloom did not apparently injure the open blossoms.

The field was selected and the plan of work laid out before the buds were showing at all. Owing to a brief illness and consequent pressure of routine duties the writer was unable to reach the field again until some of the first blossoms were beginning to open. At this time (April 27th) the beetles were present everywhere throughout the field, but were markedly more numerous as the woodland to the south was approached.

The whale oil soap, whale oil soap and pyrethrum, "Blackleaf 40," and whale oil soap having scorched the plants were not repeated. The arsenite of zinc burned the plants badly and was discontinued. The arsenate of lead in water, pyrethrum, Bordeaux, tobacco dust, having proven relatively ineffective were not repeated. The powdered arsenate of lead and sulphur combinations, the powdered arsenate of lead and the hydrated lime having been found to give good protection between April 30th and May 5th were repeated on May 6th.

Thus it appears that the mixture of powdered arsenate of lead and sulphur gave better protection than any substances tried and that the mixture composed of one part of lead to one part of sulphur is a little the more effective.

In view of this fact that neither the mixture containing the largest amount of sulphur nor the pure lead gave so good results as the mixturo which had a smaller amount of sulphur it is obvious that it is neither the arsenate of lead alone nor the sulphur by itself which is effective but the mixture of the two.

When the plants reached maximum bloom the effect of the successful treatments was very marked, the successfully treated blocks being as white as snow while the checks were green with a sprinkling of blossoms.

There can be no question as to the effectiveness of this year's treatments. Whether these results can be duplicated next year remains to be seen.

Anti-Peach-Borer Coatings.

Thus far in the study of the peach borer all the really promising measures of control have been concerued with an effort to prevent the larvæ from gainiug an entrance to the tree or to destroy it after it has entered.

Extensive studies of coatings to prevent the larvæ from entering the tree have been made by Peters[1], Smith[2], Slingerland[3], Cory[4],and others. The upshot of the whole effort seems to have been that while many of the coatings do not hurt the trees and do reduce the borers, none of them are entirely effective.

[1]Memoirs Phila. Soc. Prom. Agr. 1, pp 15-19, 1908.
[2]N. J. Sta. Bull. 128, 1898.
[3]N. Y. Cornell Station, Bull. 176, 1899.
[4]Maryland Station Bull. 176, 1913.

Of all the agents used for destroying the larvæ after it has entered the tree the knife and wire have proven the most effective and are the dependence of the most successful peach growers at the present time.

The insistent demand for methods of control whereby the injury done by the borer before it can be killed and removed may be prevented, has lead us in spite of the failures of the past to see what could be done towards developing a method of preventing the larvæ from entering.

A number of the more promising substances were experimented with, tanglefoot, white wash (government formula), Borowax, sulfocide, white lead and pure linseed oil, concentrated lime and sulphur, and asphaltum of both soft and hard grades.

The test with tanglefoot began in 1912 and covered a period of two years. The first year it greatly reduced the number of borers and did not apparently injure the trees. The second year of test on the same tree, it again reduced the borers but killed some of the trees and seriously injured more.

The test with white wash began in 1913 covered two years and reduced the borers without injuring the tree. The test with Borowax began in 1912 and covered three years. The first year it reduced the borers but seriously injured the trees to which it had been applied as a coating. The second and third year it was applied as a collar about the base of the tree and reduced the borers without injuring the tree. The test with sulfocide began in 1913, covered two years and reduced the borers very slightly without injuring the trees. The test with white lead and pure linseed oil began in 1913, covered two years and reduced the borers without injuring the trees.

The test with winter-strength lime sulphur began in 1913 covered two years and reduced the borers without injuring the trees. The test with asphaltum began in 1913 covered two years and reduced the borers without injuring the trees.

Thus it appears that this work has simply confirmed that of previous years—that there are many coatings which reduce the borers without injuring the tree, but that none of them absolutely or even approximately prevented infestation. Naturally of course, the question is "Why do they not prevent?" Here again our experience is quite in accord with that of other observers that these coatings do not prevent because they are not sufficiently complete.

All lack completeness within the limits of the coating itself, that is, uncovered spots exist as the result of imperfect application or weathering. The coatings made with a soft grade of asphalt when applied with care appeared to show no uncovered spots but allowed them to appear as the result of the first season's weathering. In the trials of 1913 and 1914 the material was applied with a brush or a paddle and the obtaining of a complete coating seemed difficult, but in 1915 a method of pouring the coating was devised and it was found easy to make it complete.

Matters were at this point when Blakeslee and Scott came out with their card collar protectors. Both described their protectors before the

27th annual meeting (1914-1915) of the American Association of Economic *Entomologists*, and the pieces of apparatus by means of which they proposed to prevent the entrance of the borer were practically identical.

Essentially the method consisted in the placing of a wide paper or fiber collar about the base of the trees having first mounded the soil about the trunk to serve as a support, and cementing it firmly to the *tree in such a fashion that the larvæ have to crawl over and under the* outer rim before reaching the trunk of the tree below the coating. The theory seems to have been that the larvæ would not have strength enough to make this long journey successfully.

A test of these protectors as compared with asphalt coatings was *planned and executed by Mr. Harry B. Weiss and the writer.* Cards were purchased from Scott together with a couple of gallons of sealing material. Three different orchards were selected—two on very sandy soil near South Amboy and one on considerably heavier soil near Middletown. The first orchard at South Amboy consisted of young peach trees averaging about 2 1/2 inches in diameter and the second of peach trees about 5 to 6 inches through. The orchard at Middletown was composed of peach trees 6 inches or more in diameter. On June 17th and 18th the Scott Protector of proper size was applied according to directions to 32 of the five- to six-inch trees at South Amboy. On the same date the Scott cards were applied to 19 of the two and one half-inch trees. On June 24th the Scott protectors were placed on 20 of the six-inch trees at Middletown.

At South Amboy three types of soft asphaltum coatings were used, the first of which was simply a two and one-half to three-inch plate or collar poured on the soil about the base of the tree, the second a coating starting 6 to 8 inches above the soil and extending downward to the surface where it spread out as a collar 2½ to 3 inches wide, the third a coating beginning 6 to 8 inches above the surface of the soil and extending down to the points where the first large roots came off and then spreading out to form a two and one-half to three inch-wide collar. The asphalt treatments were limited to the two and one-half inch trees.

A check stood beside every treated row and where possible a check row on each side of the treated row was secured.

The summer rains were heavy and the winds strong. The soil was washed and the trees were whipped about. In the young orchard great cavities were found about the bases of many of the trees.

The trees at South Amboy were wormed on November 4th and November 5th by Mr. Weiss with the following results.

"Larvæ were one-eighth to three-quarters of an inch long, the majority measuring one-half an inch or less. Many of the protectors have broken loose and slid down the trunk. Others are twisted. Some have flattened out following the washing away of the supporting soil. Only one was perfectly sealed at time of worming. The few cards which were sealed with soft asphaltum showed imperfections. Sealing materials sticks to the tree but not to the protector. Many of the flaps are open. Under each protector on the young trees there is a cavity around the trunk due to swaying. No larvæ are found above the protector. All are below, some just under and others five, six, seven and eight inches below. Soil under the protectors and close to the trunk is dry. In a grassy orchard this would make an ideal condition for field mice.

"In the old orchard the protectors have stood up better. There is no cavity about the trees such as found about the young trees. Many breaks occur in the sealing material and borers have entered through them. Flaps have stuck imperfectly. Under protectors were found a nest of field mice, colonies of sow bugs, crickets, ground beetles, cocoons, angleworms, and empty peach borer cocoons. One tree here was found perfectly sealed and no borers were discovered in it.

"The row treated with asphalt coating and surface collar showed two trees on which the collar and coating were in good condition. Coatings on many of the trees have weathered badly. Lenticels show through. Some of the collars have broken away and slipped down. Many borers have entered breaks in asphalt above the collar and at the collar where it has broken loose.

"The row treated with the asphalt collar showed only the collar slipped down or broken away and largely covered up with sand.

"The row treated with a coating and below-ground collar showed most of the borers above the ring where it had broken away from the coating. Borers also entered lenticles where the same had broken through the asphalt coating."

At Middletown the trees were wormed on November 10th and the following notes were taken.

"Protectors are in good shape as far as form is concerned. Much grass is around them. Everyone is imperfectly sealed, especially about the flap. Sealing material failed to hold the cards close to the trunk. This orchard has been regularly wormed by the owner for years."

Place.	Character of protector.	Time of placing—worming.		Number of trees.	Average number of borers per tree.	Reductions in average number per tree.
S. Amboy young orchard	Scott Protector	6/17 & 18	11/4 & 5	19	3.3	.7
"	None	"	"	19	4.0	......
"	Asphalt coating and surface collar	"	"	18	2.4	......
"	None	"	"	19	4.2	1.8
"	Surface collar of asphalt	"	"	19	2.4	4.8
"	None	"	"	17	7.2	......
"	Asphalt coating with below ground collar	"	"	13	4.3	2.9
S. Amboy old orchard	Scott protector	"	"	32	7.5	5.5
"	None	"	"	11	13.	......
Middletown	Scott protector	6/24	11/10	20	1.5	4.8
"	None	"	"	14	6.3	......

It thus appears that neither the Scott protectors nor the asphalt coatings give satisfactory protection, and that result is due to incompleteness of the covering.

Effect of Moisture Upon Lethal High Temperature.

The work of Goodwin[1] has shown that moisture in the form of relative humidity of the air influences the temperature, at which insects succumb, only to a slight extent. He shows that moist heat kills the rice weevil (*Calandra oryzae* L.) at from 3°C. to 4°C. lower than dry heat, that as a rule the difference between the lethal temperature with moist and with dry heat is much less, and that the Indian meal moth (*Plodia interpunctella* Hbn.) succumbs somewhat more readily to dry heat than to moist heat.

The maximum difference between dry and moist heat appears to have been about 50 per cent, which is probably but not necessarily as large as would obtain in practical work of utilizing heat as an insecticide. Furthermore, it occurred to the writer, that the introduction of seeds, which seems a perfectly practical proceeding, into an already heated chamber with the consequent sudden rise of temperature might give different results.

As the opportunity has arisen in connection with other studies, a series of tests with the bean weevil (*Bruchus obtectus* Say.) supplemented with a few experiments on the pea weevil (*B. pisorum* Say.) have been made. In general the plan has been (1) to determine the lethal temperature by heating different stages of the insect on a water bath until death resulted, consuming not more than ten minutes in the rise of temperature from that of room 70°F. to 80°F. to the lethal degree, without regard to factors other than temperature; (2) to standardize the temperature and moisture in the incubators using about the lethal temperature in both instruments and saturation in one chamber and the lowest possible relative humidity in the other; (3) to introduce into each incubator wire cages containing as many individuals of the stage being studied as possible; (4) to remove a wire cage from each incubator at half hour intervals thereafter. The air taken from outside the building for each machine was drawn through the incubators at the rate of approximately 1 liter per minute. The water used for saturating was distilled.

In the case of the bean weevil, twelve adults were subjected to a rapidly rising temperature. Signs of heat rigor appeared at 104°F. (40°C.) and all were dead at 122°F. (50°C.). The experiment with many more specimens was reported with the same results. Putting the matter more in detail we may summarize the first experiment by saying that four died at 104°F. (40°C.) three more at 113°F. (45°C.) three more at 117.5°F. (47.5°C.) and two more at 122°F. (50°C.).

In the case of the weevil inside the bean, two lots of beans, composed of twenty-five each, were subjected to 125°F. (37.40°C.) with no mortality in larvæ, pupæ or adults. A lot of 25 was subjected to 135°F. (43°C.) with

[1]Journal of Economic Entomology, Vol. 7, pp. 313-322.

a 100 per cent killed of stages above mentioned. A lot subjected to 140°F. (45.7°C.) showed all infestation dead.

Test of the Adult Weevils.

Date.	Time exposed.	Temperature.	Relative humidity.	Number living.	Number dead.
July 15, '15.	30 min.	125°F.	8%	10	0
	60 min	"	7%	0	10
	1½ hours.	"	6%	0	10
	2 hours.	"	6%	0	10
	30 min.	"	100%	10	0
	60 min	"	"	0	10
	1½ hours.	"	"	0	10
	2 hours.	"	"	0	10

Test of Larvae, Pupae, and Adults.

Date.	Time exposed.	Temperature.	Relative humidity.	Number of larvæ alive–	dead	Number of pupæ alive–	dead	Number o adults alive–	dead
July 16,'15	30 min	135°F	6%		all		all		all
	1 hr. to 2½ hrs	"	6%		all		all		
	30 min	"	100%		all		all		
	1 hr to 2½ hrs	"	100%		all		all		
July 21,'15	30 min.	135°F.	4%	all		all			
	1 hr to 2½ hrs	"	4%		all		all		
	30 min.	"	100%	all		all			
	1 hr. to 2½ hrs.	"	100%		all		all		
July 29,'15	½ to 2½ hrs.	130°F.	5%	all		all			
	½ to 2½ hrs.	130°F	100%	all		all			

The first table shows clearly that a difference of from 92 to 94 per cent relative humidity has practically no effect upon the lethal temperature for the unprotected bean weevil. It also indicates that time of exposure is an important factor, but comparing this table with the first item of the next table shows clearly that an increase of 10°F. in the lethal high temperature is quite sufficient to annul the influence of time.

The second table is more complex and requires closer study. The July 16th item indicates that 94 per cent increase in relative humidity has no effect upon the lethal temperature. The July 24th item indicates that time is a consideration. The July 29th item indicates that a drop of 5°F. in the lethal temperature gives complete immunity. Taking the second table as a whole it indicates that large increases in relative humidity—say 94 to 96 per cent—have less influence on the lethal temperature than has a change of 5°F.

Test of the Larvae of the Pea Weevil Inside.

Date	Time exposed.	Temperature.	Relative humidity.	Larvæ dead–	alive.	Remarks.
Aug. 4, '15.	30 min.	135° F.	5.4%	0	9	No pupæ or adults present.
	60 min.	"	5.4%	8	0	
	30 min	"	100%	0	7	
	60 min.	"	100%	0	9	

This table seems to indicate that both time and relative humidity influences the lethal temperature for the pea weevil. As a matter of fact the peas still contained a great deal of moisture and that may have influenced the result.

Potato Dusting and Spraying.

Regular Crop.

This year as last the work of dusting and spraying potatoes, while a cooperative project between the Departments of Plant Pothology and Entomology, has been carried on under the immediate direction of the writer. In this case, however, he was assisted by Mr. H. Clay Lint, Research Fellow in the Department of Plant Patbology, and in view of the large measure of independence accorded to Mr. Lint, the Entomologist has requested him to write up the detailed results and suggested that his report be published as a part of Plant Pathologist's report. Persons who may be interested in the detailed account will find it in that report. The writer purposes merely to set forth certain general phases of this work.

The acreage and distribution of the work this year was slightly less than last, about 18 acres at Freehold, 25 acres at Mt. Holly and 10 acres at Elmer. The cooperation with Mr. Frank Jones of Freehold and Mr. J. Harry Kandle of Elmer was continued while Mr. John Black of Mt. Holly took the place of Mr. Robert Dilatush of Robbinsville.

The plan of work was not materially changed. The experiments were so arranged as to show the relative values of the arsenical dusts and Bordeaux sprays in the control of insects and diseases and in increasing the yields per acre. The work was again organized as a cooperation between certain insecticide, fungicide and spraying-machinery manufacturers and the Experiment Station on the one hand and between the Experiment Station and certain potato growers on the other. The commercial concerns were the Union Sulphur Company, the Corona Chemical Company, the Kil-Tone Company, the Dust Sprayer Manufacturing Company, and the Bateman Manufacturing Company. The Union Sulphur Company furnished the sulphur and made up the dust mixtures. The Corona Chemical Company furnished the arsenate of lead. The Kil-Tone Company furnished the Kil-Tone. At this point it should be said that Mr. F. E. Embree, Manager of the Burlington County Farmers' Exchange, furnished a potato spray called Tonicide, took personal interest in and very materially contributed towards the successful issue of the work at Mt. Holly. The Dust Sprayer Manufacturing Company furnished three dusters. The Bateman Manufacturing Company furnished two new sprayers—one at Freehold and one at Mt. Holly. The Experiment Station furnished the materials for Bordeaux, and put on and carried out the test. The cooperating growers furnished the fields, plants and the labor necessary to make the applications and helped to keep account of the results.

Spraying and dusting started when the potatoes were about six inches high and was continued at intervals of about two weeks until the vines met in the rows and rendered further treatment likely to do more harm than good.

At Freehold the vines grew so rapidly that only three sprayings could be given but at both Mt. Holly and Elmer four applications were made. At Freehold the variety grown was the Giant and at Mt. Holly and Elmer the variety was Cobbler. The mixtures were applied at all places in such a fashion as to give the potato plants as complete a coating as practicable. Approximately 100 gallons of spraying mixture was used in each application for each acre of plants. Approximately 30 pounds of the dust mixture were used on each acre in each application.

These amounts meant: (1) 10 pouuds of copper sulphate, 10 pounds of lime and 6 pounds of lead arsenate (30+ per cent arsenic oxide) for each acre each application of home-mixed Bordeaux; (2) 25 pounds of sulphur and 6 pounds of lead arsenate (30+ per cent arsenic oxide) for each acre each application of powdered sulphur lead; (3) 25 pounds of sulphur and 6 pounds of arsenite of zinc for each acre each application of powdered sulphur zinc; (4) 6 pounds of lead arsenate (30+ per cent arsenic oxide); (5) 20 pounds of Kil-Tone, (6) 20 pounds of Tonicide (7) 2 pounds of Paris Green.

Insofar as practicable a block of potatoes treated as a check was interpolated between each of the treatments. At Freehold the check was Paris green, at Elmer the check was really Bordeaux, and at Mt. Holly the check was arsenate of lead.

Freehold.

Plot Number.	Treatment.	Yields in Bushels per acre. Firsts, Seconds, Totals	Increase over Paris Green.
1 and 7	Bordeaux.	407.75	.26
2, 4, 6, 8, 10, 12	Paris Green	407.49	0.00
3 and 9	Sulphur Zinc	403.00	4.49
5 and 11	Sulphur Lead	429.50	21.75

Elmer.

Plot Number.	Treatment.	Yields in Bushels per acre.			Increase over lead.
		Firsts.	Seconds.	Totals.	
1 and 11	Sulphur Lead.	298.4	67.22	365.62	12.88
2, 6, 8, 12	Bordeaux	323.275	64.075	387.35	8.85
3 and 9	Sulphur Zinc.	338.15	63 775	401.925	23.42
4 and 10	Kil-Tone	328.3	62.835	391.135	12.63
5 and 11	Lead	303.85	74.65	378.50	0.00

Mt. Holly.

Plot Number.	Treatment.	Yields in Bushels per acre.			Increase over lead alone.
		Firsts.	Seconds.	Totals.	
1	Sulphur Lead.	238.68	34.88	273.56	24.96
2	Bordeaux	273.85	32.16	306.01	57.41
3	Sulphur Zinc.	261.51	34.46	295.97	47.37
4	Tonicide.	220.0	34.62	254.62	6.02
5	Lead.	209 95	38.65	248.60	0.00
6	Bordeaux	242.86	27 75	270 61	22.01

The dust distributing machines gave satisfactory service. The "Iron Age" sprayers in use at Freehold and Mt. Holly were very satisfactory, maintaining 100 pounds pressure when covering four rows at a single trip.

Examining the Freehold table shows that the yields of all treatments are very similar, repeating the experience of last year. Examination of the Elmer table shows the same slight variation in yield. Examination of the Mt. Holly table shows an increase for all treatments ranging from 6.02 bushels for "Tonicide" to 57.41 bushels for home-mixed Bordeaux.

All insects except the potato flea beetle were satisfactorily controlled by all treatments.

Some figures on the relative effect of the different dusts and sprays upon flea beetle feeding have been accumulated and are set forth in the following table.

Plant No.	Treatment	Total punctures.	Number of leaves.	Average number of holes per leaf.
1	Sulphur Lead.	47,828	358	183.60
2	Bordeaux.	30,722	353	87.03
3	Sulphur Zinc.	39,665	379	104 65
4	Tonicide.	39,638	336	117.96
5	Lead Arsenate.	44,915	360	124 75
6	Bordeaux.	19,680	262	75.115
7	Paris Green.	74,410	360	206.20

These facts confirm the conclusions reached last year by Mr. Cameron that of all the substances tested Bordeaux gives the best protection and that it eliminates about one-half the usual injury.

When it is understood that the difference in flea beetle control exerted by the different mixtures are about the same in all places it does not seem likely that the difference is adequate to explain the large increases at Mt. Holly. Insect control exerted by the different treatments must therefore, be eliminated as the principal cause of the difference in yield. Likewise because the amount of disease has been inadequate to bring about these differences, diseases must be eliminated in our search for the principal cause. Differences in the soil conditions in different parts of the experimental fields, which are doubtless responsible for small variations in yield will not explain such differences as now found at Mt. Holly. No doubt the slight amount of insect injury, the small amount of plant disease injury, and differences in soil conditions may well serve to explain such variations as were found at Freehold and Elmer, but they are inadequate to account for such variations in yield as are exhibited at Mt. Holly.

It will be remembered that last year the outstanding difference between Elmer and Robbinsville on the one hand which showed large increases in yield in the treated block, and Freehold on the other, which showed only slight increases was the greater yield per acre, the lowest yielding block at Freehold giving 34.93 bushels per acre more than the lowest yielding at Robbinsville and 62.26 bushels more than the lowest at Elmer. It would seem that this difference in favor of Freehold must be due to the better growing conditions with which the potato plant was surrounded or *possibly to the variety (which does not seem likely)*, and Mr. Cameron at the time advanced the idea that the excellent growing conditions at Freehold may have stimulated the plant to such an extent that the simulative effect of the mixture was overcome.

This year the same thing seems to have happened at Elmer, the growing conditions have been so good that the stimulation they afforded the potato plants has overcome the stimulative effect afforded by the mixtures.

In the light of these conclusions—that when extra large yields are obtained, the stimulative effect of Bordeaux is likely to be lost—it is significant to examine the Mt. Holly case. Here the Bordeaux yield is 81.3 bushels an acre less than at Elmer, 101.7 bushels less than at Freehold and the stimulative effects of the spraying and dusting treatments is marked. It seems to be very much as Mr. Jones has summed it up to the writer, "it pays well to spray the roots of the potato."

At the same time we should remember that such growing conditions as were furnished to parts of New Jersey last year are comparatively rare, and that such soil conditions as Mr. Jones has at Freehold are still more rare.

Figures on acre cost of the different dusts and spray depend upon *such variable factors that no really satisfactory notion can be given.* Speaking roughly however, it is safe to say that it will vary from five to ten dollars. There was really very little difference between the cost of dusting and spraying except when an arsenical was used by itself.

For facts regarding the relative values of dusts and sprays attention must this year largely be limited to Mt. Holly. It is there shown that while the returns from sulphur zinc and sulphur lead are not as large as those from home-mixed Bordeaux, they are good.

Second Crop.

After the preceding discussion was written the data from dusting and spraying on second crop of Cobblers on Mr. Kandle's farm came in. Briefly stated, the field consisted of fourteen acres planted with last year's second crop seed which had been kept in cold storage. Although the time of planting extended over a considerable period—July 27th to August 10th—the rate of growth was such that effects of the difference in time of starting were apparently overcome. The following blocks, consisting of more than one-half acre each, were laid off and treated as indicated: Plot No. 1 home-mixed Bordeaux (5-5-50) plus 3 pounds of arsenate of lead (30+ per cent arsenic oxide); Plot No. 2 sulphur (5 lbs.) lead arsenate (1 lb.) (dust); Plot No. 3 lead arsenate (3 lbs. to 50 gals. of water); Plot No. 4 home-mixed Bordeaux; Plot No. 5 sulphur (5 lbs.) zinc arsenite (1 lb.) (dust); Plot No. 6 lead arsenate; Plot No. 7 Bordeaux; Plot No. 8 sulphur lead arsenate; Plot No. 9 lead arsenate; Plot No. 10 Bordeaux; Plot No. 11 sulphur zinc arsenite; Plot No. 12

lead arsenate; Plot No. 13 Bordeaux; Plot No. 14 sulphur lead arsenate.

Three applications of dusting and spraying mixtures were made, the last occurring at a time when the vines were meeting in the rows. The first application came August 23rd, the second September 8th, and the third September 24th. Approximately 100 gallons of spray were used on each acre each application and approximately 30 pounds of dust were used for each acre each treatment.

No insects other than the Colorado potato beetle were present in troublesome numbers and that species succumbed to arsenicals. Early blight was, however, very abundant. The Bordeaux treated plots were much better protected from blight than any other and remained green after the others of similar date of planting were dead.

Plot No.	Treatment.	Bushels per acre.	Increase in bushels per acre over lead arsenate alone
3, 6, 9 and 12	Lead Arsenate	236.75	00.00
4, 7, 10 and 12	Home-mixed Bordeaux	281.34	44.59
8 and 14	Sulphur Lead	227.34	−9 41
5 and 11	Sulphur Zinc	229.13	−7.62

In calculating the results, plots 1 and 2 have been omitted because the Colorado beetle damage before the regular treatments were made was such as materially to affect the yield.

No doubt the substantial increase which followed treatment with Bordeaux mixture was the natural result of its better control of early blight. The differences between the yields from lead sulphur and zinc sulphur on the one hand and lead arsenate alone on the other are easily within the limits of experimental error.

As a matter of fact, Mr. Kandle sold a considerable portion of his second crop at the rate of $1.12 a bushel and could have sold all of it at the same figure if he had cared to do so. In view of the fact that his Bordeaux application cost him about $8.25 an acre his net profit on spraying was in this instance not less than $40 an acre.

REPORT ON MOSQUITO WORK FOR 1915

Report on Mosquito Work for 1915

THOMAS J. HEADLEE.

The attention of the Entomologist and his field assistants has been devoted to forwarding the control of the salt marsh mosquito, the extension of aid to boards of health and others interested in mosquito control, and to furthering in every practical way the work of the county mosquito extermination commissions.

Salt Marsh Mosquito Work.

The salt marsh work must be considered under two divisions, the first of which is concerned with direct work of survey and drainage in cooperation with local boards of health, and second with the drainage of the salt marsh through the work of the county mosquito extermination commissions.

Salt Marsh Drainage by the Experiment Station.

Plans have been prepared for six different pieces of work and four have been carried out. The pieces planned for were: (1) ditching in Maps 1, 2, 3 of Bergen County; (2) diking, sluicing, tide gating, Map 1 of Bergen County; (3) ditching in Map 4 of Bergen County; (4) cleaning of the ditching in Ocean County; (5) ditching in Stafford Township, Ocean County; (6) ditching in the Borough of Ocean City and Upper Township of Cape May County. The pieces of work carried out are numbers 1, 3, 5, and 6.

In Bergen County.

As set forth in last year's report, the inspection service maintained on the Hackensack Valley throughout the mosquito breeding season of 1914 served to demonstrate that at certain times mosquitoes bred at various points throughout the entire area and that the Bergen section as well as the Hudson County section must be drained if the cities and towns lying along its edges and for many miles to the north and west were to be protected. Accordingly, drainage plans were prepared and the Experiment Station decided to spend approximately $7,000. This sum, when taken with the amount the county mosquito commission expected to spend on the marsh, it was hoped would prove sufficient to drain the worst spots.

In order to relieve that portion of Bergen, Essex and Passaic counties, which in previous years had suffered from flights of *Aedes cantator*

Coq., it was decided to begin work in the southern portion of the county. Accordingly, after complying with the provisions of Chapter 134, Laws of 1906, bids for cutting 200,000 feet or more of ditching on Maps 1, 2, 3, and 4 of Bergen County were advertised for, and on May 22nd, 1915 three bids were presented; that of the U. S. Drainage and Irrigation Company being the lowest was accepted and a contract entered into with that concern to cut 225,000 linear feet of 10 by 30 inch ditching or its equivalent. On March 31st all preliminaries had been completed and the contractor was notified to begin work.

Scarcely had the trenching begun when an enormous brood of mosquito wrigglers was discovered on the central part of Map 1. Throughout about six hundred acres of the tract lying between Kingsland Creek and Saw Mill Creek the breeding was bad—as bad as any the writer has ever seen. The ditching of this area was hastened to the utmost extent, the water run off and a whole brood practically eliminated.

No sooner had this brood been eliminated than another made its appearance in the north end of the area on Map 3 on the marsh lying near the woodlands and to some extent in the woodlands themselves. The gangs rapidly worked north putting the minimum amount of ditching in Map 2 and concentrating on the breeding grounds on Map 3. Here the utmost speed succeeded in eliminating only about 95 per cent of the brood.

The very speed with which the territory had been covered, involving the cutting of 225,000 linear feet of 10 by 30 inch ditching or its equivalent, prevented the proper operation of the cleaning and deepening gangs. In Map 3 that portion of the ditches near the woodlands ran for several hundred feet over what had apparently only recently been cedar swamp and ditches cut with the ordinary patented ditching spade were so full of roots and obstructions as to be unserviceable. Gangs of men were then set to work on cleaning out this ditching by cutting out and removing roots, tree trunks and stumps. This was hard and slow work and the contractor asked for an adjustment on the ditches about the woodland. Report from the inspector in charge, Mr. Chas. S. Beckwith, supplemented by personal study led the writer to conclude that to insist on putting the ditches down to 30 inches would fail to give better drainage to the area. Accordingly, he prepared a modification of the specifications as applied to this particular cedar swamp area and submitted the same to the Director of the New Jersey State Experiment Station for his approval.

After making a personal investigation of the conditions the Director approved the change and the contractor was promptly informed of the action. Briefly stated the modification applied to only those ditches about the central woodlands in Map 3 and required that the ditches be not less than 12 inches at their sources, that they have a regular and even fall to their outlets, and that they be so cleared of obstructions that water could lie dead in them nowhere. This modification was granted only with the proviso that they should efficiently drain the area. In case they did not do this they should be driven deeper. As a matter of fact the drainage afforded by them has been efficient.

An immense amount of time was consumed in this work and the time limit of the contract was reached and passed. As the contractor was steadily at work and as he made every effort to prevent breeding over the territory served by the ditching it seemed well to allow him to continue. In this way all the ditching on Maps 2 and 3 was brought up to satisfactory compliance with the requirements. By this time the contractor had received two-thirds of the stipulated pay. The question then became one of bringing the ditches on Map 1 up to standard.

The territory comprised in Map 1 was placed under dike and sluice gates many years ago, apparently for agricultural purposes. The usual result followed—the marsh shrank and the surface level was lowered. Much of the old dike had been washed away and the sluice gates at Kingsland Creek destroyed. Through a ten to fifteen foot breach just south of the Boonton Branch of the Delaware, Lackawanna and Western Railroad bridge the waters of the Hackensack River poured into the area from a point a little above low water to high tide, and the monthly extra high tides poured over the remains of the dike for long distances. The only outlet for all this inflow in addition to the rainfall was two tide sluices each six feet wide by three feet high. Obviously this opening was barely enough to take care of the inflow through the breach just south of the Delaware, Lackawanna and Western Railroad bridge not to mention the water which came in the monthly extra high tides and the rainfall. In normal seasons this area was covered by water in the spring but by midsummer was usually uncovered by evaporation.

This breach was eliminated by building an earthen dam, and two sluices were set in the mouth of Kingsland Creek. Thus the daily intake from the river was stopped and the outlet doubled. Under good conditions the water fell to a point between four and six inches below the surface of the low parts of the marsh and from ten to twelve inches below the surface in the central portion.

As most of the roots left in the ditches on Map 1 were fifteen inches or more below the surface of the sod they were constantly under water and exceedingly difficult to remove.

When formally requested to remove the roots from these ditches, the contractor maintained that the drainage was as satisfactory now as it would be after they were removed, and that their removal, except at unreasonable cost, was impossible.

Both the Entomologist as Executive Officer and the Director of the Experiment Station felt that the drainage effected by the ditches in their present condition was not satisfactory, that conditions would be decidedly better if they were deepened to conform to specifications, and that the specifications upon which the contractor bid gave him due warning. Accordingly the whole matter was turned over to the Attorney General for advice.

Realizing the extent to which the drainage of the territory on Map 1 depended upon keeping the waters of the Hackensack River out and providing ample outlets, a plan for completing the dike along the river from the mouth of Saw Mill Creek to the Boonton Branch of the Delaware, Lackawanna and Western Railroad and the placing of a double tide gate with necessary bulk-heading at the mouth of Kingsland Creek and two single gates at other points was worked out. Bids for the diking and tide-gating were called for separately. One bid of practically fifty cents a linear foot was offered for the diking and two bids—one of four thousand and another of three thousand dollars—for the tide-gating. The bid on the diking was rejected on the ground that a single bid did not constitute competition and the others on the ground that the construction of the full number of gates without the dike would be an unwise expenditure of the funds in hand. Later on, Bergen County placed a pair of tide gates with perhaps one hundred and fifty feet of bulk-heading in the mouth of Kingsland Creek following more or less completely the specifications prepared by us at a contract cost of $1,800.

At this juncture, the office of the State Comptroller decided to hold up all funds for permanent improvement until the exact relation between the State's income and outgo could be determined. When the funds for permanent improvement were released we found it impossible because of technical difficulties in administration of the act of 1906, coupled with the short period of time left in the fiscal year, to do further work on Maps 1, 2 and 3, and therefore turned our attention to the salt marsh of the Borough of Carlstadt which lies just north of Map 3. Sealed proposals for cutting 60,000 feet or more of 10 by 30 inch ditching on this marsh were opened on October 11th, 1915. Three bids were offered, the lowest of which was 2 2/3 cents a foot.

Mr. Fred. A. Reiley of Atlantic City being the lowest bidder and having demonstrated that he had the tools and machinery with which to do the work was awarded the contract, subject to the filing of proper papers. Mr. Reiley was given a contract for the cutting of 90,000 linear feet of 10 by 30 inch ditching or its equivalent and at a total cost of $2,400. Three hundred dollars were reserved with which to do such additional work on the area as could not be classified under the 10 by 30 inch ditching or its equivalent.

All papers relative to the initiation of the work were filed with the State Comptroller on October 31, 1915, and the contractor was instructed to begin work. This he did.

The work began promptly and was in progress at the close of the fiscal year. Owing to the presence of roots and stumps throughout this area the cutting of the ditching contemplated is certain to prove a difficult matter. Anticipation of this condition doubtless lead the contractors to bid the unusually high figures.

In Ocean County.

Being aware that much of the salt marsh trenching in Ocean County has become so clogged as not only to fail to drain but actually to increase the water surface for breeding mosquitoes it was planned to clean the ditching that had already been installed. It was planned to clean thoroughly 100,000 linear feet and to remove the blockages from 500,000 more. Proposals were submitted for this work, the lowest of which was $3,400. Bids were rejected because the figures were believed to be too high. Just at this junction the holp-up in funds for permanent improvement occurred and it was decided in conference that the county mosquito commission (which had just at that time received a small appropriation) should do the cleaning with its own labor and that the money from the State should be spent in new work. Accordingly, the county undertook the work of cleaning and covering all the ditches of the county, which totalled 1,349,217 feet, and did the work for about $1,200.

In accordance with the understanding reached with the county authorities, as soon as funds were released we advertised for bids for cutting 150,000 or more linear feet of 10 by 30 inch ditching or its equivalent on the salt marsh of Stafford Township, Ocean County, as laid down on Stafford Township Maps 1, 2, and 3. Four bids were received on September 14th, 1915, and that of the U. S. Drainage and Irrigation Company being the lowest ($.0148 linear foot) was accepted and a contract for cutting 189,189 linear feet of 10 by 30 inch ditching or its equivalent was awarded to that concern subject to the filing of the necessary papers. Three hundred dollars were set aside for doing such necessary additional work as could not properly be included under the 10 by 30 inch ditching or its equivalent.

On October 26th, 1915, all the papers necessary to the beginning of the work were placed on file with the State Comptroller and the contractor was notified to begin work.

The territory comprised in Stafford Township, Map 1, was already partly ditched, having on it about 90,378 linear feet of 10 by 30 inch ditching or its equivalent. The territory comprised in Stafford Township, Map 2, was also partly drained. About 134,000 linear feet of 10 by 30 inch ditching or its equivalent had been cut. Such footage as may be left after completing the drainage in the territory covered by Maps 1 and 2 will be placed in that represented by Map 3. At the end of the fiscal year the drainage under this contract was going forward.

In Cape May County.

The willingness of Atlantic County to spend its own money in trenching the salt marsh to the north and south of Atlantic City and Pleasantville has led us to execute three contracts for salt marsh drainage laid out in relation to the country work. This year, however, the drainage had proceeded as far to the south as the county line and mosquitoes breeding over in Cape May County were found to make their way on occasion into Longport, Margate and Somer's Point.

It thus became evident that the next step was to start drainage in Cape May County. Accordingly, it was planned to spend the available funds in the Borough of Ocean City and Upper Township. Sealed proposals were received and opened on October 14th, 1915. Three bids were presented and that of Mr. Fred. A. Reiley of Atlantic City ($.0139 per linear foot), being the lowest and Mr. Reiley having demonstrated that he had the tools and machinery with which to do the work, was accepted. He was given a contract for cutting 209,634 linear feet of 10 by 30 inch ditching or its equivalent. Four hundred dollars were set aside for doing such additional work as could not properly be included under the regular contrart ditching.

At the close of the fiscal year the work under this contract was going forward.

Other Counties.

The Experiment Station during the present fiscal year has paid for salt marsh drainage at no other point in the State than at those already specified, but it has kept in close touch with drainage all along the coast and has directed the salt marsh drainage work in Ocean County, which was done with the county funds under the authority of the Mosquito Commission of that county. The Entomologist and his assistants have heen called upon in an advisory function to aid in practically all the salt mash mosquito drainage undertaken throughout the State.

As a matter of fact from a place in which the Experiment Station paid for practically all the salt marsh drainage carried out it has reached the point where it pays for the smallest part. Yet, never before have so many feet of ditching been cut in a single year, so many rods of dike been built, and so many tide gates been installed.

Local authorities are doing what the State could not be induced to do—making appropriations of sufficient size to cover their salt marsh territory rapidly.

TABULAR STATEMENT.

Tabular Statement of the Salt Marsh Ditching Work From the Beginning to and Including the Year 1915.

PERIOD	Acres.	Feet of ditching.	Cost to the State		
			Ditching.	Necessary studies and publications.	Administration.
Up to 1907, as reported	15,851	2,215,524		$11,000.00	
In 1907, as reported	10,951	1,565,524	$19,400.00		$4,100.00
In 1908, as reported	6,669	888,650	15,758.00		4,242.00
In 1909, as reported	2,672	365,800	9,917.00	539.00	4,543.00
In 1910, as reported	4,650	350,000	4,471.00		2,528.00
In 1911, as reported	8,528	712,000	19,650.00		5,350.00
In 1912, as reported	6,195	1,000,180	21,650.00		3,350.00
In 1913, as reported	7,174	1,564,842	21,580.00		4,026.70
In 1914, as reported		1,293,840	7,533.86		5,213.65
In 1915, as reported		2,685,071	13,425.25		4,885.40

Tabular Statement of 1915 Salt Marsh Ditching Work.

MEADOW.	Number of acres in area.	Number of feet of 10x30 inch Ditching or its equivalent.	COST TO THE STATE Ditching—Cleaning.
Hackensack Valley west of the River from *Saw Mill Creek north to the Paterson* Plank Road	5,500	225,000	$4,218.75
		additional	106.50
Hackensack Valley west of the River from the Paterson Plank Road north to the northern boundary of the Borough of Carlstadt	2,000	90,000	2,400.00
		additional	300.00
Stafford Township (Old survey)	5,400	189,189	2,800.00
		additional	300.00
Borough of Ocean City and Upper Township from the Meadow Road north to end of Peck's Island on the east and to Beasleys Point on the west	1,500	209,634	2,900.00
		additional	400.00
Totals	14,400	713,823	$13,425.25

Administration

Advertising for proposals	$108.50
Map drawing, blue printing, etc.	134.16
Equipment (motorcycle, surveying instruments, and other apparatus)	535.92
Office suppl es and printing	103.05
Express and freight	5.60
Telephone and telegraph	44.87
Postage	27.20
Sundries	35.85
Part of salary and travelling expenses	3,682.91
Clerical work and temporary labor	207.34
	$4,885.40

Tabular Statement of the Salt Marsh Drainage Done by the State Experiment Station and by the County Mosquito Extermination Commissions.

DATE.	EXPERIMENT STATION DITCHING.		COUNTY COMMISSION DITCHING.	
	Number of feet cut.	Number of feet cleaned.	Number of feet cut.	Number of feet cleaned.
1912	1,036,189*	....	239,800	470,000
1913	689,842	Minimumamount	879,365	1,300,000
1914	321,601	None	1,057,167	919,000
1915	713,823	None	1,971,248	3,171,128

* Maximum figures, probably 25 or more per cent. too high.

Financial Statement of the Experiment Station's Mosquito Work for 1915.

Total appropriation		$20,000.00
Salt marsh ditching (contracts and incidental labor)	$13,425.25	
Advertising for proposals	108.50	
Map making, blue printing, etc.	134.16	
Equipment, (motorcycle, surveying instruments, and other apparatus)	535.92	
Office supplies and printing	103.05	
Express and freight	5.60	
Telegraph and telephone	44.87	
Postage	27.20	
Salaries of regular and temporary employees.	3,720.00	
Travelling expenses of same	1,462.91	
Clerical and laboratory assistance	207.34	
Sundries	35.85	
Balance reverting to State Treasury	189.35	
		$20,000.00

Aid Extended to Boards of Health, County Mosquito Extermination Commissions, and Others.

BOARDS OF HEALTH.

In past years most of the requests for aid in fighting the mosquito pest came from boards of health, which were located in the coast counties somewhere between Cape May and Jersey City. Their efforts appear to have contributed to the formation of active mosquito extermination commissions under whose direction the work of control has been taken up in an efficient and vigorous manner.

Still, some boards of health in counties where the county-wide movement for mosquito control does not find favor are actively trying to bring about local control. As might be expected the interest in such places is mainly in eliminating the malarial species (*Anopheles quadrimaculatus* Say).

On August 23rd the writer at the request of the Board of Health of the City of Trenton examined and reported on some breeding places. The first place examined was a branch of a canal which had been cut off by South Warren street and thus transformed into a dead end. A heavy growth of spatterdock and other water weeds lined one side and the place was suspected of breeding malarial mosquitoes. Nearly thirty minutes of the most careful search failed to reveal any mosquito wrigglers whatever. In a small tin can partly filled with water and standing on the bank of this pocket, were large numbers of the house mosquito wrigglers.

Two other areas were examined both lying almost opposite the end of Hoff Avenue, one on the north and one on the south side of Oakland

Avenue. Several pools were found in each area. Larvæ of the genus *Anopheles* and of *Uranotaenia sapphirina* O. S. were found on the south side and larvæ of *Uranotaenia sapphirina* O. S. were found on the north side.

These two depressions are within the building area of the city and the process of filling them has already been begun. The water should be oiled as the breeding appears until the areas are eliminated by filling.

The Board of Health of the Borough of Princeton has this year shown more anti-mosquito activity than any other similar local organization. More than 100 cases of malaria were reported in Princeton during the season of 1914 and that is probably the reason for its activity. The Borough itself was ready to spend the money for work within its confines but the Board felt that the best efforts of the Borough Authorities might go for naught unless the breeding in surrounding townships could be brought under control.

Accordingly the Entomologist called a meeting of the Board of Health authorities of the Borough of Princeton and of the surrounding townships for June 18th. A good representation was present and the problem discussed from various angles, Dr. A. Clark Hunt of the State Board of Health presenting the malarial side. A representative committee with Dr. Ulric Dahlgren as chairman was appointed to take charge of the work and cooperation of surrounding townships promised.

The first step seemed to be to find out the mosquito breeding conditions. For this survey Mr. W. H. W. Komp was detailed from this office and Mr. W. T. Eakins from the State Board of Health. The survey started on June 21st and was continued until completed. A formal report of the finding was prepared and submitted to the committee. Through the activity of the committee a detailed map of Princeton and of adjacent parts of surrounding townships was prepared. On this map the locations of the breeding places were indicated.

For the purpose of checking up the results of elimination work undertaken in and about Princeton and to determine what places most needed attention, a series of night collections was undertaken. The results of these studies were placed in the hands of the above committee and. it is the writer's understanding that this committee proposes to prepare and perhaps to publish a formal report covering the mosquito extermination work done by it during the season just past.

Mosquito Commissions.

Throughout the past year the Entomologist has held himself ready to respond to the needs of the county mosquito commissions. He has filled 54 appointments and spent about 42 days of 10 to 12 hours each. In addition to this plans of action have been formulated, surveys have been made, maps and specifications have been prepared. In fact, all the problems incident to starting and carrying on the work of mosquito extermination both on the salt mash and the upland have had to be met and some solutions worked out.

Others.

Two years ago the Entomologist helped to form the New Jersey Mosquito Extermination Association and has served continuously as its Secretary-Treasurer. In this capacity he has edited the proceedings of the annual meetings for 1914 and 1915.

On July 1st Mr. E. T. Judd who has a boys' camp south of New Egypt complained of mosquito trouble and requested help. A careful inspection revealed the fact that the species of mosquito concerned was the white-banded salt marsh mosquito, which breeding on the salt marshes of the coast or river had winged its way across the pines to this camp. It was necessary to report that local work would be useless and to advise him to move the camp out of the salt marsh mosquito range.

Last winter at the request of State Entomologist of Connecticut, the Entomologist appeared before the Committee of Public Safety of the Connecticut Legislature in behalf of the mosquito extermination bill that is now one of the statutes of that State. At the request of Dr. C. B. Davenport and others interested, he gave a talk on mosquito extermination work before a representative group of Nassau County people who were vitally interested in mosquito control. At the request of one of the property owners (Mr. E. B. Walden) and with the consent of the Connecticut authorities he appeared before a large group of property owners at Sachems Head for the purpose of explaining mosquito control and its results as carried on and realized in New Jersey.

Many letters have been received from individual citizens of the State relative to habits and methods of controlling mosquitoes and in every case the fullest information available has been furnished. A considerable number of letters have been received from persons and organizations in other parts of the country requesting information on mosquito control methods being used in New Jersey. In practically all cases these persons or organizations were looking for a solntion of a particular local problem.

County Mosquito Extermination Work.

The county mosquito work has this year covered the largest territory in its history of four years. Something like 118 miles of the Atlantic coast has been patrolled, 850,000 acres of territory have been covered, and about one and one-half millions of people received a considerable measure of protection.

Although a large part of the salt marshes in this coastal strip had been ditched by the Experiment Station before the County unit for anti-mosquito work had been created it was not until the creation of the county unit was authorized that the movement for the control of all species assumed a large enough aspect to be promising. Previous to 1912 local cooperation over a sufficient extent of contiguous territory to render the work free from being spoiled by migrations from outside the protected district seemed impossible.

With the enactment of a bill authorizing the creation of the county anti-mosquito unit, the rapid growth of local effort began. In 1912 Essex and Union Counties began work throughout their territories. In 1913 Atlantic and Hudson Counties took up the same work covering all land within their limits. In 1915 Bergen joined the above four. Beginning in a small way with educational work, one or two years previously, active work covering a part of the territory in each case has been carried on during the present season in Middlesex (salt marsh only) with all species in two municipalities, Monmouth (salt marsh only), Ocean (salt mash only and only the drained part of that), and Passaic (the southern half) Counties.

Hudson County.

In considering the work of mosquito control in Hudson County in any given season it is necessary to keep in mind the nature of the problem with which the mosquito commission has to deal. In the 1914 report on pages 459-460 the writer briefly described the mosquito problem of Hudson County as he understood it and the following discussion of this years' work will be based upon that description.

The control of fresh water breeding was continued along the lines of last year. The number of breeding places exclusive of sewer basins, owing to the heavy rainfall, increased from 4,121 in 1914 to 7,468 in 1915. This merely refers to the number and does not cover the increase in size which is more important for while the number has been almost doubled the actual water surface has probably been multiplied by 10. Of the breeding places mentioned 5,206 or almost 70 per cent were permanently eliminated. The remaining places are old wells, cesspools, and cisterns.

The control of salt marsh breeding as might be expected from the large marsh to be covered has proven more difficult. Hudson County originally had about 11,468 acres of tidal marsh. Something over 1300 acres have been filled leaving approximately 10,000 acres throughout practically all of which mosquitoes would breed under proper conditions. Experience in salt marsh ditching has shown that not much less than 300 linear feet 10 x 30 inch ditching is necessary to drain an acre of open salt marsh when good tidal creeks exist. On this basis, the Hudson County salt marsh would need 3,300,000 linear feet of ditching. As a matter of fact, about 660,000 feet have been cut. Furthermore much of the Hudson County salt marsh is not furnished with good outlets. The activity of man in building roadways, railways, fills and dikes has destroyed the excellent drainage system established by nature and rendered the removal of the water from certain parts of this marsh extremely difficult. To make a bad matter worse certain cities along both the eastern and western ridges have poured sewage into the marshes adjacent to them and thereby created enormous breeding areas hundreds of acres in extent from which the small dark species which penetrates the screens and troubles the sleeper, migrates into adjacent houses and makes sleep a nightmare.

The County Mosquito Commission seems to have done everything its funds would permit to eliminate these places but the work is as yet very incomplete. That portion of the marshes at Constable Hook and Port Johnston, which is still unfilled, appears to have been rather adequately drained although a small amount of breeding can occasionally be found on the latter.

The salt marsh extending between the Hackensack River and Jersey City highland to the east is, with the exception of the Pen Horn Creek Valley from the Lackawanna and Erie Railroads to the Paterson Plank Road, fairly open meadow and likely to be mosquito-proofed by the usual type of marsh ditching. This area which includes between four and five thousand acres has 195,000 feet of ditching or less than one-fifth the amount that would normally be required on bad breeding meadow.

That part of the salt marsh included in the valley of the Pen Horn Creek is entirely inadequately drained. The twelve to thirteen hundred acres not only have less than 1/19 the usual ditching for such areas but the outlets are stopped up in such a fashion that the accumulated water from rains simply cannot quickly escape.

To make matters worse many sewers are spilling their contents into the cattails with which this area is covered.

That portion of the Hudson County marsh which lies west of the Hackensack River is with the exception of the territory between the Lincoln Highway and the Central Railroad of New Jersey, entirely enclosed by dikes and has been so for many years. In addition to this interference with natural drains many railway grades and roadways cross and divide this shut-in territory into a considerable number of more or less independent areas of various sizes and shapes.

The exception, that part laying between the Lincoln highway and the Central Railroad still depends upon a tidal creek for outlet but even there, one creek is now doing the work of two.

That area lying north of the Lincoln Highway and extending northward to the Pennsylvania Railroad, down-town line, is in process of being filled. The fills extend along each side and shut off proper access to the river. Temporary work of oiling is the only method of preventing mosquito development at present possible and naturally leaves much to be desired.

The area that lies north of the Lackawanna Railroad and extends northward to the Greenwood Lake branch of the Erie Railroad depends upon two creeks and some ditches for outlets. About 2500 acres are included in this tract and it is served by about 65,000 feet of ditching. To make the drainage yet more difficult a part of this area is apparently below sea-level. Along the highland to the east of Kearny and Harrison several sewers discharge and formerly flooded the meadow just as the sewers now flood the Pen Horn Creek Valley. The ditching already cut when taken with the two centrifugal pumps is sufficient to keep down heavy breeding under ordinarily moist weather but is inadequate during seasons of heavy rainfall.

That portion of the salt mash lying north of the Greenwood Lake branch of the Erie Railroad and extending northward to Saw Mill Creek includes more than 1000 acres, has very little ditching and in parts is a heavy breeder of mosquitoes. It is one area which demands careful and extensive drainage.

Long strides have this year been made toward solving certain of the most difficult problems of the salt marsh. The low lying marsh lying just east of Harrison and Kearny bounded on the north by the Greenwood Lake branch of the Erie, and the east by the Bellville Turnpike and the "uptown" line of the Pennsylvania Railroad and on the south by the mass of tracks running east from Manhattan Transfer, and known as the Frank Creek section of the Kearny marsh consisting of about 1300 acres has this year, for the first time, been almost eliminated as a mosquito breeder. The opening of the channel of Frank Creek and the connecting of the various sewers from Harrison with its channel, had in 1914, markedly improved conditions.

In the latter part of the season of 1915 a four-inch high-head gasoline driven centrifugal pump was installed just east of Frank Creek where that stream enters the tunnel under the Lackawanna and Pennsylvania Railroad tracks and was connected with a three hundred acre area by means of ditching. With one exception during the past season this pump has kept the 300 acres far from breeding. The exception followed the heavy rains of midsummer when the pump was taxed beyond its capacity and six barrels of oil had to be used. In the season before the pump was operating $300 were expended for labor and sixty barrels of oil were used on this area.

The entire cost of the pump ready to run and protected by a corrugated iron house was about $600.

In the spring of 1915 a twelve-inch low-head electrically driven centrifugal pump was installed on the east bank of Frank Creek about one-half mile north of the four-inch pump at a cost of about $1,300. It was expected that this pump would draw the water from 800 acres. As a matter of fact this pump could never be worked to capacity because the drainage channels were not so constructed as to bring the water in with sufficient rapidity. The efficiency of the pump was such as to show that it could easily take care of 1000 acres if connected with the proper channels. In spite of the relatively inadeqnate arrangements for utilizing the pumps' full power, the writer has never seen this area in so good condition.

The Commission has begun the cutting of drains from the area of marsh, lying just east of the Arlington Highland and between the Greenwood Lake Branch of Erie and the Belleville Turnpike, into the lower course, of Saw Mill Creek where the same is an active stream.

About 215,000 feet of old ditches have been cleaned and 131,076 feet of new ditching have been cut.

Bergen County.

This year Bergen County undertook a general campaign against all species of mosquitoes. This meant an effort to meet the woodland pool mosquito, the fresh water swamp species, the house mosquito, and the salt marsh mosquitoes.

On the salt marsh the County and the Experiment Station together have cut more than 500,000 feet of ditching, without doubt eliminating the worst breeding places. Nevertheless there is good evidence to show that more is needed. If figured on a three hundred foot to the acre basis more than 1,500,000 feet more would be needed. The excellent system of tidal creeks may however, render such a large amount unnecessary.

With the possible exception of an area lying in the extreme southwestern portion of the salt marsh the drainage of the entire 8000 acres may be had by a gravity flow.

The Commission has installed two excellent tide gates at the mouth of Kingsland Creek and plans to repair the dike along the Hackensack River from Saw Mill Creek to the Boonton Branch of the D. L. & W. Railroad. This, together with some additional ditching, should afford the best gravity drainage possible to the marsh comprised in drainage Map Number 1.

The methods of upland work exhibited no features new to mosquito control work. Owing to the emphasis placed on the salt marsh it was naturally done less completely than would otherwise have been the case.

Passaic County.

In Passaic County this year the work was limited to the southern half of the County and largely to the Cities of Paterson and Passaic. Perhaps the most striking development of the season was the finding of heavy breeding of the house mosquito along the shores of the Passaic River. This breeding occurred above the dam where the water was not affected by the tide. It was met by shearing off the overhanging weeds and brush and by regularly oiling.

The other methods used were the same as those already employed in upland work in previous years and need no comment.

Essex County.

This is the fourth season of work in Essex County. The methods of fresh water mosquito control have undergone no great change. Perhaps the most important innovation was a change in the method of checking up the work. Under the new scheme a complete record of all permanent breeding places was kept in the central office and a special small force proceeded from one part of the country to another following the regular inspectors; first in this section then in another to see that these premanent places were properly looked after.

The problem of salt marsh breeding has been attacked from a new angle. Dikes and tide gates have been installed in such a fashion as to keep the sea off of about 3000 acres and to let the normal water out at every low tide In order to carry the normal water to the sluices about 879,903 linear feet of ditches ranging from 10 to 50 inches in width were cleaned. The results of this work have been most gratifying. Never has the writer seen the Newark marsh so free from breeding.

Union County.

This is the fourth season of work for Union County. No radical changes have been made in upland work. As previously carried on in this county, the practice of placing the bulk of the cost of permanently eliminating the upland breeding places upon the shoulders of land owners has been continued and the county in that way is getting an amount of work done at private expense which represents in a single year as much as the county appropriates for the entire work. This practice of securing private cooperation cannot be too strongly commended. To give an idea of the extent of this cooperation the following brief table is submitted.

Year	*Estimated Cost of Private Work.*	*Percentage of total Inland Drainage.*
1912	$ 2,000	41%
1913	25,000	77%
1914	25,000	88%
1915	20,000	87%

The Union County Commission has made an attempt to eliminate mosquito breeding on several hundred acres of the North Elizabeth meadow by means of dikes and sluice gates built according to the suggestions of Mr. James E. Brooks. The Chief Inspector's description of the results is quoted as follows. "The observation of the embanked meadow, west of the Central Railroad of New Jersey shows an interesting comparison with the meadow exposed to the tide east of the Central Railroad in the North Elizabeth section. This embanked meadow, after the diking and tide gate work was completed in the late spring, quickly dried out and the water in the ditches remained at an average of one foot below the meadow level, even at times when the other meadows exposed to the tide's action were completely flooded. This same condition continued with no serious breeding found in the embanked meadows, up to the first of August although scattered serious breeding had been observed east of the Central Railroad, which is exposed to the tidal action and which had been flooded during the monthly high tides.

"The big storm of early August partially flooded the embanked meadow, and at the same time the water remained at almost constant high water level outside of the gates, which kept the gates closed for several days after the big storm and prevented the proper run-off of the water. In other words, a period of continuous high tides and heavy rain storms coincided. It was observed that breeding commenced in the ditches and that fish which were inside of the embanked meadow as well as outside, did not move out of the deeped holes in the meadow and salt ponds into the smaller ditching. Efforts were made to attract the fish into the small ditches by baiting these ditches and by other means, but without success. It then became necessary to oil the ditches which were breeding in the embanked area, which was done, and a few days later when the tide had gone down outside of the gates sufficiently so as to flood the meadow as the gates were raised. The sluices were then opened, more fish were admitted and the tide allowed to circulate through the ditches, and no further breeding was then observed for the remainder of the season, although the gates were again lowered and remained so until the end of the summer.

"The same condition of inactivity of the fish in the ditches during this period in August, was noticed all along the Atlantic Coast from Cape May to the Hackensack Valley.

"The results of the observation of the diked meadow would tend to show that by a proper procedure of keeping the gates open for a portion of each month so as to keep up the fish supply inside of the embanked meadows, although at the same time preventing the flooding of the meadows, practically no breeding will take place except during a period of ten days or two weeks in early August, when the fish in the ditches are inactive, and then only if there is a combination of high tide coincident with the short period of inactivity of the killi-fish. In this case it will be necessary to oil the ditches in the embanked meadow, which is not an exceedingly difficult matter. If the tide is low during early August and breeding appears in the ditches, oiling will not be necessary as breeding can be prevented by flushing out the ditches through raising the gates for several days. The system of diking and tide-gating therefore, through its effect in reducing the water table on the embanked meadow and in preventing submerging from high tides, seems to keep the meadow dry and to prevent almost 100 per cent of the normal breeding. It therefore seems advisable as funds will permit from time to time to continue the diking and tide-gating work on the Union County salt marsh in order to get better results in cutting down salt marsh mosquito breeding."

Middlesex County.

This is the second season for Middlesex County and this year as last the mosquito commissions' attention was devoted primarily to the salt marsh and secondarily to demonstration campaigns in a municipality or two.

The work in Middlesex has differed from that in other counties in that the Freeholders were informed from the start that the mandatory feature of the law would not be invoked. They were asked to make an appropriation in response to popular sentiment.

Although the demand this year for larger funds in order that more than the salt marsh breeding could be prevented was larger and much more insistant, the Board of Freeholders was under such pressure to cut down expenditures that it failed to appropriate a larger sum.

The work had therefore to be limited to the salt marsh and to the supervision of such fresh water mosquito control as individual municipalities would pay for.

The Borough of Metuchen and the Township of Woodbridge were the only municipalities that made appropriations. The methods employed in this work were those commonly used and hence deserve no especial consideration. The 8,199 acres of salt marsh have only 541,064 linear feet of ditching and surely require much more to make them free from breeding. 116,564 linear feet of ditching were cut and 424,500 feet were cleaned. In Middlesex more perhaps than in any other county the practice of patrolling all the salt marsh througbout the mosquito breeding season has given good results. In both 1914 and 1915 it has given the final toucb to efficient mosquito control.

The barrels of oil are distributed tbroughout the salt marshes at the beginning of the season and as remnants of developing broods left by the drainage ditches appear about ready to emerge they are destroyed by the judicious use of small amount of oil.

In one instance during the past season an inspector proved inefficient and allowed the mosquitoes to develop letting off a sufficient brood to distress greatly residents living witbin two miles of the neglected section. This happening served to emphasize the value of efficient patrol.

Monmouth County.

The Mosquito Problem.

Physically Monmouth County rises rapidly from a rather narrow sand beach into high lying level or rolling fertile land. A range of low hills begins at Atlantic Highlands and extends southwestward across the country to Mt. Holly gradually becoming lost in the general elevation. To the north of this range the land rises from Raritan Bay and to the south from the ocean. The beaches on the bay are shallow and salt marsh areas large and plentiful. Along the ocean tbe beach runs rapidly into deep water and the marshes are limited to river courses. In fact, the vast acreage of the salt marsh of Monmouth County is found along the Shrewsbury and Navesink Rivers and Raritan Bay. Small marshes are found on the Shark River and larger ones along the Manasquan. As one goes southward, the beach widens and shallows. Back of tbe immediate sandy shore area the soil runs into a fertile loam which is thickly settled by successful farmers.

The limited woodlands and the porous soil prevent the woodland pool and to very large extent the fresh water swamp mosquito problems. The streams give a serious malarial mosquito problem in parts of the county, the water holding receptacles incidental to settlement of the land by people give rise to a house mosquito problem, and the salt marshes provide a salt marsh mosquito problem.

It does not seem likely that the house or malarial mosquito problem is of sufficient importance anywhere except in the towns and cities to render county-wide control practicable. It seems therefore best to undertake the control of the salt marsh species, which fly far and give trouble over a wide range, with county funds and to let the municipalities handle the fresh water species in their own funds, as a local problem.

This is the first season of anti-mosquito work in Monmouth County under the direction of its mosquito commission. It is not the first season of effort against the salt marsh mosquito, however. Some of the earliest practical work of trenching the marsh to prevent the breeding of the salt marsh mosquito was done along the Shrewsbury River. This project was undertaken and carried out for the purpose of getting rid of the occasional visitations that the imperfectly drained marshes still permitted to develop.

The work on the Little Silver area was maintained by the same concern which cut the ditching and the Commission kept a patrol on the marsh as a check on the work of the contractor and did, the writer understands, a certain amount of oil spreading to kill off bad breeding in limited spots.

During the present season the attention of the mosquito commission was given almost wholly to the problem of controlling the salt marsh mosquito and most excellent results followed wherever the funds permitted the work to be sufficiently well done. All told 268,441 linear feet of 10 x 30 inch ditching or its equivalent was dug or re-dug. On the basis of 300 linear feet per acre, disregarding the Little Silver area altogether, about 389,000 linear feet additional will be required to furnish all the marshes with satisfactory drainage.

An effort was made to interest the various shore towns in locally supported campaigns against the fresh water breeding species, but no satisfactory response was obtained and the house mosquito became abundant in places.

Ocean County.

The Mosquito Problem.

Physically Ocean County rises from the Ocean as a low narrow strip of sand beach behind which lies Barnegat Bay with salt marshes bordering both sides. Behind the bay the gently rising sand land quickly passes into the pine woods, which cover almost all of the back lying portions. To the northeast the county runs into some fertile loam where the business of farming is practiced with great success. Scattered through the pines are low-lying water filled cedar swamps, some of which are enormous in extent.

The porous nature of the soil appears to prevent the woodland pool mosquito problem and the nature of the cedar swamp water appears to be hostile to the larvæ of all important species.

The mosquito problem of Ocean County is thus limited to the house mosquito, breeding in water-holding receptacles about human habitations or in streams and pools polluted with human waste and the salt mash species bred upon its large costal and river marshes.

The salt marsh mosquito is so completely the all-prevalent species and the amount of money ($3,000) furnished by the Board of Freeholders was so small that all of the commission's efforts were directed to the control of breeding on the salt marsh.

The county has 40,400 acres of salt marshes, 22,393 of which have been partly drained and 18,007 have been untouched. The mosquito commission cleaned 1,349,217 feet of ditching in such a fashion as to put it into efficient working order. The drained marshes were patrolled and 30,000 additional feet were cut at points where the patrol indicated such work as necessary.

A great deal of local interest was manifested. Long Beach cleaned its ditching and cut such additional ditching as was necessary at its own expense. Ocean Gate furnished needed supplies of oil for use in adjacent marshes and the Tribune Company which was engaged in developing Beechwood, contributed $250. Seaside Park and Bayhead made efforts to destroy their local breeding.

The great need in Ocean County is more salt marsh drainage.

Atlantic County.

This is the third season that Atlantic County has been at work. The large problem in Atlantic is the control of the salt marsh mosquito, and to that phase of the problem the principal attention of the commission has consequently been devoted.

Nevertheless very efficient work has been done in controlling the fresh water species of which the house mosquito is the principal member. The beneficial efforts of fresh water control have been felt in Atlantic City, Ventnor, Margate, Pleasantville and Hammonton, but in May's Landing and Egg Harbor and smaller places between Hammonton and the coast, they have been almost swallowed up by the migration of salt marsh species from the undrained marshes both of Atlantic and adjacent counties.

The salt marsh work of the present season, amounting to 825,100 linear feet of 10 x 30 inch ditching or its equivalent has completed the drainage of the salt marsh from a point 5 miles north of Absecon to Somers Point and up the Great Egg Harbor River with its northern affluents to Powell's Creek, a distance of 22 miles freeing approximately 12,000 acres from breeding. Thus it is seen that two blocks of salt marsh aggregating 18,731 acres, one amounting to about 8,496 acres and lying south of the Great Egg Harbor River and along both sides of its upper course and the balance on Brigantine Island, along Great Bay, and the Mullica River, yet remain to be drained.

Atlantic County deserves great credit for having developed a machine by means of which the cost of ditching has been reduced from 2.5 cents a linear foot for 10 x 30 inch ditching to between .5 and 1 cent. In fact, it is this development that has enabled the Commission to cover so large a territory with so small an amount of money at its disposal.

In spite of the large territory lying within the limits of county adjacent thereto which is yet to be covered, the reductions in salt marsh mosquitoes in Atlantic City, Ventor, Margate and the towns along the Shore Road from Somers Point to Absecon is remarkable.

Cape May County.

Physically Cape May County is a low wide penninsula projecting into the Atlantic Ocean. On the east coast the low narrow strip of sand beach characteristic of Atlantic County is continued to the end of Cape May, and back of it lies the usual open water bordered by salt marsh. To the west the shore is unprotected by a beach strip and the salt marshes are largely limited to the water courses. As one proceeds northward along the Delaware Bay coast the marsh strips are seen to widen and to become confluent.

Cape May County is credited with 53,638 acres of salt marsh, and an examination of the species of mosquito on the wing during the summer season shows that the mosquito problem is one of suppressing breeding on the salt marsh.

Thus far the task of taking up the burden of salt marsh drainage has been impossible and the Commission has devoted its time to educational and a little survey work.

Camden County.

The work in Camden County this year has been very limited. Owing probably to a determination on the part of the mosquito commission to have enough funds to cover the County or none at all, it proved impracticable to obtain any additional funds, and such work as was done had to be supported on funds left over from the preceding year. This amounted to about $1,500 the writer understands, and was spent in a limited campaign in the municipality of Collingswood.

A Summary and Discussion of Expenditures for Mosquito Control.

For some time there has existed a desire for such a statement of the facts relative to the cost of mosquito control in the various counties as would give a real basis for comparing the expenditure of one county commission with that of another. The tabular statement of expenditure (see table below) will, I hope, give such a basis. The preparation of this table has been made possible through the willingness of the various commissions and their employees to fill out the information blanks furnished.

The writer will attempt to give a very brief survey of the expenditures on the salt marsh and inland work, to state such of the general principles upon which the expenditure is based as his study has developed clearly, and to comment upon the general efficiency of the work.

Up to the year 1912, when the county mosquito extermination commissions were created, the State Experiment Station had expended about $130,000.00 in salt marsh mosquito work, and municipalities, groups of individuals and individuals had spent about $70,000.00 more in the same work. The known breeding places on the salt marshes from Jersey City to Toms River had been drained and a measure of protection given to perhaps, a million people. Along the lower part of Newark Bay, the Arthur Kill, Raritan Bay and the Monmouth shore, owing to the comparatively open and easily drained nature of the marsh, the elimination of serious breeding was with a few exceptions much more complete than it was either at the northern or southern end of the area.

Tabular Statement of Expenditures.

ESSEX COUNTY.

	1912, 6 mos.		1913		1914	
Total Expended	$35,317.23	%	$65,313.99	%	$62,997.76	%
Administration	4,103.38	12	8,915.60	14	9,673.46	16
Inspection	15,846.90	45	21,354.85	33	19,475.54	31
Elimination—						
Permanent Work	4,412.75	12	17,357.84	26	10,447.48	16
Salt Marsh	2,196.25	6	14,570.95	22	9,627.23	15
Inland	2,216.50	6	2,786.89	4	820.25	1
Temporary Work	7,285.49	21	14,026.68	21	16,250.58	26
Salt Marsh	1,843.99	5	4,040.49	6	5,029.44	8
Inland	5,441.50	16	9,986.19	15	11,221.14	18
Equipment	3,211.04	9	3,098.47	5	4,556.78	7
Miscellaneous	457.67	1	360.55	1	2,592.91	4
Per Capita Cost (Cts.)	6.37	..	11.08	..	11.37	..
Cost Per Sq. Mile ($)	278.00	..	514.00	..	488.00	..

UNION COUNTY.

	1912, 6 mos.		1913		1914	
Total Expended	$15,792.54	%	$31,107.05	%	$23,746.35	%
Administration	1,529.70	9	3,963.63	13	4,074.26	17
Inspection	3,829.81	24	8,696.19	28	7,770.74	33
Elimination—						
Permanent Work	7,202.50	46	12,718.31	40	8,753.70	37
Salt Marsh	4,340.93	28	4,500.02	14	4,526.81	19
Inland	2,861.57	18	8,218.29	26	4,226.89	18
Temporary Work	2,106.04	13	1,324.62	4	953.75	4
Salt Marsh	....	..	50.00	..	200.00	..
Inland	2,106.04	..	1,274.62	..	753.75	..
Equipment	988.00	6	1,032.82	6	1,335.96	6
Miscellaneous	136.49	2	2,573.48	9	857.94	4
Per Capita Cost (Cts.)	10.57	..	20.82	..	15.89	..
Cost Per Sq. Mile ($)	153.00	..	302.00	..	230.00	..

HUDSON COUNTY.

	1913		1914	
Total Expended	$25,917.06	%	$31,063.36	%
Administration	3,865.82	15	4,472.74	15
Inspection	5,173.25	19	6,207.30	20
Elimination—				
Permanent Work	6,524.74	25	8,377.88	26
Salt Marsh	4,071.09	16	5,711.93	18
Inland	2,453.65	9	2,665.95	8
Temporary Work	8,246.92	32	10,542.15	34
Salt Marsh	1,608.14	..	3,260.86	21
Inland	6,638.78	..	7,281.29	13
Equipment	1,498.15	6	1,108.17	4
Miscellaneous	355.12	3	355.12	1
Per Capita Cost (Cts.)	5.08	..	5.42	..
Cost Per Sq. Mile ($)	675.00	..	722.00	..

ATLANTIC COUNTY.

	1913, 6 mos.	%	1914	%
Total Expended	$16,666.75	%	$24,702.01	%
Administration	2,231.27	13	3,890.22	15
Inspection	2,672.37	16	4,906.39	20
Elimination—				
Permanent Work	9,410.48	57	11,968.47	48
Salt Marsh	9,364.48	57	11,911.47	48
Inland	46.00	..	57.00	2
Temporary Work	131.77	1	661.06	2
Salt Marsh	....	..	7.92	..
Inland	131.77	1	653.04	2
Equipment	1,292.32	8	2,081.76	8
Miscellaneous	1,058.31	5	1,855.17	7
Per Capita Cost (Cts.)	21.07	..	32.02	..
Cost Per Sq. Mile ($)	29.29	..	43.41	..

CAMDEN COUNTY.

	1913	%	1914	%
Total Expended	$504.32	%	$2,929.44	%
Administration	477.82	99	920.26	32
Inspection	....	99	636.63	22
Elimination—				
Permanent Work	....	..	900.73	31
Salt Marsh	....	..	....	..
Inland	....	..	900.73	31
Temporary Work	....	..	163.59	5
Salt Marsh	....	..	....	..
Inland	....	..	163.59	5
Equipment	....	..	221.49	6
Miscellaneous	26.50	1	86.65	3

MIDDLESEX COUNTY.

	1914	%
Total Expended	$5,427.46	%
Administration	1,043.67	18
Inspection	1,209.91	23
Elimination—		
Permanent Work	1,529.23	31
Salt Marsh	1,519.23	31
Inland	10.00	..
Temporary Work	461.58	7
Salt Marsh	369.47	6
Inland	92.11	1
Equipment	1,131.97	20
Miscellaneous	51.10	1

In the year 1912 the county mosquito extermination commissions became active and for the first time the ditching placed by the State Experiment Station had, at certain points, that maintenance and extension which experience has shown to be so essential. Most of the active commissions, are operating in counties possessing at least 4,000 acres of salt marsh and a very considerable part of the total expenditure has been devoted to the elimination of breeding on the marsh. For the initiated there is little need to explain why year out and year in a large percentage of total expenditures is devoted to the salt marsh, but many persons who may read this report may not understand. In our experience no salt marsh has ever been so drained that breeding could not later be found on it. When the systems of ditching were installed under the direction of the Experiment Station the ditches were cut only where breeding could be found. Later years have revealed that other places, not at that time supposed to breed, are really heavy breeders. The drainage itself sets up certain changes that create breeding where none before existed. A good example of the former is the Bergen County Hackensack salt marsh. Reported as free from breeding in past years, it has been shown since 1913 to be a very heavy breeder and to supply much of northeastern Essex and southern Passaic as well as Bergen Counties with *Aedes Cantator Coq.* The type of breeding place that comes about as the result of drainage is usually a cat-tail swamp, the drainage of which is incident to cleaning up breeding areas adjacent to it. In such a swamp the water formerly stood at a fairly constant level, and, as at no time was the wet mud exposed for deposition of eggs, no breeding occurred. The drainage allows the water level to rise and fall with the tide, thus exposing the bottom for egg deposition. Under drainage the cat-tails eventually disappear and sedges take their place.

In fact, so variable is the location of breeding on a given salt marsh that the writer has almost reached the conclusion that the only safely drained marsh is one from which the water is completely removed. It is not his thought that such complete drainage should be cut as rapidly as the marsh is covered, for he seriously doubts whether the necessary funds could be obtained.

The usual practice is to drain those parts where breeding is known to exist, to keep the ditches already cut open and to install additional ditching as new breeding places appear. This method seems best from the standpoint of obtaining necessary funds and from the standpoint of expending them most effectively. The writer realizes that some persons would be inclined to take issue with him on this point, but he feels that its truth is borne out by experience.

With the creation of the County Mosquito Extermination Commission a really effective agency for the control of fresh-water breeding species was formed. The problem facing most commissions has been first, of obtaining funds; second, of forming an efficient mosquito-fighting machine; third, of finding the local breeding places; fourth, of eliminating them; and fifth, of combating mosquito invasions.

The first phase has usually been solved by a campaign of education in the course of which the purposes and methods of mosquito control have been explained and discussed and substantial public support obtained.

The second has been largely determined by the statute itself. Competent persons with a knowledge of the technique of mosquito control work have been employed as chief inspectors, and the selection and organization of subordinates, largely left to them.

The third has been met by periodically examining every square yard of territory of the protected area for water in which mosquito larvæ breed, and by tracing the mosquitoes found on the wing to the places where they originate.

The fourth has has been met by draining, filling, cleaning, stocking with fish, or oiling at regular intervals all pools in which breeding is found.

The fifth has never been adequately met, owing principally to the attitude of Boards of Freeholders that no money should be spent outside of county limits. Thus far, it has been limited to tracing broods and oiling. The good results of even such limited extra-territorial work are shown in the Hackensack Valley marsh report, which forms a part of the 1914 Report of the Experiment Station. There is given a detailed statement of the breeding throughout the season of 1914 as determined by a force of inspectors made up of employees from Union, Essex, Hudson and the Experiment Station.

In every county having a salt marsh the control of breeding upon it has proven thus far as least to be the most difficult part of the mosquito problem. An average of 26 per cent of all expenditures in the counties, covering their whole territories, has been devoted to salt marsh mosquito elimination, and as high as 57 per cent was reached in one case.

Yet in spite of all this care from time to time broods of greater or less size have issued. Ordinarily, from the standpoint of the householder living near the marsh, the broods have been negligible, yet at times they have been too large. *It is the writer's opinion that the proportion spent* upon the salt marsh is rarely too large and in some cases undoubtedly too small.

In every county having a salt marsh and attempting to cover only a part of the problem of mosquito control, the salt marsh has first received attention.

Any study made for the purpose of finding the general principles underlying the cost of mosquito control work must be concerned with an analysis of the effect which increase in population has on the mosquito breeding places, for obviously mosquito control becomes important only as the land is transformed from a wilderness into homes for people.

Before the settlement of the country there existed the fresh and salt-water marshes, streams and woodland pools. With the coming of population many fresh-water swamps and woodland pools have been drained or filled, while the drainage of others has been rendered more difficult and many have been polluted with human wastes. Many streams have been cleaned and straightened, but others have been stopped up and swamps created where none before existed. Many have been so polluted with human wastes that they have *become virulent producers of mosquitoes*. The salt marsh drains established by nature have been stopped up, the water held on the marsh, and the areas transformed into worse breeders of mosquitoes than they were formerly. Many of the salt marshes have become polluted with human wastes. Many entirely artificial breeding places, such as rain barrels, tubs, buckets, old tin cans, stopped-up roof gutters, privies, lot and roadside pools, cesspools and sewer catch-basins, have been created.

Thus far at least the settlement of the land by man has increased rather than diminished the mosquito output. Examination of the tabulated list of expenditure shows clearly that on a county-wide basis in New Jersey the cost of mosquito extermination increases as the population increases in density. Hudson, with a population of 14,000 per square mile, spent $675 in 1913, $722 in 1914; Essex, with 5,000, $514 and $488; and Union, with 1,400, $302 and $230. There is of course, a difference of opinion as to whether permanent improvement of the mosquito breeding places incident to increase in population will not eventually overtake the increase in number and effectiveness of breeding places, and that the cost of mosquito control from that point will decrease as the population increases. From what we see in the most densely populated sections of our large cities where sewering and grading has reached its highest perfection it looks as if such a point might be reached.

Thus we have the relation which the cost of mosquito extermination bears to the whole population, and we have now to examine its relation to the individual. The tabular statement of expenditures shows clearly that per capita cost decreases as population increases. Hudson, with a population of 14,000 per square mile, had a per capita cost of 5.08 cents in 1913, 5.42 cents in 1914; Essex with 5,000, 11.8 cents and 11.37 cents; Union, with 1,400, 20.82 cents and 15.89 cents.

In county units, at least, increase in population means increase in wealth. Increase in density of population means, therefore, a decrease in the proportion paid by the individual taxpayer. In no case can the tax be greater than one mill, and in no case has any mosquito commission asked for the full amount available under the statute.

The efficiency of mosquito extermination work may be measured by increased freedom from mosquito-borne disease, increased real estate values, and by the public support accorded to it.

The amount of malaria recorded within the limits of the counties at work is so small, and the diagnosis so rarely founded on blood tests, that it is impossible to draw any definite conclusions as to the effect of the work on public health.

The increase in values is however, a different matter. Unfortunately, nothing like a complete collection of data has ever been made relative to it. In the course of some stndies of the increase in ratables along the shore alone it was found that since the salt marshes had been drained there has occurred an increase of $5,600,000 in shore values alone in the territory from Jersey City to and including Sea Bright, and that the increase ranged from 15 per cent in the manufacturing sections to 300 per cent in some of the residential sections. Statistics set forth by Dr. Lipman[1] serves to show the possibilities of this phase of the work.

With a few minor exceptions, the completion of the first season's work has been sufficient to enlist the hearty support of the public press.

Repeatedly the legislators from the counties in which the work was going on have withstood attempts to repeal the law made by representa-

[1]Lipman, J.,G., Proceeding 2d Ann. Meeting N. J. Mos. Exter. Ass'n, pp. 6-9-74, 1915.

tives of counties where no work had been done. During the fall of 1914 an inquiry was prepared and sent out for the purpose of ascertaining in still another way the attitude of the public toward anti-mosquito work. From the telephone directories in each of the principal towns and villages in the protected districts, so many persons whose surnames began with "A" were selected, so many persons whose surnames began with "B" and so on through the alphabet. To each of these persons so selected a brief statement of the expenditures since work began in this county was made, and he was requested to state whether he had been benefited an amount equal to the stated per capita cost of the work and whether he favored its continuance.

Eighty per cent of the persons replied that benefit had been received, and 95 per cent favored the continuance of the work.

Mosquitoes of the Year.

Neither the time nor the space is available within the limits of this report to present an adequate discussion of this subject. In fact so large is the mass of accurate data that it is deemed worthy of presentation in a separate paper.

As usual the brown salt marsh mosquito (*Aedes cantator Coq.*) appeared this year to our certain knowledge from Cape May to Jersey City. From midsummer on it was replaced from Jersey City south by the white-banded salt marsh mosquito (*Aedes sollicitans* Wlk.). In the latter part of summer, the latter became in the territory adjacent to the undrained marsh a terrible pest, Cape May and Cumberland Counties suffering especially. In the northern portion of the Hackensack valley *A. cantator* bred throughout the season.

Among the fresh water species this was a year when the unusual species bred commonly. The heavy rainfall of midsummer multiplied the breeding water surface by ten and in the unprotected parts of the State the fresh water species were a veritable scourge. This condition seems to have obtained practically all over the country.

The principal species concerned in this trouble in New Jersey were the house mosquito (*Culex pipiens* Linn.) and the fresh-water swamp mosquito (*Aedes sylvestris* Theob). Contrary to the usual experience, the latter bred everywhere.

While the salt marsh species in the protected area as a whole were under better control than formerly, being entirely absent from many places where last year they were bad, the fresh water species were most unusually hard to control and the local mosquito fighting organizations were given a most severe test.

REPORT OF THE DEPARTMENT OF PLANT PATHOLOGY

Department of Plant Pathology

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*Resigned October 1, 1915.
†Appointed July 1, 1915.
‡Appointed August 1, 1915.

CONTENTS

Report of the Department of Plant Pathology

I.

INTRODUCTORY.

The organization of the Department has been slightly changed since our last report. Mr. G. W. Martin resigned October 1, 1915 and Mr. W. H. Martin, A. B. of the University of Maine and Mr. W. S. Krout, M. S. of the Ohio State University have been appointed assistants. The former began work July first and the latter August first. Mr. H. Clay Lint, M. S. of the Kansas Agricultural College continues in the Fellowship in Plant Pathology, supported by the Union Sulfur Company, for the study of potato scab. Mr. C. A. Schwarze, M. S. of the Columbia University continues with us as Assistant State Plant Pathologist and Mr. Edgar L. Dickerson, B. S. of Rutgers College was employed as special Assistant State Plant Pathologist during July and August to assist in the nursery inspection work.

Climatic Conditions.—The season of 1915 will be remembered as one in which we had heavy rainfalls from early in the spring until late in the summer. This exceptionally wet weather resulted in a very large number of fungus diseases on the agricultural crops, and increased the number of demands for personal visitation to the farms for the purpose of giving advice, and also increased the amount of correspondence. It was impossible to respond to all the calls for assistance.

Cooperation.—Experiments and studies on the brown blotch and black spot of the pear were conducted on the farms of Mr. E. L. Boles, Vineland, Mr. W. H. Jones, Glassboro; and Mr. Wm. H. Titus, Titusville, by Mr. G. W. Martin. The results of these experiments have been published in circular No. 52.

Experiments for the control of the potato scab were conducted on the farms of Mr. Walter Minch, Bridgeton; Mr. Jos. H. Fogg, Bridgeton; Mr. Hartley Ridgeway, Bridgeton; Mr. M. F. Riley, Elmer; Mr. W. J. MacFarland, Burlington; Mr. Earle Dilatush, Robbinsville; Mr. J. Carroll Burtis; Allentown; and Mr. C. W. Stevens, Jr., New Brunswick, by Mr. H. Clay Lint and supported by the Union Sulfur Company. The results of these experiments are appended to this report (page 375).

Spraying experiments in cooperation with the Department of Entomology, and under the direction of Mr. H. Clay Lint were conducted on the farms of Mr. J. Harry Kandle, Elmer; Mr. John W. Black, Mt. Holly; and Mr. Frank P. Jones, Freehold, the results of which are appended to this report. Additional spraying experiments by this Department were conducted on the farm of Mr. Courtney Brown of Jamesburg, and the results are incorporated with the above spray experiments on potatoes (page 381).

Spraying experiments for the control of Black Rot of the grape were conducted by the writer on the farm of Dr. T. Franklin Gifford at Glassboro, the results of which have been published in circular No. 55.

PLANS FOR 1916.—The following outline of field experiments for 1916 is proposed:

1. A continuation of the experiments for the control of potato scab by the use of sulfur, by H. Clay Lint.
2. A continuation of the potato spraying experiments, by H. Clay Lint.
3. Studies on the diseases of the tomato and experiments for their control, by W. H. Martin.
4. Studies of the diseases of celery and methods for their control, by W. S. Krout.

NURSERY INSPECTION.—All the nurseries of the State have been inspected in accordance with Chapter 54, Laws of 1911. They were exceptionally free from fungus and bacterial diseases. The nurserymen are much more interested in these diseases than they have been at any time in the past and many of them are taking every possible precaution for the control of these pests.

The shipments of nursery stock into this State have been much larger than usual and it has been impossible to inspect any considerable amount. However, the work was carried forward as thoroughly as time and funds would permit. It was found necessary to destroy stock in but very few cases.

In our last two reports, we called attention to our cooperation with the Department of Horticulture for the control of Peach Yellows by the distribution of peach buds to the nurserymen in the State who wished to make use of them. The increased demands upon the time of the workers in both this and the Department of Horticulture made it necessary to discontinue this work this year.

EPIDEMICS.—There were four very pronounced epidemics this year. The first was the Fire Blight of the pear and apple which was very destructive throughout the southern half of the State. The second was the Rhizoctonia of the potato which was the cause of poor stand and reduced yields. A special paper on this disease is appended to this report. The third was the Mosaic of the tomato which was very severe in many localities of the State and was also the cause of heavy losses. Fourth, the anthracnose of beans was also much more severe than in the past years and was the cause of heavy losses.

PUBLICATIONS—The following publications have been issued during the year: Circular 44, "Common Disease of Apples, Pears, and

Quinces." Circular 45, "Common Diseases of Peaches, Plums and Cherries." Circular 48, "Bordeaux Mixture."

NEEDS.—The demands of the farmers for personal inspection and advice in regard to a number of diseases, and the very heavy correspondence, emphasize the necessity of having another man in the Department who will devote the greater part of his time to this work, and also to the direction of demonstrations in spraying and other methods of treatment of plant diseases. The increase in the number of county demonstrators is increasing the demand for a man to do this kind of work. During the past year the writer has been compelled to refuse to visit a number of those who requested advice.

The very great importance of the potato industry in New Jersey makes it urgent that there should be at least one man, not necessarily connected with this Department, to make studies on varieties best suited to the State, character of the seed, treatments for diseases and many other problems which are constantly arising in connection with this industry.

The Department is also in need of a plot of ground and a greenhouse specially constructed for experimental work with diseases of plants. At present many experiments and studies are impossible, while the few that we are able to undertake must be conducted on the charity of other departments, at great inconvenience to all parties concerned, and with reduced efficiency.

There is an urgent demand for investigation in a number of diseases which are proving very destructive every year. Among the most important are the Fusarium wilt of the tomato, the Mosaic of the tomato and the Septoria leaf blight of the tomato; the root rot of celery, leaf blight of celery; the wilt disease of egg plant; the wilt and blight diseases of melons and cucumbers; the root disease of alfalfa, the leaf spot of alfalfa; a root disease of coniferous trees; and numerous diseases of ornamental plants. The growing of ornamental plants in New Jersey is one of the most important industries, and the inquiries concerning the diseases of these plants are becoming more and more numerous. These problems are worthy of a very careful study.

II.

MOST COMMON DISEASES OF THE YEAR.

The following is a list of diseases which have been reported or collected by members of the staff during the year. More than half of these diseases were sent in by farmers with inquiries as to their character and methods of control. In some cases there were a great many inquiries concerning a disease.

Alfalfa.

LEAF SPOT (*Pseudopeziza medicaginis* [Lib.] Sacc.). This disease has been about the same as in past years. There were several inquiries concerning it, and it is no doubt the cause of rather heavy losses due to the dropping of the leaves.

WHITE SPOT (Undetermined). Prevalent but not causing a falling of the leaves.

LEAF SPOTS (*Pleospora sp., Cercospora medicaginis* E. & E. *Phyllosticta sp.* and *Ascochyta* sp.) are occasional.

Several undetermined leaf spots which may have been incipient stages of some of the above, or due to some other causes were sent in from time to time.

ROOT ROTS (*Rhizoctonia* sp.). This organism was found in two plantings. Reports *indicated that this or some other root rot organism was causing considerable damage in* other localities.

Ampelopsis.

LEAF SPOT (*Phyllosticta ampelopsidis* Ell. & Mart.). This disease was quite common on the lower part of the ivy plants on buildings, and was a very serious pest in the nurseries. It attacks both *A. quinquefolia* and *A. tricuspidata*.

DIE BACK (*Cladosporium sp.*). This disease occurs on the *A. tricuspidata*. It was much less severe than in 1914. This was probably due to the fact that in 1914 we had a very dry season and in 1915 a very wet season.

Apple.

JONATHAN SPOT (*Alternaria sp.*) A peculiar spotting of the Jonathan is without doubt due to this organism. It continues to be about equally severe from year to year.

Other similar spots are no doubt due to other causes.

BLOSSOM END ROT (*Alternaria sp.*). This disease continues to cause a great deal of trouble with many varieties. It has been less prevalent than in 1914.

ANTHRACNOSE, OR BITTER ROT (*Glomerella rufomaculans* [Berk.] S. & Von S.). Several records. More common than usual.

BLACK ROT (*Sphaeropsis malorum* Pk.). Common and severe on unsprayed orchards.

FIRE BLIGHT (*Bacillus amylovorus* [Burr.] De Toni.). This outbreak occurred soon after blossoming and was very destructive. Much of it was due to blossom infection which later spread to the young fruits. There was also an abundance of twig blight, and many orchards looked as though they had been swept by fire. In many localities large trees were killed by the disease. It was most severe in the southern half of the State.

BLOTCH (*Phyllosticta solitaria* E. & E.) (Fig. 1). This disease has been very severe on some varieties, especially Smith's Cider, but no more severe than in previous years.

SOOTY BLOTCH (*Phyllachora pomigena* [Schw.] Sacc.). Common in unsprayed orchards.

SCAB (*Venturia pomi* (Mont. & Fr.) Sacc.). This was less severe than usual.

BROWN ROT (*Sclerotinia fructigena* (?) [Per] Schroet). More than usual.

PINK ROT (*Cephalothecium roseum* Cda.). Common.

LEAF SPOTS (*Phyllosticta pyrina* Sacc.) (*Sphaeropsis malorum* Pk.). Common, but not so severe as usual.

RUST (*Gymnosporangium juniperi-virginianae* Schw.). Very common in Cape May County and frequently collected in small quantities in other parts of the State. (*G. globosum* Farl.). Occasional.

MILDEW (*Podosphaera oxyacanthae* [De C.] De Bary). One record.

CROWN GALL (*Pseudomonas tumefaciens* E. F. Smith & Townsend). This very common disease is receiving more attention from both nurserymen and growers.

WATER CORE. Occasional.

SPRAY INJURY was much more common than for many years. Spray mixture which had not previously resulted in injury proved very injurious although applied by men thoroughly familiar with the business.

WINTER INJURY was less common than for several years.

LEAF SPOT (*Coryneum foliicolum* Fckl.). In 1912 we reported one case of this disease but later studies indicate that this was an error.

LEAF SPOT AND FRUIT ROT (*Monochaeta* sp.). Occasional.

Asparagus.

RUST (*Puccinia asparagi* De C.). This disease occurred in various places, but not in sufficient quantity to be of any importance.

ROOT ROT (*Rhizoctonia sp.*). This organism was found to be very destructive in one planting and reports indicate that it may be prevalent in other places.

Aster.

YELLOWS. This disease, which is due to an unknown cause, occurred in many places and was very destructive. It was much more severe on outdoor than on indoor plants.

ROOT ROT (*Fusarium sp.*). Several reports.

Barley.

SMUT (*Ustilago nuda* [Jens.] Kell. & Sw.). Very common and in some cases very abundant.

MILDEW (*Erysiphe graminis* D. C.). One very severe outbreak on one of the College Farm experiments.

Bean.

ANTHRACNOSE (*Colletotrichum lindemuthianum* [Sacc. & Magn.] Bri. & Cav.). This disease was much more abundant than in past years and was the cause of many complaints. Its prevalence was, no doubt, due to the rainy season.

LEAF SPOT (*Phyllosticta phaseolina* Sacc.). This disease was quite common on the leaves of lima beans.
RUST (*Uromyces appendiculatus* [Pers.] Lev.). One record.
POD SPOT (*Phoma subcircinata* E. & E.). This disease was very common on lima beans.
DOWNY MILDEW (*Phytophthora phaseoli* Thaxter). Common on the lima bean.
ROOT ROT (*Rhizoctonia* sp.). Investigations of several complaints showed that this organism was present in cankers on the stems. It was frequently associated with *C. lindemuthianum*.

Beet.

LEAF BLIGHT (*Cercospora beticola* (Sacc.). Quite common.

Blackberry.

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Common, and destructive in many places.
LEAF SPOT (*Septoria rubi* West.). Common.
RUST (*Gymnoconia peckiana* [Howe] Trans.). Common, and the subject of many inquiries.

Cabbage, Cauliflower and Kohlrabi.

CLUB ROOT (*Plasmodiophora brassicae* Wor.). This disease was reported from many localities, but most frequent from the northern part of the State.
LEAF MOULD (*Macrosporium brassicae* Berk.). One report.

Cantaloup.

See Muskmelon.

Carnation.

RUST (*Uromyces caryophyllinus* [Schrank] Wint.). Common but not serious.
ROOT ROT (*Corticium vagum* B. & C. var. *solani* Burt.). Common but not serious.
BUD ROT (*Sporotrichum poae* Pk.). One record.
YELLOWS (?). Serious on some varieties.

Catalpa.

LEAF SPOT (*Marcrosporium catalpae* Ell. & Mart.). Common.
LEAF SPOT (*Phyllosticta catalpae* Ell. & Mart.). Common.

Cedar.

RUST (*Gymnosporangium juniperi-virginianae* Schw.) (*Gymonsporangium germinale* [Schw.] Kern.). Reported but of little importance. The former was most abundant in Cape May County. *G. botryapites* was found to be quite abundant in Atlantic County.

Celery.

EARLY LEAF BLIGHT (*Cercospora apii* Fr.). Reported from several places. Very destructive.
LATE BLIGHT (*Septoria petroselini* Desm. var. *apii* Br. & Car.) Very abundant in certain localities and one of the most important celery diseases in the State.
ROT (Bacterial [?]). Very severe in many localities.

Chard.

LEAF SPOT (*Cercospora sp.*). One record.

Cherry.

BROWN ROT (*Sclerotinia cinerea* [Bon.] Wor.). Common.
LEAF SPOT (*Cylindrosporium padi* Karst.). Common, and the subject of many complaints.

Chestnut.

BARK DISEASE (*Endothia parasitica* [Mur.] Ander.). Common throughout the State.
LEAF SPOT (*Actinopelte japonica* Sacc.). One record.
LEAF SPOT (*Marssonia orchroleuca* B. & C.). One record.

Citron.

LEAF SPOT (*Cercospora citrullina* Cke.). Common.

Crimson Clover.

CROWN ROT (*Sclerotinia libertiana* Fuckel.). Not as common as usual.

Red Clover.

RUST (*Uromyces trifolii* [Hedw.] Lev.). Occurs throughout the State.
LEAF SPOT (*Cercospora medicaginis* E. & E.). One record.
LEAF SPOT (*Pseudopeziza trifolii* [Bernh] Fd.). One record.
ANTHRACNOSE (*Colletotrichum trifolii* Bain). One record.

Sweet Clover.

STEM SPOT (*Ascochyta caulicola* Loubert). One record.

Corn.

Smut (*Ustilago zeae* [Beckm.] Ung.). This very common and very widely distributed disease is not often serious except on sweet corn.

Wilt (*Pseudomonas stewarti* Erw. Smith). This disease was reported from several localities in the early part of the season, and was the cause of considerable loss among growers of early sweet corn.

Rust (*Puccinia sorghii* Schw.). Not serious.

Cowpea.

Leaf Spot (*Cercospora dolichii* E. & E.). Frequent.

Crab (Flowering).

Rust (*Gymnosporangium*, probably *G. juniperi virginianae* Schw.). Occasional.

Black Rot (*Sphaeroosis malorum* Pk.). One record.

Cranberry.

Scald (*Guignardia vaccinii* Shear). This disease was widely distributed throughout the State, and the cause of considerable loss where the bogs were not well sprayed.

Gall (*Synchytrium vaccinii* Thomas). Very abundant in one bog.

False Blossom (Cause undetermined). Prevalent in one part of one bog. Said to have been introduced on plants from Wisconsin.

Croton.

Leaf Spot (*Gloeosporium* sp.). In greenhouse—One report.

Cucumber.

Wilt or Blight (*Bacillus tracheiphilus* Erw. Smith). Very widely distributed, and the cause of considerable loss.

Downy Mildew (*Plasmopara cubensis* [B. & C.] Humphrey). Common, and frequently the cause of heavy losses.

Dahlia.

Leaf Spot (*Phyllosticta* sp.). Common.

Dewberry.

Double Blossom (*Fusarium rubi* Wint.). This disease continues with equal severity where the nurserymen and growers do not try to control it. However, many of our most progressive men are keeping it well under control by hand picking of the diseased buds early in the season. It is most severe on Lucretias, Rathbuns and Black Diamonds.

Anthracnose (*Gloeosporium venetum* Speg.). Very abundant, and in some cases destructive.

Leaf Spot (*Septoria rubi* West). Common.

Rust (*Gymnoconia peckiana* [Howe.] Tranz.). Reported as common, and in some cases destructive.

Dracaena terminalis.

Leaf Spot (*Phyllosticta maculicola* Hals.). In green-houses.

Egg Plant.

Leaf Blight (*Phomopsis vexans* [*Sacc. & Syd.*] Harter; Syn. *Phyllosticta hortorum* Speg.). Very common and in some cases destructive.

Wilt (*Fusarium* sp.). Common and destructive.

Elm.

Leaf Spot (*Melasmia* stage of *Rhytisma* ulmi Fr.). Very common.

Euonymus.

Mildew (*Microsphaera euonymi* [D. C.] Sacc.). One record.

Gladiolus (Gladiolus sp.)

Bulb Rot. Cause undetermined.

Grape.

Black Rot (*Guignardia bidwellii* [Ell.] Viala & Ravaz). (*Fig. 2*). Common and very destructive in some vineyards in the southern part of the State.

Anthracnose or Bird's Eye Rot (*Gloeosporium ampelophagum* Sacc.). One record.

Ripe Rot (*Gloeosporium fructigenum* Berk.). One record.

Necrosis (*Fusicoccum viticolum* Reddick). Two reports.

Downy Mildew (*Plasmopara viticola* [B. & C.] D. T.). Common but not serious.

Bitter Rot (*Melanconium fuligineum* S. & V. Cav.). One record.

Hawthorne (English).

Berry Spot (*Phyllosticta* sp.). One record.

Hollyhock.

Rust (*Puccinia malvacearum* Mont.). (Fig. 3). Very common, and the subject of many inquiries.

Horse-Chestnut.

LEAF BLOTCH (*Phyllosticta paviae* Desm.). Less severe than usual.

Horse Radish.

LEAF SPOT (*Septoria lactucae* Pass.). One record.

Juniper.

RUST OR CEDAR APPLE. See Apple.

Kohlrabi.

CLUB ROOT (*Plasmodiophora brassicae* Wor.). Common.

Lettuce.

LEAF SPOT (*Septoria lactucae* Pass.). One record.

Lilac.

MILDEW (*Microsphaera alni* [Wallr.] Wint.). Abundant throughout the State.
LEAF SPOT (*Phyllosticta halstedii* Ell.). Reported from several localities.

Maple.

DARK DISEASE (*Nectria coccinea* or *N. cinnabarina* [Tode.] Fr.). The *Tubercularia* stage of *Nectria* was found on Norway maples, evidently working as a weak parasite.
TAR SPOT (*Rhytisma acerinum* [P.] Fr.). Occasional.
LEAF SPOT (*Phyllosticta acericola* C. & E.). Common.
ANTHRACNOSE (*Gloeosporium apocryptum* E. & E.). Several records.
LEAF SCALD (Physiological). Many complaints.
WINTER INJURY. Occasional.

Mignonette.

LEAF SPOT (*Cercospora resedae* Fckl.). One record.

Mulberry.

DIE BACK (*Sphaeropsis mori* Berl.). One record.
DARK DISEASE (*Nectria* sp.). One record. Evidently working as a weak parasite.

Muskmelon.

WILT OR BLIGHT (*Bacillus tracheiphilus* Erw. Smith.). Common and destructive in some cases.
DOWNY MILDEW (*Plasmopara cubensis* [B. & C.] Humphrey). Common but not severe.
MOLD (*Cladosporium cucumerinum* Ell. & Arth.). Common.

Oak.

ANTHRACNOSE (*Gnomonia veneta* [Sacc. & Speg.] Kleb.). The *Gloeosporium* stage was common and the cause of many complaints.
MILDEW. Conidial stage. Occasional.

Nasturtium.

LEAF SPOT (*Bacterium aptatum* B. & J.). One record.

Oats.

SMUT (*Ustilago avenae* [Pers.] Jens.). Common.
RUST (*Puccinia coronata* Cda.). Common.
RUST (*Puccinia graminis* Pers.). Occasional. (In the Report of the Plant Pathologist of the New Jersey Station for 1913, it was stated that this was common. This was an error.)

Onion.

ROT (*Bacterial?*) Several reports. Probably influenced by the wet weather.

Okra.

WILT (*Verticillium* sp.). Abundant in one locality and found in another.

Pea.

STEM AND ROOT ROT (Apparently due to *Fusarium* sp.). Quite common, and destructive in some localities.
LEAF SPOT (*Ascochyta pisi* Lib.). Two records.

Peach.

BROWN ROT (*Sclerotinia cinerea* [Bon.] Wor.) (Fig. 4). Common throughout the State. Severe on fruit in unsprayed orchards. Also the cause of more dying back on the new growths than usual.
CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Common. See Apple.
LEAF CURL (*Exoascus deformans* [Berk.] Fuckel.). Abundant where the orchards were not sprayed.

SCAB (*Cladosporium carpophilum* Thum.). The severity of this very common disease varied with the thoroughness of the spraying. In most cases it developed much later than usual, an indication which led many growers to believe that it would not be a serious pest.

SHOT HOLE (*Phyllosticta circumcissa* Cooke). Common.

SHOT HOLE (*Bacterium pruni* Smith). Less severe than for the past two years.

POWDERY MILDEW (*Sphaerotheca pannosa* [Wallr.] Lev.). Occasional.

YELLOWS AND LITTLE PEACH. Very abundant and the cause of heavy losses.

WINTER INJURY. Several reports.

SPRAY INJURY. Several reports.

Pear.

BROWN ROT (*Sclerotinia fructigena* (?) [Pers.] Schroet). More abundant than usual.

FIRE BLIGHT (*Bacillus amylovorus* [Burr.] De Toni.). Common. See Apple.

LEAF BLIGHT (*Fabraea maculata* Lev.—Entomosporium stage). Abundant on leaves and fruit. This disease is likely to cause severe losses in good crop years unless the growers give more attention to its control.

LEAF SPOT (*Septoria pyricola* Desm.). Abundant.

BROWN BLOTCH. (Cause?). Common in southern part of the State. (Figs. 5, 6, 7.)

Peony.

BUD ROT (Cause undetermined). Prevalent.

Pepper.

ANTHRACNOSE (*Colletotrichum nigrum* E. & H.). Common in the fall.

ROT (*Macrosporium* sp.). Common on fruits and also found on seeds. May have been secondary.

Pine.

ROOT DISEASE. This disease is evidently due to the attack of a root fungus resulting in a Mycorhiza. It is very destructive in the nurseries on pines and other coniferous stock grown under crowded conditions.

RUST (*Peridermium piriforme* Pk.). Common in Atlantic County and probably has a wider distribution. The *Cronartium* or *Comptoniae* was also collected in Atlantic County.

(*P. acicolum* collected on *P. taeda*). Common in Atlantic County.

(*P. pini*) was also collected in Atlantic County on *Pinus taeda*.

Plum.

BLACK KNOT (*Plowrightia morbosa* [Schw.] Thum.). Common throughout the State.

BROWN ROT (*Sclerotinia cinerea* [Bon.] Wor.). Common throughout the State. See Peach.

SHOT HOLE (*Phyllosticta circumscissa*). Occasional.

LITTLE PLUM (Cause undetermined). Occasional.

Poplar.

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Occasional.

LEAF SPOT (*Marsonia populi* [Lib.] Sacc.). Common.

Potato.

SCURF (*Rhizoctonia* or *Corticium vagum* D. & C. var. *solani* Burt.). This very widely distributed disease was much more severe this year than usual. A special paper on this disease is appended to this report.

BLACK LEG (*Bacillus phytophthorus* Appel). This well-known disease was less severe than usual.

SCABS. (*Actinomyces chromogenus* Gasp.). This disease was fully as severe as in past years.

RUSSET SCAB. A peculiar russetting was common in many parts of the State. It appears that this condition can be produced by the common scab organism or by *Rhizoctonia*.

SILVER SCURF (*Spondylocladium atrovirens* Harz.). This newly introduced European disease was found in a few fields. It is very doubtful if it will prove serious on our New Jersey crop.

EARLY BLIGHT (*Alternaria solani* [E. & M.] S. & G.). This disease was more abundant, but it cannot be said to be of much importance in the New Jersey crop.

LATE BLIGHT (*Phytophthora infestans* De By.). This disease was more abundant on the growing crop than usual.

ARSENICAL POISONING was reported from a few localities. It was always due to careless treatment.

TIP BURN. The season was much wetter than usual and the potatoes ripened at least two weeks earlier than usual. This early ripening was apparently due to tip burn caused by intense heat on rather succulent plants growing with a superabundance of water, but was complicated to some extent by fungus diseases, especially by the prevalence of *Rhizoctonia*.

NET NECROSIS (Cause undetermined). Much more abundant than usual.
ROLL LEAF (Cause unknown). This disease was quite prevalent in many localities.
MOSAIC (Cause unknown). Prevalent in some fields.
CURLY DWARF (Cause unknown). Occasional.
DODDER (*Cuscuta* sp.). Occasional.

Phlox.

POWDERY MILDEW (*Erysiphe communis* [Walh] Schl.). Common.

Privet.

ANTHRACNOSE (*Gloeosporium cingulatum* [Atk.] S. & S.). One record.

Quince.

BLACK ROT (*Sphaeropsis malorum* Pk.). Very abundant and very severe. See Apple.
FIRE BLIGHT (*Bacillus amylovorus* [Burr.] DeToni). Abundant and severe. See Apple.
RUST (*Roestellia aurentiana* Peck). Reported from several localities.

Raspberry.

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Abundant and destructive.
CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Abundant. See Apple.
LEAF SPOT (*Septoria rubi* West). Abundant.
CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Abundant and destructive. The cause of an increasing number of complaints.
CANE SPOT (*Cytospora rubi* Schw.). One record.
CANE SPOT (*Rhabdospora rubi* Ellis). One record.

Rose.

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Frequent.
ANTHRACNOSE (*Gloeosporium rosae* Hals.). Common, but no serious.
LEAF BLOTCH (*Actionema rosae* [Lib.] Fr.). Common, and very severe in the greenhouses.
POWDERY MILDEW (*Sphaerotheca pannosa* [Wallr.] Lev.). Common and more severe than usual.
RUST (*Phragmidium subcorticum* [Schr.] Went.). One record.
LEAF SPOT (*Phyllosticta rosicola* Mass.). Abundant, and frequently confused with black spot.
CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Common, and the cause of many complaints.

Screw Pine (Pandanus utilis).

LEAF SPOT (*Phomopsis sp.*). In greenhouses. Does considerable damage.

Snap-Dragon.

ANTHRACNOSE (*Colletotrichum antirrhini* Stew.). One record.

Strawberry.

LEAF SPOT (*Mycosphaerella fragariae* [Tul.] Lindau). Common.
LEAF SPOT (*Ramularia tulasnei* Sacc.). Common.
LEAF SPOT (*Marsonia potentillae* [Desm.] Fish). Frequent.
WINTER INJURY. Reported from several localities.

Sweet Potato.

BLACK ROT (*Sphaeronema fimbriatum* [E. & H.] Sacc.). Abundant, but not so severe as in 1912.
WET ROT (*Rhizopus nigricans* Ehr.). Common in storage, but readily controlled by ventilation.
STEM ROT OR YELLOW ROT (*Fusarium batatatis* Wollen.). Common, but not so destructive as in 1912.
ROT (*Diaporthe batatatis* Harter & Field). The Phoma stage. Common.
CHARCOAL ROT (*Sclerotium bataticola* Taub.). Frequent.
ROT (*Trichoderma Koenigii* Ould.). Common.
ROT (*Melanospora globosa* Berl.). Common. May have been secondary.
ROT (*Penicillium sp.*). Common. May have been secondary.
SCURF OR SOIL STAIN (*Monilochaetes infuscans* E. & H.). More abundant than in past years.

Sycamore.

ANTHRACNOSE (*Gnomonia veneta* [Sacc. & Speg.] Kleb.). Much more severe than usual.

Timothy.

RUST (*Puccinia phlei-pratensis* E. & H.). One record.

Tomatoes.

ANTHRACNOSE (*Colletotrichum phomoides* [Sacc.] Chester). A few reports.
FRUIT ROT (*Macrosporium solani* E. & M.). More abundant, and more severe than usual.
FRUIT ROT (*Botrytis sp.*). Common in greenhouses and causing a blossom end rot.
STEM BLIGHT (*Fusarium lycopersici* Sacc.). Common and very severe in some localities.
BLOSSOM END ROT (Cause questionable). Common.
LEAF SPOT (*Septoria lycopersici* Speg.). Abundant and severe.
LEAF SPOT (*Ascochyta lycopersici* Brum). Common in the greenhouse.
MOSAIC—Filiform Leaf (Cause undetermined). Very abundant in many localities.

Walnut.

LEAF SPOT (*Marsonia juglandis* [Lib.] Sacc.). Abundant.

Water Melon.

ANTHRACNOSE (*Colletotrichum lagenarium* [Pass.] E. & H.). Abundant in southern part of the State.

Wheat.

RUST (*Puccinia coronata* Cda.). Common. (*Puccinia graminis* Pers.). Occasional. (*Puccinia rubigo-vera* [DeC.] Wint.). Common. (*Puccinia triticina* Erik.). Common.
SMUT (*Tilletia foetens* [B. & C.] Trel.). Frequent (*Tilletia tritici* [Beij.] Wint.). Abundant.
SMUT (*Ustilago tritici* [Pers.] Jens.). Common.
MOLD (*Cladosporium herbarum* [Pers.] Lk.). Abundant in places.

Willow.

LEAF SPOT (*Gloeosporium salicis* West). Common.

Forest and Shade Trees.

We had many complaints concerning a burning or scald of the foliage which was rather difficult to explain but apparently due to physiological conditions. We also had some few complaints of gas injury.

III.

REPORT OF POTATO SCAB EXPERIMENTS, 1915*

H. Clay Lint.

The investigation of the influence of sulfur in the control of potato scab, *Actinomyces chromogenus* (Gasparini), which was begun by the Department of Plant Pathology in 1914 has been continued during the past summer. In 1915 attention was given to a number of factors bearing on the extent and control of the disease.

It has been impossible to continue work with all the conditions relating to the effectiveness of sulfur as a soil fungicide. Of the five lines of investigation taken up formerly, the two dealing with (1) the influence of cover crops on the control of scab as affected by sulfur, and, (2) the time of application of sulfur, were discontinued.

Very satisfactory results were obtained pointing toward a smaller benefit from sulfur on soil which had grown a cover crop than one which had not. Likewise, spring applications of sulfur proved more satisfactory than the application of an equal quantity the preceding fall. Both have practical bearing and would merit continued investigation.

The results of the experiments in 1914 show that the benefits of sulfur may vary with the type of soil and variety of potatoes. It has been found impossible to test out all these factors so that the work for 1915 has been limited to the Irish Cobbler variety. Practically all of the early grown potatoes are of this variety. It is grown commercially in all potato growing sections of the State. It has a more pronounced tendency to scab than any other commercial variety grown within New Jersey so that under the limited conditions it was considered best to use but one variety. Unfortunately, it has been impossible to have the same seed used everywhere and therefore, climatic and soil differences are not the only variants between duplicate experiments. Undoubtedly a variation in results is occasioned by differences in soil texture but because of the impossibility of testing all soil types, we have tried to locate experiments on typical potato soils ranging from the loam to sandy loam nature.

The results of many previous investigations as well as those obtained in our own work last year plainly indicate that sulfur applied to the soil can decrease the amount of scab. Several instances in which sulfur applied to potatoes has resulted in an injured stand of the succeeding grass crop has been noted. The problem of making this material desirable for general application resolved itself into that of eliminating the objectionable features.

With this object in view, the experiments of this year were designed to compare the effects of small applications for two or more years, with

*Syn. *Oospora scabies* (Thaxt.) *Actinomyces scabies* (Thaxt.) Güssow.

a heavy application for one year. The use of a sulfur-limestone mixture was tested for its relative efficiency in scab control as well as for any *deleterious effect on the yield.* Sherbakoff* of the Cornell Agricultural Experiment Station reports that the benefits of sulfur are not impaired and the injurious effects lessened in such a mixture.

In addition to the preceding experiments, the following lines of investigation were continued this year:

(1) The influence of the method of application. Last year a considerable variation was occasioned in the results from this cause. The method of applying the sulfur in a narrow strip on top of the row was not used this year because of the decreased production which usually results where the sulfur is so applied.

(2) The influence of the form in which the three essential elements, Nitrogen, Phosphorus and Potasium are supplied in the fertilizer.

(3) The influence of the formalin treatment of the seed on the efficiency of sulfur.

Influence of the Various Factors Tested in 1915.

FIRST: *Influence of the method of application.* As in this work conducted last year, this phase of the problem has been limited to those methods which are practical with a considerable acreage.

Three methods of application were tested:

(a) Mixture of sulfur with the fertilizer.
(b) Broadcasting of sulfur before planting.
(c) Broadcasting of sulfur after planting.

The time element of "before" and "after" planting is of no consequence; the principal difference being that when the sulfur is broadcasted before planting it becomes well integrated with the surface soil through the process of harrowing and planting.

Experiments covering this part of the problem were conducted in cooperation with Mr. M. F. Riley at Elmer, New Jersey, and Mr. Earle Dilatush at Robbinsville. While the degree of benefit from sulfur differs in these two experiments, yet the relative efficiency is in the same order. The method of broadcasting the sulfur being much more efficient than that of mixing with the fertilizer. This point was demonstrated last year in the experiment conducted in cooperation with Mr. Clifford Flitcraft of Elmer, New Jersey, and is substantiated by the results at two places this year. The results of the experiment in cooperation with Mr. M. F. Riley this year show an average increase in the percent of clean potatoes due to application of six hundred pounds of sulfur per acre:

(1) Mixed with the Fertilizer = 2.28 ± 1.117
(2) Broadcasted after planting = 8.39 ± 1.59
(3) Broadcasted before planting = 31.39 ± 1.57

At Robbinsville the fact of the inefficiency of sulfur when used in mixture with the fertilizer was even more apparent. The scab was not controlled by this mixture, and the potatoes which grew in actual con-

*Sherbakoff, C. D.—Cornell Agr. Exp. Sta. Bul. 350; pp. 707-743 (1914).

tact with the mixture produced a corky epidermis which was as unsightly as the scab itself. Such a condition is shown on the potatoes in Figure 8.

That actual contact with the fertilizer produced this condition is not at all doubtful, since many tubers were clean on the upper side and suberized on the lower. The epidermal tissue was very acid to the taste, and the condition is probably explainable for that reason. The results on the scab control here show 7.01 .880 more scab on the plots receiving the sulfur-fertilizer mixture than the checks as compared with 13.6% 2.325 for broadcasting of the sulfur after planting.

The deleterious effect of the sulfur-fertilizer mixture on the yield is shown by a decrease of 27.01 bushels per acre on those plots as compared with a loss of only .15 bushels per acre for the plots receiving broadcast application after planting.

At Elmer the application of sulfur in all cases resulted in an increased yield as shown by the following results.

Increase in yield due to sulfur applied at rate of six hundred pounds per acre:

(1) Sulfur in mixture with fertilizer = 21.73 ± 6.45 bu. per acre.
(2) Sulfur broadcasted after planting 17.20 ± 4.965 bu. per acre.
(3) Sulfur broadcasted before planting 29.69 ± 6.48 bu. per acre.

Apparently there has been a reversal in the results of applying sulfur before and after planting from that obtained in 1914. The seasonal contrast from an exceptionally dry to very wet, with almost as much contrast in temperature conditions, may have caused this occurrence.

Plot Arrangement, Method of Taking and Interpreting Data With the Probable Error.

In the experimental work with sulfur this year we have used plots four rows wide by one hundred feet long in most cases. Small plots have been generally accepted as more accurate because of the fewer variations within the plot itself and particularly is this advisable in work with potato scab which is notorious for its lack of uniformity of distribution. In all experiments there have been parallel check plots either alternating with or adjacent to the treated plots.

In calculating the results the theoretical yield or per cent clean was calculated for each plot from the data for the adjacent checks. The benefit claimed for the treatment is the difference between the calculated data and the actual data. The average of the benefits so derived is then calculated rather than taking the difference of the average of all checks over that for all treated plots.

The experimental error appended to most of the figures quoted is to be taken as an index of the uniformity of the figures which go to make up the average. It also serves to tell to what extent a certain benefit is due. The experimental error is calculated by the formula $Pe. = .6745 \sqrt{\frac{\Sigma d^2}{N\ (N-1)}}$

In harvesting, the entire crop of each plot was picked up and the yield determined. A portion of the yield varying from one-half to the entire production was sorted into relative clean and scabbed potatoes. The weights of each class were then used for calculating the per cent of clean potatoes. In most cases the scab attack has not been so prominent as common and the grading was very strict.

SECOND: The influence of the form in which the three essential elements, Nitrogen, Phosphorus, and Potasium are supplied to the fertilizer.

An experiment testing the results obtained from the use of sulfur when used in connection with fertilizers containing nitrate of soda versus ammonium sulfate as a source of nitrogen; acid phosphate versus steamed bone as a source of phosphorus; and sulfate of potash versus chloride of potash as a source of potash, was conducted in cooperation with Mr. Jos. H. Fogg at Bridgeton, New Jersey.

Essentially the same experiment was conducted on the same area in 1914. Due to the high cost of potash salts only a 4-8-7½ fertilizer was used this year whereas 4-8-10 was used in 1914. Each fertilizer was used on the same area as the year previous. The sulfur plots of 1914 which were either seven or nine rows wide were split into two plots in 1915, one receiving sulfur again this year, the other receiving none in order to note the second influence.

The results of the experiment this year bear out those of 1914 in two out of three cases. The sulfur is more effective in combination with KCl than with K_2SO_4 and with acid phosphate than with steamed bone as shown by the following table:

Table I.

Comparison of the Influence of Sulfur in Combination With KCl Versus K_2SO_4.

Fertilizer	*Treatment 1914*	*Treatment 1915*	*% Clean*
KCl	Check	Check	37.92
K_2SO_4	Check	Check	59.00
KCl	300 lbs. S. per acre.	Check	62.20
K_2SO_4	300 " " " "	Check	65.55
KCl	300 " " " "	300 lbs. S. per acre.	66.28
K_2SO_4	300 " " " "	300 " " " "	74.50
KCl	600 " " " "	Check	61.50
K_2SO_4	600 " " " "	Check	67.20
KCl	600 " " " "	300 lbs. S. per acre.	64.60
K_2SO_4	600 " " " "	300 " " " "	60.00

Table II.

Comparison of the Influence of Sulfur Combination With Acid Phosphate Versus Steamed Bone.

Fertilizer	*Treatment 1914*	*Treatment 1915*	*% Clean*
Steamed Bone	Check	Check	43.40
Acid Phosphate	Check	Check	37.92
Steamed Bone	300 lbs. S. per acre.	Check	48.08
Acid Phosphate	300 " " " "	Check	62.20
Steamed Bone	300 " " " "	300 lbs. S. per acre.	61.65

Acid Phosphate	300 lbs. S. per acre.	300 lbs. S. per acre.	66.26
Steamed Bone	600 " " " "	Check	69.00
Acid Phosphate	600 " " " "	Check	61.50
Steamed Bone	600 " " " "	300 lbs. S. per acre.	58.20
Acid Phosphate	600 " " " "	300 " " " "	64.60

Table III.

Comparison of the Influence of Sulfur in Combination With $NaNO_3$ Versus $(NH_4)_2SO_4$

Fertilizer	*Treatment 1914*	*Treatment 1915*	*% Clean*
$NaNO_3$	Check	Check	38.65
$(NH_4)_2SO_4$	Check	Check	30.70
$NaNO_3$	300 lbs. S. per acre.	Check	41.70
$(NH_4)_2SO_4$	300 " " " "	Check	41.65
$NaNO_3$	300 " " " "	300 lbs. S. per acre.	59.20
$(NH_4)_2SO_4$	300 " " " "	300 " " " "	49.45
$NaNO_3$	600 " " " "	Check	63.85
$(NH_4)_2SO_4$	600 " " " "	Check	50.33
$NaNO_3$	600 " " " "	300 lbs. S. per acre.	55.70
$(NH_4)_2SO_4$	600 " " " "	300 " " " "	65.30

The results with nitrate of soda as compared to sulfate of ammonia are somewhat reversed, the sulfate of ammonia showing a smaller increase in three out of four possibilities than nitrate of soda. In 1914 the sulfate of ammonia gave a more pronounced difference than nitrate of soda.

Since nitrogen fertilizers are the only ones in which micro-organisms play any important role in rendering the nitrogen available, it is possible that the wide climatic differences in the two seasons may have caused entirely different biological activities. A cold and moist soil would not be as active biologically as a warmer one, but since we do not know the influence of this agent any considerations are purely theoretical.

Third: The infinence of seed treatment by soaking in solution of formaldehyde or of corrosive sublimate, as recommended by this Department, gave promising results in 1914. This phase of the work has been continued during the present season. Two experiments covering this point in connection with sulfur application were made this year, one at Burlington in cooperation with Mr. W. J. McFarland, the other at Bridgeton in cooperation with Mr. Walter Minch. In general, the results of seed treatment bear out those of last year to the effect that (1) seed treatment will decrease the amount of scab to a certain extent even on soils contaminated with the scab organism. (2) Sulfur is more effective in controlling scab when used with treated than with non-treated seed.

The results of seed treatment at Burlington were very marked. Applications of sulfur at the rate of six hundred pounds per acre increased the amount of clean tubers about 20 per cent for both treated and untreated seed. We find that it is more difficult to increase the per cent of clean potatoes, the 20 per cent from 50 to 70 per cent than from 30 to 50 per cent, and since the treated seed was normally cleaner than the untreated, it followed that the sulfur must have been more effective to cause the same increase in the per cent of clean tubers.

FOURTH: Influence of limestone-sulfur mixtures on the control of scab. Since these experiments were designed to cover at least two years work, any statements concerning the results before the end of the second season would be premature. The sulfur has decreased the scab, much as it has on other experiments, but subsequent applications of limestone alone, sulfur-limestone mixtures and of sulfur alone are called for in the future plans of the work and thus far these experiments show no results not heretofore brought out in other experiments. Two experiments of this type were conducted in cooperation with Mr. Hartly W. Ridgeway at Bridgeton and Mr. Carroll Burtis at Allentown, respectively.

Second Year Influence of Sulfur.

(1) On Succeeding Crops.

Two cases of injury to the hay crop following potatoes to which sulfur had been applied were noted in 1914. No permanent injury was effected in either case. The plots to which sulfur was applied last year were seeded to a variety of crops, none of which have shown any injurious effects. Corn crops planted on the experimental areas on the farms of John Prinsen, Salem; Aaron Cuff, Salem, Walter Minch, Bridgeton; John Ballinger, Mullica Hill; Edward Ackerson, Lafayette; showed no effects whatever. At Elmer in the farm of Clifford Flitcraft, the soil received about two tons of lime to the acre after potatoes and was seeded to alfalfa. In the late fall and the following spring, the sulfured areas were faintly marked by a less even stand. By the end of the following summer no differences were detectable. Alfalfa is probably as sensitive towar acidity as any of the common crops and if a satisfactory stand can be secured immediately after potatoes through the liberal application of lime, there should exist no fears of any permanent injury to the soil because of sulfur application.

(2) Influence on Succeeding Potato Crop.

The areas on which the experiments were conducted on the farms of Mr. John DuBois and Mr. D. Howard Jones at Freehold in 1914 were planted in potatoes again this year but did not receive additional applications of sulfur. It was observed that the vines on the sulfured areas died about seven days earlier than the non-sulfured areas. On Mr. Jones' farm the rows ran at right angles to the sulfured areas and it was impossible to obtain data as to any injury. On the adjacent farm of Mr. DuBois, however, the yields of tubers from the sulfured and unsulfured areas showed a slightly larger yield on the sulfured areas. These same plots in 1914 showed a pronounced decrease in yield and that no injury was done here despite the earlier death of the vines indicates no injurious after effects. As pointed out last year there exists a varietal difference in the response to sulfur applications. With the Giants there results an earlier maturity, a feature which has not been observed with Irish Cobbler vines. The amount of scab was too small to merit sorting the potatoes grown this year on Mr. DuBois' farm, but there existed a perceptible difference in the quality of the yields from sulfured and non-sulfured areas. The potatoes on the former possessed a whiter epidermis with an apparently finer texture.

Data showing the second year influence of sulfur on the control of scab is shown by the following table of results of the experiment in cooperation with Mr. Jos. H. Fogg at Bridgeton, New Jersey.

Table IV.

The average per cent of clean potatoes for each condition is the average of six similar plots relative to sulfur treatment.

Treatment 1914.	Treatment 1915.	Average % Clean.	± Error	Increase in % Clean
Check..............	Check	41.278	3.513	....
300 lbs. S. per A......	Check	53.33	2.965	+ 12.955
300 lbs. S. per A......	300 lbs. S. per A.	61.32	2.35	+ 20.042
600 lbs. S. per A......	Check	58.46	3.225	+ 17.182
600 lbs. S. per A......	300 lbs. S. per A.	60.89	1.012	+ 19.612

These results show a pronounced second year influence from application of both 300 and 600 pounds of sulfur per acre in 1914. While no great difference exists between any of the last three conditions noted above, still it appears as though the second year influence of 600 pounds of sulfur to the acre is greater than for 300 pounds. Two successive applications of 300 pounds of sulfur per acre appear to be more effective than only one of 600 pound per acre and also as good as 600 pounds per acre followed by 300 pounds. These results are quite indicative and have intimate bearing on the practical side of the problem of scab control by means of sulfur. Whether or not these indications are authentic will be determined by the sulfur-limestone experiments mentioned previously.

IV.

REPORT OF POTATO SPRAYING EXPERIMENTS FOR 1915.

H. Clay Lint.

Dusting and spraying experiments on Irish potatoes were first started by the Experiment Station two years ago. Since both fungus and insect enemies play an important rôle as causes of injury to the potato vines, the experiments have been conducted cooperatively by the Departments of Entomology and Plant Pathology. The work was started in 1913 under the supervision of Mr. George W. Martin of this Department. In 1914 the scope of the work was broadened by the addition of three experiments at Elmer, Robbinsville, and Freehold, respectively. These experiments were run under the supervision of Mr. A. E. Cameron of the Entomology Department.

Experiments similar in scope and nature to those of 1914 were planned and it was the privilege of the writer to supervise the work of applying the prescribed treatments. The work of taking the data on the yields was done by Mr. Frank Jones, one of the cooperating growers, Mr. W. H.

Komp of the Department of Entomology and by Messers W. S. Krout and W. H. Martin of the Department of Plant Pathology. Because of his having given attention to these experiments throughout the growing season, the writer has been permitted to submit this report.

Experiments this year were conducted under the conditions of the three distinct sections in which potato growing is carried on extensively. At Elmer the work was carried on in cooperation with Mr. J. Harry Kandle, on whose farm similar work has been done in both 1913 and 1914. A second experiment was located at Mt. Holly and carried on in cooperation with Mr. John Black. The third of this type was conducted in cooperation with Mr. Frank P. Jones on his farm at Freehold, N. J.

The Experiment Station has also cooperated with a number of commercial firms in this work as follows:

(1) The Union Sulfur Co., of New York City, has donated, through Mr. F. H. Pough, Manager of the Research Department, the sulfur-dust mixtures used and furnished also the machines used in applying these materials.

(2) Mr. C. D. Vreeland, manufacturing chemist of the Kil-Tone Co., of Newark, N. J., has furnished the "Improved Kil-Tone" used at Elmer.

(3) Mr. F. E. Embree, Manager of the Burlington County Farmers Exchange, has donated Hermann's Tonicide for use in the work at Mt. Holly.

(4) The Corona Chemical Company, of Milwaukee, Wis., has furnished the lead arsenate used in the dust mixture, and also a sufficient quantity for spraying the check plots and for use in combination with Bordeaux mixture.

There are three possible ways in which spraying treatments might promote a healthy development of the plants and consequently a maximum yield of potatoes.

(1) The control of insect enemies. Two insects annually cause great damage to the vines of potatoes if no control measures are practiced. The Colorado Potato Beetle (*Leptinotarsa decemlineata* Say.) is very prevalent but can be effectively controlled by the use of arsenical poisons. The Flea-beetle (*Epitrix cucumeris* Harris) is very abundant, and to date has been most successfully eliminated as a cause of injury by thorough spraying with Bordeaux mixture which acts principally as a repellent.

(2) The fungus enemies of the foliage which can be controlled by means of spraying are:

(a) The Late Blight (*Phytophora infestans* DeBarry). This fungus is very common in the potato sections of New York and New England. It sometimes attacks potatoes in the more northern counties of New Jersey, but very seldom in the large potato growing sections. With its infrequency of occurrence it is not probable that spraying would prove a profitable insurance against injury by this fungus.

(b) The Early Blight (*Alternaria solani* E. & M. Jones & Grout). This fungus seldom causes any extensive injury to potatoes in this State. A great majority of the crop is harvested before suitable conditions for the development of this fungus present themselves. On the second crop potatoes the Early Blight is much more common. This fungus can be controlled by thorough spraying with Bordeaux mixture. An experiment this year on the second crop potatoes shows to what extent the control of this fungus is a factor in increasing the yield.

(3) Vine.simulation:—The property of invigorating potato vines has been attributed by some writers to copper and sulfur compounds. To what extent transpiration is modified because of the presence of a coating of spray material has not been consistently demonstrated. Neither of these factors has been extensively tested, and to what degree they are operative, and under what conditions, is problematical.

In a ten-year experiment in New York State, it was found profitable to spray. Some years the increase little more than paid for the spray but in the long run the continued practice was found advisable. It is probable that conditions in New Jersey are less favorable to obtaining increased production than in New York, and it is probable that a satisfactory solution of the problem here can only be accomplished by continuing the work over a series of at least ten years.

Negative results were obtained in one experiment in 1915. Two positives and one negative were obtained under the different climatic conditions of 1914. Obviously, the question merited repetition this year.

Experiments at Elmer.

The experiment here was conducted on a trapezoidal-shaped field of about twelve acres. The soil is a sassafras loam to sandy loam, very uniform in texture throughout the field and well adapted to potatoes. In topography the field is slightly undulating and in ordinary years these differences would not be objectionable. With an abundance of moisture this summer these topographical differences were accentnated, tuber rotting and root suffocation resulting in some of the lower areas due to an excess of moisture.

The field was divided into twelve plots, each twenty-four rows wide. The spraying treatments of Bordeaux, sulfur-lead, sulfur zinc, Kiltone and lead arsenate alone were arranged in six plots of series I and repeated in series II. Four Bordeaux plots out of twelve were used as checks on the uniformity of the field. The two lead arsenate plots were adjacent to a Bordeaux plot.

The Bordeaux mixture used was of the 5-5-50 composition as ordinarily recommended, lead arsenate being added at the rate of 3 pounds of the powdered form to 50 gallons of Bordeaux. All liquid sprays were applied at the rate of 100 gallons per acre with a Watson Traction sprayer furnished by the Field Force Pump Company of Elmira, New York. A pressure of 60 to 80 pounds per square inch was required to deliver the correct quantity of spray to the acre. The sprayer covers four rows at a time with three nozzles to a row, one above and one at each side.

The Kil-tone (a commercial Bordeaux-lead paste) was used at the rate of 10 pounds to 50 gallons of water. This compound was of an excellent physical nature and worked up easily into a thin paste for pouring through the strainer into the sprayer tank.

For the lead arsenate plots, 3 pounds of dry arsenate powder manufactured by the Corona Chemical Company of Milwaukee, Wis., was used to 50 gallons of water, the same rate at which it was used in the Bordeaux-lead arsenate mixture.

Two dust mixtures were used, the one containing 16-2/3 per cent of Corona lead arsenate to 83-1/2 per cent of finely ground sulfur. The second contained the same proportion of sulfur and zinc arsenate. Both mixtures were prepared for experimental purposes by the Union Sulfur Company. Of these two, the sulfur-lead mixture is applied much the easier. The latter tends to become lumpy on standing and is more compact, thus clogging the machine sometimes. The sulfur-lead mixture retained its original fineness and gave no trouble.

Four applications of spray were made, starting on May 17th, at which time the plants varied from eight inches in height or less in order as they had been planted. The second spraying was made June first, the third June 24th and the fourth July 2nd. Frequent rains delayed the application of the third spray and undoubtedly lessened any stimulating effects of the sulfur dust mixtures, since these were invariably washed off within a few days. No diseases were observed in any material quantity. A few scattered infections of early blight were noted about the time the vines started to die. (Plate V.)

On July 18th about the time the vines had fully matured the stems and leaves of the vines on the Bordeaux and Kil-Tone plots were undoubtedly greener and more vigorous than those on the sulfur dust or lead arsenate plots. The possibility of a considerable difference in the yield due to spraying treatments looked very promising. All vines were completely dead when the potatoes were dug, in the latter part of August. The results of the different spraying treatments are based on the difference between the actual yield obtained to the calculated yield for the plot based on the data of the checks.

With Bordeaux as the checks, the average yield was 389.12 (+ or —13.65 bushels) per acre. Data for the other spraying treatments show a decreased yield of 8.60 bushels for sulfur-lead arsenate; a decreased yield of 1.95 bushels per acre for sulfur-zinc arsenate, an increased yield over Bordeaux of 5.85 bushels per acre on the Kil-tone plots; an increased yield of 4.62 bushels per acre on the lead arsenate plots. The experimental error of each plot is almost as much as its deviation from the theoretical yield and all the differences are easily included in the error of 13.65 bushels of the Bordeaux average. Hence, it is obviously impossible to claim any superiority for any of the treatments used. Even assuming that these differences were authentic, in no case do they represent much over 2 per cent of the total crop which is not sufficient margin upon which to base experimental evidence.

The Experiments at Mt. Holly In 1915.

Spraying work representative of the conditions for the middle section of the State was carried on in cooperation with Mr. John Black at his farm about two miles east of Mt. Holly. The experiment was located on a large rectangular field of about 25 acres. The soil is a loam to silt loam in texture, in an excellent state of tilth and well adapted for potatoes. In topography the area is almost level, exceptionally even in this respect for so large a field. The field has been intact for over thirty years so that no differences in fertility were probable, because of past treatments. For the last seven years the crops grown have been:

1915, Potatoes; 1914, Potatoes; 1913, Timothy and Clover; 1912, Potatoes; 1911, Timothy and Clover; 1910, Wheat; 1909, Potatoes.

This year the entire area was planted with Maine seed, variety Irish Cobbler as contrasted with "second crop" New Jersey seed used at Elmer.

A very good stand was secured and the development of the vines throughout the early part of the growing season was very good. About July 1st, the yellowed appearance of the vines followed by leaf wilt, a condition very prevalent in this section, was first noted. It was observed that the vines on the two Bordeaux plots and the sulfur-zinc plot were not nearly so badly affected as the lead arsenate, Tonicide and sulfur-lead plots respectively. About one ton of 5-8-3 fertilizer per acre was used here.

The plot arrangement here was the same as at Elmer except that the series could not be repeated. The plots were 32 rows wide and over three acres in area. The liquid sprays were applied here with an "Iron Age" traction sprayer furnished for the work by the Bateman Manufacturing Company, of Grenloch, New Jersey. The dusts used and the machine for applying them were identical with the one used at Elmer. Hermann's Tonicide, a commercial Bordeaux lead arsenate paste, was tested here instead of Kil-Tone as at Elmer.

Table V.

Schedule of Spraying.

Plot No.	Treatment.	First Spray.	Second Spray.	Third Spray.	Fourth Spray
1	Sulfur-lead..........	5/26	6/9	6/22	6/30
2	Bordeaux, ...	5/20	6/8	6/21	6/29
3	Sulfur-zinc..........	5.27	6/9	6/23	6/30
4	Tonicide............	5/19	6/8	6,21	6/29
5	Lead arsenate	5/20	6/8	6/21	6/29
6	Bordeaux...........	5/26	6/9	6/22	6/30

The row lengths here were about 1700 feet and it was planned to divide the field in half, perpendicular to the row length, and by harvesting separately, thereby duplicate the experiment. At digging time this was found impracticable so that we have but one plot of each treatment, except for Bordeaux, with two plots which served as a check on the uniformity of the field. In harvesting the plots, however, the data on the several rows were taken in groups and from the variation in the yields of these various rows of the plot, it was possible to compute the probable error of the total yield which represents the average of the varying conditions within the plot.

The following table will show the yields of potatoes in bushels per acre:

Table VI.

Plot No.	Treatment.	First.	Seconds.	Total.	Probable error ±
1	Sulfur-lead	238.68	34.88	273.56	5.13
2	Bordeaux	273.85	32.16	306.01	3.52
3	Sulfur-zinc	261.51	34.45	295.96	3.64
4	Tonicide	220.0	34.62	254.62	3.208
5	Lead arsenate	209.95	38.65	248.60	2.555
6	Bordeaux	242.86	27.75	270.61	4.66

The proper interpretation of the above data is rendered difficult because of the whole scheme not having been repeated and on account of having but two Bordeaux checks on the uniformity of the field. Calculating the theoretical yields, however, for the plots on the basis of these checks we obtain these results as shown in the following table.

Table VII.

Plot No.	Treatment.	Calculated Yield.	Actual Yield.	Difference
1	Sulfur-lead	314.86	273.56	−41.30
2	Bordeaux	306.01	306.01	....
3	Sulfur-zinc	297.16	295.97	− 1.19
4	Tonicide	288.31	254.63	−33.68
5	Lead arsenate	279.46	248.60	−31.26
6	Bordeaux	270.61	270.61	....

Apparently sulfur-zinc has given as good results as Bordeaux itself to within experimental error. That there should be any material difference in the properties of sulfur-lead and sulfur-zinc to account for the difference of minus 40 bushels between them seems improbable. This difference is more probably due to the fact that the first and third sprays on plot 1 were applied in the late afternoon of a day followed by a rain in the night, probably washing off the greater part of the material. The sulfur-zinc plots on each occasion were sprayed the following day and were not so washed off. In the light of this fact and the improbability of any real difference in the activity of the two dusts we are inclined to believe that had all conditions been the same these two plots would here have shown up equally well. If then, sulfur-zinc proved to be as good as Bordeaux to within experimental error, we can claim no superiority for the Bordeaux over sulfur-lead.

In considering the data for the Tonicide and lead arsenate plots which lie between the two Bordeaux plots, the evidence of an increased yield due to Bordeaux spraying is more apparent. That an inferior yield *should result on these plots is in correlation* with the appearance of the vines. The actual difference between lead arsenate and Tonicide is within the experimental error of the plots, so that no claim of superiority of Tonicide over lead arsenate is valid. From the data, Bordeaux may have increased the yield of potatoes over Tonicide 33.68 bushels per acre and over lead arsenate by 31.26 bushels per acre. These figures must be discounted, however, by the fact that the treatments were not repeated and also by the fact that the two Bordeaux plots themselves differed by 35.40 bushels per acre, a figure larger than the difference between the actual yield for the plots in question and the calculated Bordeaux yield for those plots.

This experiment alone of the three of this type conducted this year indicates the possibility of any superiority of Bordeaux lead over a straight arsenical spray. Any superiority of Bordeaux over the sulfur dusts is doubtful, and to what extent we shall claim benefit over lead arsenate is a matter of interpretation of the data. Roughly speaking, the increase approximated 30 bushels per acre.

The Experiment at Freehold in 1915.

The potato spraying work at Freehold was conducted on an irregularly shaped field of about 17 acres on the farm of Frank P. Jones. The same area was used for the spraying experiment of 1914 at this place. The field was sub-divided into two series of six plots each the arrangement of the twelve plots being as follows:

Plot 1 Bordeaux	Plot 7 Bordeaux
Plot 2 Check	Plot 8 Check
Plot 3 Sulfur-zinc	Plot 9 Sulfur-zinc
Plot 4 Check	Plot 10 Check
Plot 5 Sulfur-lead	Plot 11 Sulfur-lead
Plot 6 Check	Plot 12 Check

The liquid spray, in this case Bordeaux-lead only, was applied at the rate of 100 gallons per acre of 5-5-50 in composition. Three pounds of Corona powdered arsenate of lead were added per 50 gallons of Bordeaux. The applications were made with an "Iron Age" traction sprayer donated for the work by the Bateman Manufacturing Company. The sulfur-zinc and sulfur-lead dusts used here were of the same composition (5-1) as used elsewhere. The applications were likewise made with the same type of dusting machine as in the other experiments.

The potatoes grown here were of the American Giant variety as contrasted with the Irish Cobblers on the other two experiments. Only three applications of Bordeaux, and the sulfur dusts could be made here since the vines so completely covered the rows as to render the mechanical injury to the vines more destructive than could be offset by the spraying.

The check plots in this experiment were sprayed with a mixture of lime and Paris green at the rate of about two pounds of Paris green to the acre. This material was applied with a Leggett duster with two nozzles per row. Mr. Jones dusted the check plots but twice, all that he considered necessary to effectively control the Colorado potato beetle. Since Paris green dusting is the most popular means of control among the potato growers of that section, the experiment resolves itself into a comparison of the Bordeaux and sulfur dusts with the common practice.

A faint difference was to be observed in the Bordeaux plots during the last stages of the death of the vines. The leaves had died on all plots and a convenient wind blew all the leaves off the stems revealing the heretofore obscured fact of the stems being greener on the Bordeaux plots. In no event was this difference nearly so well marked as at Elmer or Mt. Holly.

The results of the experiment are given in the following table.

Table VIII.

Plot No.	Treatment.	Area in acres.	Total Yield.	Bbl. per A.	Bu. per A.
1	Bordeaux	1.1413	202 bbl.	142.9	393.00
2	Paris green	1.3688	179	130.8	359.95
3	Sulfur-zinc	1.268	180	141.9	390.50
4	Paris green	1.194	186	155.75	428.50
5	Sulfur lead	1.056	180	170.5	469.00
6	Paris green	1.871	290	154.95	426.10
7	Bordeaux	1.731	270	155.95	428.84
8	Paris green	1.596	252	157.98	434.50
9	Sulfur-zinc	1.458	220	151.0	415.50
10	Paris geen	1.322	190	143.70	395.00
11	Sulfur lead	1.185	168	141.80	390.00
12	Paris green	1.0475	154	147.0	404.00

By neither method of interpreting the above figures can the writer find any legitimate difference between the yields from any of the plots due to spraying treatments. In the whole scheme Plot 5 with a yield of 469 bushels per acre between the closely agreeing checks of 428.50 and 426.10 seem to make a positive indication. Such a result is not substantiated in Plot 11, the duplicate of the above. In fact quite the reverse is true. Comparing the yields for the treated plots with the theoretical yield for such plots based on the adjacent checks shows a substantial increase for Bordeaux on Plot 1 and sulfur-lead on Plot 5. But there was a check on but one side of Plot 1, and Plot 6 parallels Plot 5 for only a little over half the length of Plot 5 as indicated by the comparative areas. Discounting these theoretical yields as partially inaccurate on these accounts and also by the fact that such phenomena fail of repetition on their corresponding duplicates, the results are in no way positive.

The mathematical averages of the plots of like treatment are all alike within experimental error as shown by the following table.

Table IX.

Plot No.	Treatment.	Bu. per A.	Average number bu. per A.	Error of average
2	Paris green.	359.95		
4	Paris green.	428.50		
6	Paris green.	426.10		
8	Paris green.	434.50		
10	Paris green.	395.00		
12	Paris green.	404.00		
Total.		2448.05	408.00	±7.83
1	Bordeaux.	393.00		
7	Bordeaux.	428.84		
Total.		821.84	410.92	±12.10
3	Sulfur-zinc	390.50		
9	Sulfur-zinc.	415.50		
Total.		806.00	403.00	±8.42
5	Sulfur-lead.	469.00		
11	Sulfur-lead.	390.00		
Total.		859.00	429.50	±26.62

These results coincide very well with those obtained by Mr. Cameron on this area in 1914. A number of factors have been suggested as possible causes for this failure to show material difference in yields due to the spraying treatments.

(1) Soil Condition. The soil management here has been in accordance with the best practices. Exceptionally fertile naturally, the field has consistently received heavy applications of fertilizer. Each year an abundant cover crop has been turned under as well as application of manure not infrequently made. The yield of potatoes itself tells, undoubtedly, of a high state of fertility and also a uniformity thereof. The explanation that all this might suggest is that the fertility of the field is such as to permit that maximum of production beyond which further stimulation is very difficult.

(2) Spraying. The Giant vines grow very rapidly and will easily make so dense a growth as to obscure the rows within five or six weeks after the plants appear through the soil. After this condition is reached, it is highly probable that injury to the vines would more than offset the benefit of spraying. This rapid growth of the vines gives but about five weeks within which to make four applications of spray. After the last spraying which can be done about July 1st, the plants continue to grow from four to five weeks before they start to die. Growth and rains will soon leave a great proportion of the foliage uncovered, thus making conditions on all plots very much alike at this most important stage of their development. That this condition exists may serve to partially explain why it is apparently impossible to obtain differences here.

(3) Variety. Other experiments in which Bordeaux spraying has resulted in an increased yield have been on the Irish Cobbler, and varietal differences in the vines may play an important rôle.

The Experiment at Jamesburg.

In addition to the foregoing experiments another was located at the farm of Mr. H. Cortney Brown lying about one mile west of Jamesburg. This experiment was designed to test out the stimulating influence of copper compounds as they exist in Bordeaux mixture.

A small area of about five acres was divided into eight plots of sixteen rows in width. Plots 1-3-5-7 were sprayed with lead arsenate alone and the alternate plots 2-4-6-8 were sprayed with Bordeaux-lead. The spray machine here could not be adjusted to deliver more than 75 gallons of liquid per acre and in order to have the same amount of materials per acre on all the spraying experiments it was necessary to use 6 pounds of dry lead arsenate powder per 75 gallons instead of 100 gallons as used elsewhere. Likewise, the 10 pounds of lime and copper sulfate were applied in 75 gallons of water instead of 100. From one viewpoint it was unfair to compare this experiment with others since the Bordeaux was obviously more concentrated. On the other hand, the same amount of copper per acre was applied in all cases.

This area is fairly uniform in the texture of soil and in topography. It varies from a loam to silt loam in texture but well adapted to potatoes upon proper cultivation. The experiment would preferably have been run on Irish Cobblers rather than the State of Maine variety as was actually done. Probably due to too liberal rainfall the vines here flattened out early, covering the middles between the rows so that it was impractical to spray more than three times.

No differences were noted on the vines on the various plots during the growing season and no consistent perceptible differences in the order of dying. That no real difference exists in the yields of the various plots is shown in the following table.

Table X.

Plot No.	Treatment.	Actual yield in bu. per A.	Calculated yield for Bordeaux.	Difference
1	Lead arsenate	262.50		
2	Bordeaux-lead	259.25	273.45	−14.20
3	Lead arsenate	284.40		
4	Bordeaux-lead	257.36	264.89	− 7.53
5	Lead arsenate	255.38		
6	Bordeaux-lead	265.80	258.39	+ 7.41
7	Lead arsenate	261.41		
8	Bordeaux-lead	250.21		

Obviously these results show a minus difference which would be easily within experimental error so that no indicative results can be attributed to this experiment.

The Experiment on "Second Crop" Potatoes at Elmer, 1915.

A very common practice in South Jersey is to grow a second crop of potatoes on the same area utilized for growing early potatoes. Ordinarily, the first crop will have been dug and the soil prepared so that the second crop can be planted from the 25th of July up until as late as September first. This year, however, the first crop in many cases was dug too late, because of low prices, to permit this practice. In general, however, any late-planted early variety of potatoes is called "Second Cropper" whether the first crop field or another is used. Some growers will secure northern stock for growing the second crop potatoes and then use this second crop for early seed the following spring. Others, as was the case with the grower with whom we cooperated, put a part of their own second crop seed in cold storage until the following summer to be used for late seed again. Which of these two methods produces the more vigorous seed, or is more free from disease, has not been sufficiently studied.

In order to test the value of the different spraying and dusting mixtures on second crop potatoes, the following experiment was conducted in cooperation with Mr. J. Harry Kandle at Elmer, N. J. The same field which was used for growing the first crop could not be used. A field of twelve acres of a similar type of soil, but much better adapted for experimental purposes, from the standpoint of topography, was used.

The area was divided into fourteen plots of approximately the same size. These plots were twenty rows wide and arranged in the following order:

Plot 1 Bordeaux mixture.
Plot 2 Sulfur-lead arsenate.
Plot 3 Lead arsenate.
Plot 4 Bordeaux mixture.
Plot 5 Sulfur-zinc arsenate.
Plot 6 Lead arsenate.
Plot 7 Bordeaux mixture.
Plot 8 Sulfur-lead arsenate
Plot 9 Lead arsenate.
Plot 10 Bordeaux mixture.
Plot 11 Sulfur-zinc arsenate.
Plot 12 Lead arsenate.
Plot 13 Bordeanx mixture.
Plot 14 Sulfur-lead arsenate.

The rates of application and the mixtures used were identical with those used on the first crop experiment conducted on this farm. The entire field with the exception of nine rows was planted with second crop Irish Cobbler stock, grown by Mr. Kandle in 1914, and kept in cold storage until July of 1915. Weather conditions and other work interfered so that the field was planted on three different dates, about July 27th, August 4th, and August 10th, respectively. These dates are only approximately correct, since no accurate record was taken. The fact of these differences in planting dates is probably of less consequence than it would have been for early potatoes. The vines all grew to a normal maturity before frost and, as a whole, the growing period for each planting was very similar to that of any other of the plantings. Reference to the data shows a striking uniformity in the duplicate series regardless of this factor, thus bearing out the probability of its minor importance.

At the time of the first spraying on August 23rd, the heights of the vines were 10 to 12 inches, 8 to 10 inches, and 3 to 6 inches respectively, for the different plantings. By the time of the second sprsying on

September 8th, these differences in height were not noted, although the vines of the first planting were probably slightly wider in the rows.

On September 24th, when the third and last applications were made, no differences in the development were observed. The vines died in the same order as planted and on October 16th those of the first planting were dead, the second almost so, and the third planting had started to die.

During the first ten days of August, great numbers of adult Colorado potato beetles from an adjacent first crop field invaded Plot 1 and a part of Plot 2, clipping many of the young plants off even with the soil. The plants were heavily dusted with lead arsenate and the beetles killed. The plants soon recovered and apparently were as far advanced as the other vines at the time of the second spraying. Reference to the table of yields will show, however, that these plots gave a yield very much lower than the rest of the field. These plots were disregarded in calculating the results of the experiment.

The potatoes were dug during the first week of November and the yields of the different plots are shown in the following table:

Table XI.
Showing Yields of Plots in "Second Crop" Spraying Experiment at Elmer.

Plot No	Treatment	Bbs. per A.	Bu. per A.
1	Bordeaux	185.42	115.89
2	Sulfur-lead	318.62	199.13
3	Lead arsenate	394.99	246.86
4	Bordeaux	473.45	295.92
5	Sulfur-zinc	367.31	229.57
6	Lead arsenate	328.28	215.85
7	Bordeaux	463.58	889.73
8	Sulfur-lead	366.78	228.71
[illegible]	Lead arsenate	[illegible]	[illegible]
10	Bordeaux	417.47	260.37
11	Sulfur-zinc	365.92	228.70
12	Lead arsenate	393.73	246.10
13	Bordeaux	450.16	281.35
14	Sulfur-lead	361.65	226.02

The above arrangement of the plots permits of two methods of calculating the results. Using the lead arsenate plots as checks and calculating the corrected yield for the intervening treated plots, we find an average increase in the yield of 44.5$\pm$7.475 bushels per acre due to Bordeaux spraying. Sulfur-lead arsenate and sulfur-zinc arsenate show an average decrease of 13.68 and 5.68 bushels per acre, respectively.

Making the calculated yields for the plots on the basis of the Bordeaux plots as checks, we find an increased yield of 47.02 bushels per acre over lead-arsenate, [illegible] bushels per acre over sulfur-lead and 51.47 bushels per acre over sulfur-zinc.

By still another method of analyzing these data, that of the mathematical averages we find the average yield on the plots of the various treatments to be:

Lead arsenate = 236.75 bu. per A.
Bordeaux mixture = 281.84 bu. per A.
Sulfur-zinc = 229.13 bu. per A.
Sulfur-lead = 227.36 bu. per A.

By this method is shown an increase of 45.09 bushels per acre due to Bordeaux spraying with 7.62 and 9.39 bushels per acre decrease for sulfur-zinc and sulfur-lead respectively.

Obviously, these three methods of analyzing the data show the same result of an average increase of about 45 bushels per acre for Bordeaux over lead arsenate. From the economic standpoint we may calculate the net profit. These potatoes sold in the field for $1.12 per bushel, which would give a gross increase of $50.40 per acre. The cost of making three applications of Bordeaux here amounts to $8.25 per acre which would leave a net profit of $42.15 per acre. About one dollar per acre might then be legitimately deducted for the cost of picking up the increased yield. No other extra work was involved since farmers bought these potatoes in the field and hauled them away themselves.

A number of factors were operative under the conditions for the second crop experiment which were not for the first crop, and these may serve to explain why such pronounced results were obtained in this case, and not in the former.

(1) Weather conditions. With our incomplete knowledge of the influence of climatic conditions on the effectiveness of spraying mixtures, we do not know to what extent they are operative. Obviously, there are great differences between a spraying season of May from 17th to July 2nd and August from 23rd to September 24th.

(2) Vine stimulation. This may have intimate correlation with climatic conditions and may have been more pronounced. Prolonged growth on the Bordeaux plots was, however, no more marked on the second crop than on the first crop where no influence was noted.

(3) Fungus enemies. The second crop potatoes were badly infected with Early Blight. Even before the first spraying was done there were many infected leaves throughout the field. The Bordeaux mixture very effectively controlled this disease and no doubt the major part of the increased production is attributable to this cause. The sulfur dusts appeared to control this disease to a certain extent but not effectively.

No insect enemies were operative upon the vines of this second crop and since lead arsenate is admittedly not especially fungicidal, the action of Bordeaux alone as a stimulant and fungicide seems well defined.

To what extend the Early Blight has been a factor can only be determined by a repetition of this experiment over a series of years during some of which it may not be a factor.

Summary of Spraying Work in 1915.

(1) In one of the spraying experiments on early crop potatoes there was an increase in the yield due to Bordeaux spraying.

(2) From a consideration of the results of three years' experiments, it appears that the climatic conditions may play an important rôle in deciding to what extent the benefits from Bordeaux spraying will be realized. Whether or not such practice proves profitable commercially, will probably be decided only through a repetition of these experiments for a series of years.

(3) Sulfur dust mixtures have given good indications but their effectiveness as compared with Bordeaux has not been clearly established through these experiments.

(4) The state of cultivation and the fertility of the field apparently have intimate relation to the benefit to be derived from spraying.

(5) It appears probable that different varieties of potatoes respond differently to spraying treatments.

(6) Bordeaux mixture has given the best control of the flea beetles of any of the mixtures applied this year.

(7) Bordeaux, both home-made and commercial preparations, prolongs the life of the vines, but the expected increase in yield from such treatment has not resulted consistently.

(8) *Bordeaux spraying in an experiment on second crop potatoes gave* an average increase of about 45 bushels per acre. The net profit realized was $41.15 per acre.

(9) Early Blight was very prevalent in the plots of the second crop experiment and it is probable that the control of this fungus may account for much of the increase in yield due to Bordeaux spraying.

PLATE I.

FIG. 1.—Apple blotch.

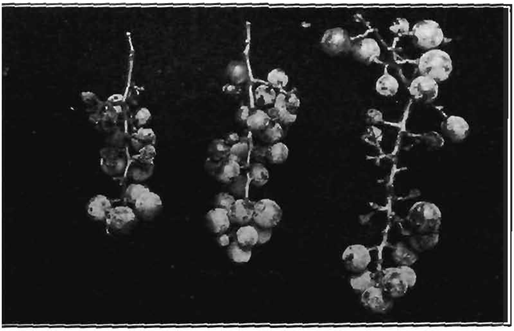

FIG. 2.—Black Rot of the grape.

PLATE II.

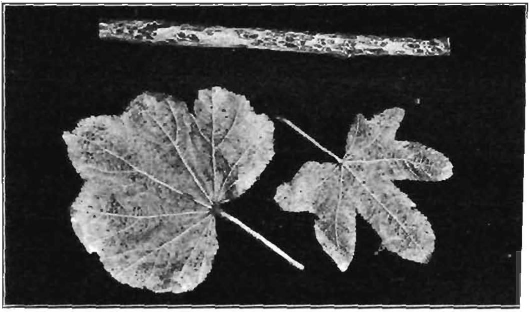

FIG. 3.—Hollyhock Rust.

FIG. 4.—Brown Rot of the peach causing a die-back of the twigs.

PLATE III.

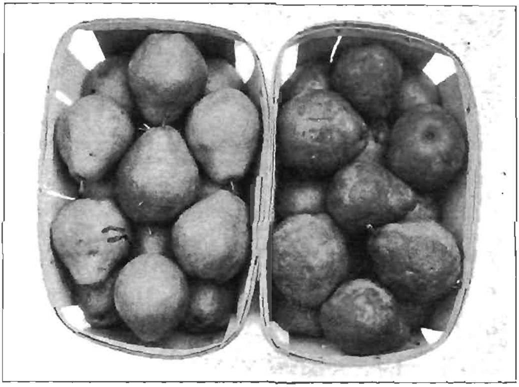

FIG. 5.—Brown Blotch on the Kieffer pear: sprayed and unsprayed fruit.

FIG. 6.—Brown Blotch of the Le Conte pear.

PLATE IV.

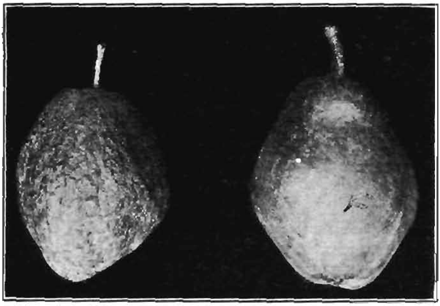

FIG. 7.—Effects of Brown Blotch after keeping pears in laboratory one week. The diseased fruit is very much shrunken.

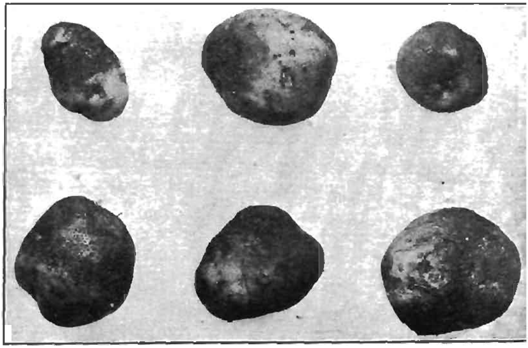

FIG. 8.—Potatoes grown in actual contact with sulfur develop a corky epidermis.

PLATE V.

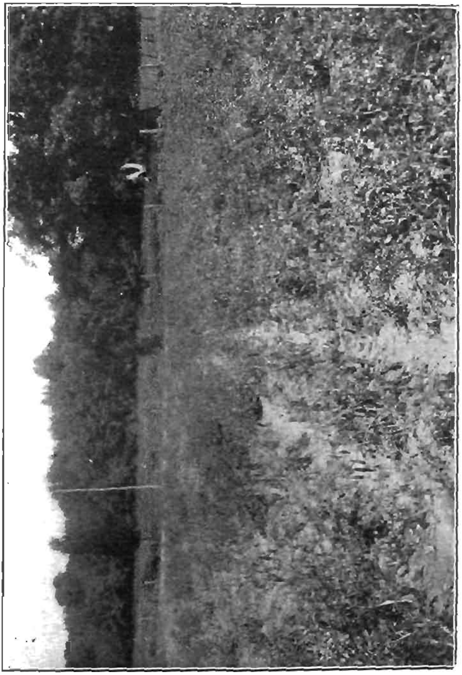

FIG. 9.—Results of spraying with lead arsenate and Bordeaux mixture; lead arsenate on the left and Bordeaux mixture on the right.