STATE OF CONNECTICUT

SEVENTEENTH ANNUAL REPORT

OF

The Connecticut Agricultural Experiment Station.

For 1893.

Printed by Order of the General Assembly.

The publications of this Station are sent free to every citizen of Connecticut who applies for them. Address, The Conn. Agricultural Experiment Station, New Haven, Conn.

NEW HAVEN:
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1894

CORRECTIONS.

Page 11. From third line of middle paragraph on *Free Nitrogen*, expunge the words "and mustard."

Page 26, third line of table; change "Reed Co., Brooklyn, N. Y." to "Read Co., New York City."

Page 38, after No. **3907**, insert "Clark's Cove Bay State Fertilizer G.G." Change the guaranteed nitrogen of this brand from 2.3 to *1.85* per cent.

Page 38. No. **3952**. Change the guaranteed nitrogen of Quinnipiac Ammoniated Dissolved Bone from 2.0 to *1.65* per cent.

Page 39. No. **3978**. Change the guaranteed nitrogen of Quinnipiac Pine Island Phosphate from 2.5 to *2.06* per cent.

Page 50. No. **3909**. For Bradley's read Bowker's.

Page 147, third line of the title, for "*Seperator*," read *Separator*.

OFFICERS AND STAFF FOR 1893.

STATE BOARD OF CONTROL.

Ex-officio.

HIS EXCELLENCY LUZON B. MORRIS, *President*.

	Term expires.
Appointed by Connecticut State Agricultural Society:	
HON. E. H. HYDE, Stafford, *Vice-President*.	July 1, 1894.
Appointed by Board of Trustees of Wesleyan University:	
PROF. W. O. ATWATER, Middletown.	1894.
Appointed by Governor and Senate:	
EDWIN HOYT, New Canaan.	1895.
JAMES H. WEBB, Hamden.	1896.
Appointed by Board of Agriculture:	
T. S. GOLD, West Cornwall.	1895.
Appointed by Governing Board of Sheffield Scientific School:	
W. H. BREWER, New Haven, *Secretary and Treas.*	1896.
Ex-officio.	
S. W. JOHNSON, New Haven, *Director*.	

Executive Committee. (T. S. Gold, W. H. Brewer, S. W. Johnson)

STATION STAFF.

Chemists.

S. W. JOHNSON, *Director*.	A. W. OGDEN, PH.B.
E. H. JENKINS, PH.D., *Vice-Dir.*	H. MONMOUTH SMITH, B.A.*
A. L. WINTON, PH.B.	W. R. JOHNSTON, PH.B.†
T. B. OSBORNE, PH.D.	R. S. CURTISS, PH.D.‡

Mycologist.

WILLIAM C. STURGIS, PH.D.

Grass Gardener.

JAMES B. OLCOTT, South Manchester.

Stenographer and Clerk.

MISS F. M. BIGELOW.* MISS C. S. GREEN.†

In charge of Buildings and Grounds.

CHARLES J. RICE.

Laboratory Helpers.

HUGO LANGE. JULIUS KORN.

Sampling Agents.

DENNIS FENN, Milford. F. R. CURTISS, Stratford.

*Till Aug. 1. †From Oct. 1. ‡From July to December.

Notice as to Bulletins.

The Bulletins of this Station, usually issued quarterly or oftener, are mailed free to citizens of Connecticut who apply for them, and to others, as far as the limited editions permit.

Applications should be renewed annually before January 1st.

The matter of all the Bulletins of this Station, in so far as it is new or of permanent value, will be made part of the Annual Report of the Director.

Bulletins earlier than No. 71 and Nos. 83, 92, 93, 100, 101, and 109 are exhausted and cannot be supplied.

Notice as to Supply of Station Reports.

The Station has no supply of its Annual Reports for the years 1877, 1878, 1879, 1880, 1881, 1882, 1883, 1884, 1887, and 1891.

The Annual Report of this Station, printed at State expense, is by law limited to an edition of 12,000 copies, of which 5,000 copies are bound with the Annual Report of the Connecticut State Board of Agriculture, and distributed by the Secretary of the Board, T. S. Gold, West Cornwall, Conn.

After exchanging with other Experiment Stations and Agricultural Journals, the Reports remaining at the disposal of the Station will be sent to citizens of Connecticut who shall seasonably apply for them, and to others as long as the supply lasts.

ANNOUNCEMENT.

The Connecticut Agricultural Experiment Station was established in accordance with an Act of the General Assembly approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, moulds, blights, mildews, useful or injurious insects, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station does not undertake sanitary analyses of water.

The Station makes analyses of Fertilizers, Seed-Tests, etc., etc., for the citizens of Connecticut, without charge, provided—

1. That the results are of use to the public and are free to publish.
2. That the samples are taken from stock now in the market, and in accordance with the Station "Instructions for Sampling."
3. That the samples are fully described and retail prices given on the Station "Forms for Description."

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs, and like Associations can efficiently work with the Station for this purpose, by sending in duly authenticated samples early during each season of trade.

All other work proper to the Experiment Station that can be used for the public benefit will be done without charge. Work for the private use of individuals is charged for at moderate rates. The Station undertakes no work, the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Results of analysis or investigation that are of immediate general interest are published in Bulletins, copies of which are sent to each Post Office in this State, and to every citizen of the State who applies for them. The results of all the work of the Station are summed up in the Annual Reports made to the Governor.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties, sent on application.

☞ Parcels by Express, to receive attention should be *prepaid*.

☞ Letters sent to individual officers are liable to remain unanswered in case the officer addressed is absent. All communications therefore should be directed simply to the

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

☞ Station Grounds, Laboratories and Office are on Suburban st., between Whitney avenue and Prospect st., 1⅝ miles north of City Hall. Suburban st. may be reached by Whitney ave. Electric Cars, which leave the corner of Chapel and Church sts., three times hourly, viz: on the striking of the clock and at intervals of twenty minutes thereafter.

☞ The Station has Telephone connection and may be spoken from the Central Telephone Office, 118 Court st., or from Peck & Bishop's Office in Union R. R. Depot.

☞ The Grass Garden, in charge of Mr. James B. Olcott, is near South Manchester and may be reached by A. Gardner's regular Passenger Express starting at 9 A. M. and 1 P. M. from Cheney's Store, So. Manchester, or starting at 10 A. M. and 4 P. M. from Burnside, where connection is made by electric car with Hartford.

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REPORT OF THE TREASURER.

WM. H. BREWER, IN ACCOUNT WITH THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION, FOR THE FISCAL YEAR ENDING SEPTEMBER 30TH, 1893.

RECEIPTS.

From the State Comptroller	$8,000.00	
" U. S. Treasurer	7.500.00	
Analysis Fees due last fiscal year and received this year	1,633.92	
Analysis Fees of this year	4,496.11	
Miscellaneous Receipts	40.77	
		$21,670.80

PAYMENTS.

	State Acc't.	U. S. Acc't.	Total.
Salaries	$5,755.00	$6,709.63	$12,464.63
General Laboratory Expenses	2,042.39	27.59	2,069.98
Mycological Expenses	....	85.66	85.66
Grass Investigation	871.00	150.00	1,021.00
Tobacco Investigation	353.32	198.26	551.58
Field Experiments	....	194.62	194.62
The Establishment, Repairs, Grounds, etc.	1,464.26	....	1,464.26
Gas	266.70	....	266.70
Water	147.00	....	147.00
Coal	593.25	....	593.25
Telephone	100.25	....	100.25
Printing	669.07	134.24	803.31
Stationery	98.53	....	98.53
Comptometer	125.00	....	125.00
Postage	144.33	....	144.33
Library	365.33	....	365.33
Collecting Fertilizers	361.51	....	361.51
Traveling Expenses of the Board	64.57	....	64.57
Columbian Exposition	403.23	....	403.23
Unclassified Sundries	346.06	....	346.06
	$14,170.80	$7,500.00	$21,670.80

MEMORANDUM.

The above accounts were duly audited December 27th, 1893, by the State Auditors of Public Accounts.

As in previous years, the Analysis Fees of fertilizers known to be on sale after May 1st and subject to the law concerning commercial fertilizers, coming into the hands of the treasurer after the closing of this account will be credited to the next year's account.

WM. H. BREWER, *Treasurer.*

REPORT OF THE BOARD OF CONTROL.

To his Excellency, Luzon B. Morris, Governor of Connecticut:

The Board of Control of the Connecticut Agricultural Experiment Station, as required by statute, herewith submits to your Excellency its report for the year ending November 1st, 1893.

In execution of the provisions of the Fertilizer Law, the agents of this Station have visited all parts of Connecticut, and have drawn samples of commercial fertilizers, representing nearly all brands sold within the State.

Two hundred and eighty-four analyses of fertilizers and manurial waste products have been made in the laboratory, and the results of these analyses are now in the printer's hands for publication.

Within the last eighteen months the extremely high prices of organic nitrogenous matters have largely increased the temptation to use in mixed fertilizers very inferior materials, such as ground leather, horn and wool. Every fertilizer analyzed, has therefore been tested for leather and also as to its solubility in pepsin solution.

A parallel series of tests, though not so extensive, has been made to compare the rapidity with which the nitrogenous matters of different fertilizers become soluble in water by putrefactive decomposition.

In connection with the same subject 24 experiments have been made, in which Indian corn was grown in an artificial soil in pots supplied with nitrogen from six different fertilizers whose relative value as regards their nitrogen it was thus sought to determine.

Ninety samples of maize kernel, all of which are represented in the Station's collection of varieties, have been analyzed and of these analyses forty-two have been used in the Connecticut corn exhibit at the Columbian Exposition. A considerable number of feeding stuffs have also been analyzed for individual purchasers.

In connection with Farmers' Institutes where dairying was discussed and also in response to requests at other times by creameries and private individuals, 93 samples of milk and 35 samples of cream have been examined. Seven samples of skimmed milk, 14 of cream, 8 of butter and 15 of butter-milk have been completely analyzed as part of the dairy experiment to be noticed later.

A large amount of work has been done in the study of Methods of Milk-Analysis, chiefly for comparing the per cent. of milk-solids determined by gravimetric methods with the per cent. of solids calculated from the per cent. of fat and the specific gravity; and for comparing different gravimetric methods of determining milk-solids.

All the chemical work required by the State Dairy Commissioner has been furnished, including the examination of 57 samples of suspected butter and expert evidence has been given in court, as required.

The work done by Dr. T. B. Osborne and his assistants since November 1st, 1892, is briefly summarized as follows:

During the year the investigation of the proteids of the wheat kernel has been completed and the results published in the American Chemical Journal, Vol. XV, No. 6, occupying 80 octavo pages.

The proteids of the rye kernel and of the kidney bean have also been investigated and the results are nearly ready for publication.

The study of the proteids of the cotton seed, begun some time ago has been finished, and the results are now ready for the printer. The proteids of the barley kernel have also been examined, but this investigation is not yet complete.

The subjects that have occupied the attention of Dr. W. C. Sturgis, the Station botanist, are as follows:

A study of the comparative value of winter and summer treatments in preventing the "scab" of apples and pears.

The continuation of the experiments of last year upon the artificial curing of tobacco.

Experimental work on the prevention of the mildew of lima beans.

Further prosecution of the experiments of last year on the prevention of potato "rot."

A study of a disease of asters and other plants of the same order caused by nematode worms; and the use of lime incorporated with the soil, as a remedy.

The use of sulphur against the "leaf-blight" of celery and mildew of grapes under glass.

Investigation of diseases of quinces, including laboratory experiments upon the germination of the spores of the "rot" fungus and a critical study of a disease of quinces new to this locality.

Under the direction of Mr. James B. Olcott the study of grasses has been continued during the past year at South Manchester.

In connection with the State Dairymen's Association and the Woodstock creamery a series of observations has been made: First, to study the loss of fat in the butter milk, when gravity-cream and separator-cream are ripened and churned together, compared with the loss when each is churned by itself. Second, to compare the efficiency of the two systems of separating butter-fat, using milk of the same herd, under the most favorable conditions.

The field experiment, on the growth of maize, noticed in previous reports, has been continued this year on the farm of James H. Webb, Esq., of Hamden.

In coöperation with S. D. Woodruff & Sons of Orange, a field experiment has been carried out to test the effect of nitrate of soda in forcing the tomato crop.

The experiments on the effect of different fertilizers on quality and quantity of the tobacco crop, of which the first report was made last year, have been enlarged in scope and carried on this year, as before, in connection with the Connecticut Tobacco Experiment Co. at Poquonock. The last General Assembly appropriated the sum of five hundred dollars ($500.00) to be spent by the Station in this work.

Three Bulletins have been issued during the year, Nos. 114, 115 and 116, covering 58 octavo pages.

The subject of No. 115 was, Common Fungous Diseases and their Treatment, Nos. 114 and 116 were regarding Fertilizers. The demand for Bulletin 115, issued in March, 1893, was so great, that a new and revised edition was printed in May. The matter of Bulletin 114 appeared in our Annual Report for 1892; that of Bulletins 115 and 116 is incorporated with the Annual Report for the present year. Bulletin 112, issued last year but not printed in the Report for 1892, is included in the Annual Report for this year. Bulletin 111, issued in March, 1892, was not printed in the Annual Report for that year, but after revision appeared as Bulletin 115 and is accordingly a part of the Annual Report for 1893.

During the present year the Station has been called upon more frequently than ever before for assistance at Farmers' Institutes, Grange meetings, gatherings of Dairymen, etc. On 29 days, one, two and sometimes three of the Station staff, were engaged in this work.

There have been two changes in the Station staff during the year. H. Monmouth Smith, B.A., chemist to the Station, was succeeded on October 1st, by William R. Johnston, Ph.B.

Dr. R. S. Curtiss, who was on the Station staff as chemist during the years 1888, 1889 and a part of 1890, and who has since that time been abroad for further chemical study, is now engaged in a special study of soils at this Station.

A detailed account of all the work above referred to, will be found in the Report of the Director, which is now in preparation.

All of which is respectfully submitted.

WM. H. BREWER,
Secretary.

NEW HAVEN, CONN., November 1st, 1893.

REPORT OF THE DIRECTOR.

A general summary of the work done at this Station during the year ending Nov. 1st, may be found in the report of the Board of Control to the Governor.

The detailed account of this work, so far as it is sufficiently advanced to justify its publication, is contained in the following pages.

In the discussion of commercial fertilizers it is found necessary to repeat annually certain statements regarding the fertilizer law and the analysis and valuation of fertilizers, to answer the questions which are constantly addressed to the Station on these subjects.

THE CONNECTICUT FERTILIZER LAW.

The General Assembly at its Session in 1893 passed an act, Chapter CLXXII, amending the fertilizer law previously in force in Connecticut.

The attention of all concerned is called to the following copy of the General Statutes of the State regarding fertilizers which embodies the amendments and is the law now in force.

Copies of the law may be had on application to the Station. Attention is specially called to the following requirements.

1. In case of *all* fertilizers or manures, except stable manure and the products of local manufacturers of less value than ten dollars a ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR IMPORTER shall have provided labels or statements and shall have paid the fee. Sections 4005 and 4007.

The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, and which are generally Nitrogen, Phosphoric acid and Potash. The analysis-fees in case of any fertilizer will therefore usually be ten, twenty or thirty dollars, according as one, two or three of these ingredients are contained or claimed to exist in the fertilizer.

2. The law also requires, *in the case of every commercial fertilizer*, that a *sealed sample* shall be deposited with the Director of the Station by the MANUFACTURER OR IMPORTER, and that a *certified statement* of composition, etc., shall be filed with him, Section 4006.

A statement of the per cent. of Nitrogen, Phosphoric acid (P_2O_5) and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the per cent. of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent to nitrogen" may likewise be stated.

The per cent. of soluble and reverted phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of, soluble and reverted.

The percentage of insoluble phosphoric acid may be stated or omitted.

In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc., the chemical composition may take account of the two ingredients: Nitrogen, Phosphoric Acid.

For Potash Salts give always the per cent. of Potash (potassium oxide): that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

3. It is also provided that EVERY PERSON in the State, who sells *any commercial fertilizer of whatever kind or price*, shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4008.

4. All "CHEMICALS" that are applied to land, such as: Muriate of Potash, Kainite, Sulphate of Potash and Magnesia, Sulphate of Lime (Gypsum or Land Plaster), Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc.—are considered to come under the law as "Commercial Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 4013 of the Act.

It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in Section 4013, that all fertilizers be analyzed and it requires the parties making or selling them to pay for these analyses in part: the State itself paying in part by maintaining the Experiment Station.

ACTS CONCERNING COMMERCIAL FERTILIZERS.

Chapter CCLIII of the General Statutes of Connecticut as amended by Chapter CLXXII of the Acts of the General Assembly, Session of 1893.

Printed statement to be affixed to all packages and to go with all lots.

SECTION 4005. Every person or company who shall sell, offer, or expose for sale, in this State, any commercial fertilizer or manure except stable manure and the products of local manufacturers of less value than ten dollars a ton, shall affix conspicuously to every package thereof a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand, or trade-mark under which the fertilizer is sold, the name and address of the manufacturer, the place of manufacture and the chemical composition of the fertilizer, expressed in the terms and manner approved and usually employed by the Connecticut Agricultural Experiment Station.

If any such fertilizer be sold in bulk, such printed statement shall accompany every lot and parcel sold, offered, or exposed for sale.

Before sale certified copies of statement and sealed sample to be deposited with director.

SEC. 4006. Before any commercial fertilizer is sold, offered, or exposed for sale, the manufacturer, importer, or person who causes it to be sold, or offered for sale, within this state shall file with the director of the Connecticut Agricultural Experiment Station two certified copies of the statement prescribed in section 4005, and shall deposit with said director a sealed glass jar or bottle containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

Analysis fee to be paid annually on or before May 1.

SEC. 4007. The manufacturer, importer, agent, or seller of any commercial fertilizer shall pay on or before May 1, annually, to the director of the Connecticut Agricultural Experiment Station, an analysis fee of ten dollars for each of the fertilizing ingredients contained or claimed to exist in said fertilizer: *provided*, that when the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee prescribed in this section.

Yearly report to Station of dealers or agents

SEC. 4008. Every person in this State who sells, or acts as local agent for the sale of any commercial fertilizer of whatever kind or price, shall annually, or at the time of becoming such seller or agent, report to the director of the Connecticut Agricultural Experiment Station his name, residence, and post-office address, and the name and brand of said fertilizer, with the name and address of the manufacturer, importer, or party from whom such fertilizer was obtained, and shall, on demand of the director of the Connecticut Agricultural Experiment Station, deliver to said director a sample suitable for analysis of any such fertilizer or manure then and there sold or offered for sale by said seller or agent.

Leather.

SEC. 4009. No person or party shall sell, offer, or expose for sale, in this state any pulverized leather, raw, steamed, roasted, or in any form, as a fertilizer or as an ingredient of any fertilizer or manure, without explicit printed certificate of the fact, such certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany every parcel or lot of the same.

Fish guano, etc.

SEC. 4010. Every manufacturer of fish guano, or fertilizers of which the principal ingredient is fish or fish-mass from which the oil has been extracted, shall, before manufacturing or heating the same, and within thirty-six hours from the time such fish or mass has been delivered to him, treat the same with sulphuric acid or other chemical, approved by the director of said experiment station, in such quantity as to arrest decomposition: *provided, however*, that in lieu of such treatment such manufacturers may provide a means for consuming all smoke and vapors arising from such fertilizers during the process of manufacture.

Penalties.

SEC. 4011. Any person violating any provision of the foregoing sections of this chapter shall be fined one hundred dollars for the first offense, and two hundred dollars for each subsequent violation.

Fertilizers for private use.

SEC. 4012. This chapter shall not affect parties manufacturing, importing, or purchasing fertilizers for their own private use, and not to sell in this State.

Director's duties and authority.

SEC. 4013. The director of the Connecticut Agricultural Experiment Station shall pay the analysis-fees received by him into the treasury of the station, and shall cause one or more analyses of each fertilizer to be made and published annually. Said director is hereby authorized, in person or by deputy, to take samples for analysis from any lot or package of manure or fertilizer which may be in the possession of any dealer.

Bulletins.

SEC. 4014. The director of the Connecticut Agricultural Experiment Station shall, from time to time, as bulletins of said station may be issued, mail or cause to be mailed two copies, at least, of such bulletins to each post-office in the State.

OBSERVANCE OF THE FERTILIZER LAW.

MANUFACTURERS who have paid Analysis Fees as required by the Fertilizer Law, and Fertilizers for which the Fees have been thus paid for the year ending May, 1893.

Firm.	*Brand of Fertilizer.*
Baker, H. J. & Co., 93 William St., New York.	Standard UnXLD Fertilizer.
	A. A. Ammoniated Superphosphate.
	Special Potato Manure.
	" Corn Manure.
	" Tobacco Manure.
	" Onion Manure.
	Harvest Home Phosphate.
	Castor Pomace.
	Pure Ground Bone.
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Stockbridge Special Tobacco Manure.
	" " Grain Manure.
	" " Grass Top-Dressing and Forage Crop Manure.
	Stockbridge Special Potato and Vegetable Manure.
	Bowker's Hill and Drill Phosphate.
	" Farm and Garden Phosphate or Ammoniated Bone Fertilizer.
	" Potato Manure.
	" Tobacco Grower.
	" Sure Crop Bone Phosphate.
Bradley Fertilizer Co., 92 State St., Boston, Mass.	Bradley's Superphosphate.
	" Potato Manure.
	" Complete Manure for Potatoes and Vegetables.
	" Complete Manure for Top-Dressing Grass and Grain.
	" Complete Manure for Corn and Grain.
	" Pure Fine Ground Bone.
	" Circle Brand Ground Bone and Potash.
	" Fish and Potash, Anchor Brand.
	" Fish and Potash, Triangle A Brand.
	" B. D. Sea Fowl Guano.
	" Original Coe's Superphosphate.
	" Farmer's New Method Fertilizer.
	" High Grade Tobacco Manure.
Chicopee Guano Co., 140 Maiden Lane, New York City.	Chicopee Potato Manure.
	" Farmer's Reliable.
Clark's Cove Fertilizer Co., Farlow Building, State St., Boston, Mass.	Bay State Fertilizer.
	Bay State Fertilizer, G. G.
	King Philip Alkaline Guano.
	Potato and Tobacco Fertilizer.
	Great Planet Manure.

Firm.	*Brand of Fertilizer.*
Cleveland Linseed Oil Co., Euclid Av., Cleveland, O.	Connecticut Wrapper Fertilizer.
Coe Co., The E. Frank, 16 Burling Slip, New York City.	High Grade Potato Fertilizer.
	High Grade Phosphate.
	Ground Bone and Potash.
	New England Tobacco Fertilizer.
	Gold Brand Excelsior Fertilizer.
	Fish and Potash.
	Alkaline Bone.
Cooper's Glue Factory, Peter, 17 Burling Slip, New York City.	Bone Dust.
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Crocker's Ammoniated Bone Superphosphate.
	" Potato, Hop and Tobacco Phosphate.
	" Special Potato Manure.
	" Ammoniated Wheat and Corn Phosphate.
	" New Rival Ammoniated Superphosphate.
	" Ammoniated Practical Superphosphate.
	" Vegetable Bone Superphosphate.
	" Special Conn. Tobacco Manure.
	" Pure Ground Bone.
	" Ground Bone Meal.
Cumberland Bone Phosphate Co., Portland, Maine.	Cumberland Superphosphate.
	Cumberland Potato Fertilizer.
Darling Fertilizer Co., The L. B., Pawtucket, R. I.	Darling's Animal Fertilizer.
	" Fine Ground Bone.
	" Extra Bone Phosphate.
	" Potato and Root Crop Manure.
	" Tobacco Grower.
Downes & Griffin, Birmingham, Conn.	Ground Bone.
Ellsworth, F., Hartford, Conn.	Shoemaker's Swift Sure Superphosphate.
	" " " Bone Meal.
	Collier Castor Pomace.
Great Eastern Fertilizer Co., Rutland, Vt.	Great Eastern General Fertilizer for Grass and Grain.
	Great Eastern General Phosphate for Oats, Buckwheat and Seeding Down.
	Great Eastern Vegetable, Vine and Tobacco Fertilizer.
Hull, H. C., Meriden, Conn.	Ground Bone.
Kelsey, E. R., Branford, Conn.	Bone, Fish and Potash.

Firm.	*Brand of Fertilizer.*
Lister's Agricultural Chemical Works, Newark, N. J.	Celebrated Ground Bone.
	Ammoniated Dissolved Bone.
	Potato Fertilizer.
	Standard Superphosphate.
	Success Fertilizer.
Mapes Formula and Peruvian Guano Co., 143 Liberty St., New York City.	Complete Manure for Light Soils.
	" " " General Use.
	" " " "A" Brand.
	Potato Manure.
	Corn Manure.
	Tobacco Starter.
	Fruit and Vine Manure.
	Grass and Grain Spring Top Dressing.
	Tobacco Manure, Wrapper Brand.
	Seeding Down Manure.
	Fine Dissolved Bone.
Miles Fertilizer and Oil Co., Milford, Conn.	Geo. W. Miles Brand, Fish Guano.
Miller, Geo. W., Middlefield, Conn.	Pure Ground Bone.
	Flour of Bone Phosphate.
National Fertilizer Co., Bridgeport, Ct.	Chittenden's Complete Fertilizer.
	" Ammoniated Bone Phosphate.
	" Fish and Potash.
	" Ground Bone.
	Russell Coe's Phosphate.
Frederick Nuhn, Waterbury, Conn.	Self-Recommending Fertilizer.
Olds & Whipple, Hartford, Conn.	Red Seal Castor Pomace.
Peck Brothers, Northfield, Conn.	Pure Ground Bone.
Plumb & Winton, Bridgeport, Conn.	Ground Bone.
Preston Fertilizer Co., Greenpoint, L. I.	Onion Fertilizer.
	Potato Fertilizer.
	Ammoniated Bone Superphosphate.
	Ground Bone.
Quinnipiac Co., 92 State St., Boston, Mass.	Phosphate.
	Potato Manure.
	Market Garden Manure.
	Bone Meal.
	Ammoniated Dissolved Bone.
	Fish and Potash, Crossed Fishes Brand.
	Fish and Potash, Plain Brand.
	Pine Island Phosphate.
	Havana Tobacco Fertilizer.
	Corn Manure.
	Dry Ground Fish.
	Sulphate of Potash.
	Muriate of Potash.
	Sulphate of Ammonia.
	Dissolved Bone Black.

Firm.	*Brand of Fertilizer.*
Read Fertilizer Co., Box 3121, New York City.	Read's Standard.
	High Grade Farmer's Friend.
	Fish and Potash.
	Vegetable and Vine Fertilizer.
Reese, J. S. & Co., 10 South St., Baltimore, Md.	Reese's Potato Special.
	Reese's New England Favorite.
	Pilgrim Fertilizer.
Rogers & Hubbard Co., Middletown, Ct.	The Rogers & Hubbard Co's Pure Ground Raw Knuckle Bone Flour.
	Pure Ground Raw Knuckle Bone Meal
	Strictly Pure Fine Bone.
	Fertilizer for Oats and Top-Dressing.
	Soluble Potato Manure.
	Soluble Tobacco Manure.
	Grass and Grain Fertilizer.
	Fairchild's Formula for Corn and General Crops.
Rogers Mfg. Co., Rockfall, Conn.	Pure Ground Bone.
Sanderson, L., New Haven, Conn.	Old Reliable Superphosphate.
	Pulverized Bone Meal.
	Blood, Bone and Meat.
	Fine Ground Fish.
	Muriate of Potash.
	High Grade Sulphate of Potash.
	Regular Sulphate of Potash.
	Nitrate of Soda.
	Sulphate of Ammonia.
	Dissolved Bone Black.
	Formula A.
Soluble Pacific Guano Co., Box 1368, Boston, Mass.	Pacific Guano.
	Potato Manure.
	High Grade General.
Standard Fertilizer Co., Farlow Building, State St., Boston, Mass.	Potato and Tobacco Fertilizer.
	Complete Manure.
	Superphosphate.
Walker, Stratmann & Co., Pittsburgh, Pa.	Potato Special.
	Tobacco Special.
	Banner Fertilizer.
	Four Fold Fertilizer.
Wilcox, Leander, Mystic, Conn.	Potato, Onion and Tobacco Manure.
	Ammoniated Bone Phosphate No. 1.
	Ammoniated Bone Phosphate No. 2.
	High Grade Fish and Potash.
Wilkinson & Co., 54 William St, New York City.	Economical Bone Fertilizer.
Williams & Clark Fertilizer Co., 71 Fulton St, New York City.	Americus Ammoniated Bone Superphosphate.
	" Brand Potato Phosphate.
	" High Grade Special.
	" Brand Pure Bone Meal.
	" Brand Fine Wrapper Tobacco Grower.
	" Corn Phosphate.
	Royal Bone Phosphate.

ANALYSES OF FERTILIZERS.

During the year 284 samples of commercial fertilizers and manurial waste-products have been analyzed. A classified list of them is given on page 16.

On a few of these samples analyses were made for private parties and charged for accordingly. A few samples also were analyzed at request of other Experiment Stations in order to compare and test analytical methods. Results of the examination of all the samples, with these exceptions, are given in detail in the following pages.

During April, May and June, Messrs. Dennis Fenn of Milford, and F. R. Curtiss of Stratford, agents of this Station, visited ninety-eight towns and villages in Connecticut and drew 652 samples representing more than 160 distinct brands of commercial fertilizers.

In this way one or more samples were secured of nearly every brand of fertilizer which is offered for sale within the State. When several samples of a single brand were drawn in different parts of the State the analysis was performed, not on any single sample, but on a mixture made of an equal weight of each of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of any single sample.

The Station agents are instructed in every case to open at least three packages of each brand for sampling, and if the number of packages is large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core through the entire length of the bag or barrel.

As a rule, the Station will not analyze samples—

1. From dealer's stock of less than one ton.
2. From stock which has lain over from last season.
3. From stock which evidently is improperly stored, as in bags lying on wet ground or exposed to the weather, etc.

The Station desires the coöperation of farmers, farmers' clubs, and granges in calling attention to new brands of fertilizers, and in securing samples of all goods offered for sale. All samples drawn by other than Station agents *must* be drawn in accordance with the Station's Instructions for sampling, and properly certified, if the Station analysis is desired. A copy of these instructions and blank certificates will be sent on application.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed a copy of it is sent to the party who furnished the sample, and also to the manufacturer, in order that there may be opportunity for explanation or protest, if desirable, before the results are published in the Bulletin.

The following "Explanations" are intended to embody the principles and data upon which the valuation of fertilizers is based, a knowledge of which is essential to a correct understanding of the analyses that are given on subsequent pages.

EXPLANATIONS CONCERNING THE ANALYSIS OF FERTILIZERS AND THE VALUATION OF THEIR ACTIVE INGREDIENTS.

REVISED.

NITROGEN is the most rare, and commercially the most valuable element of fertilizers.

Free Nitrogen is universally abundant, making up nearly four-fifths of the common air, and is assimilable, with aid of certain bacteria, by leguminous plants (the clovers, alfalfa, peas, beans), and mustard, but whether it can nourish cereals or other crops is as yet doubtful.

Organic Nitrogen is the nitrogen of animal or vegetable matters, which is chemically united to carbon, hydrogen and oxygen. Some forms of organic nitrogen, as those of blood, flesh and seeds, are highly active as fertilizers; others as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated.

Ammonia (NH_3) *and nitric acid* (N_2O_5) are results of the decay of *organic nitrogen* in the soil and manure heap, and contain Nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda. 17 parts of ammonia or 66 parts of pure sulphate of ammonia contain 14 parts of nitrogen. 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

PHOSPHORUS is, next to nitrogen, the most costly ingredient of Fertilizers, in which it always exists in the form of phosphates, usually those of calcium, iron and aluminum, or in case of some "superphosphates," in the form of free phosphoric acid.

Soluble Phosphoric acid implies phosphoric acid or phosphates that are freely soluble in water. It is the characteristic ingredient of Superphosphates, in which it is produced, by acting on "insoluble" or "reverted" phosphates, with diluted sulphuric acid (oil of vitriol). Once well incorporated with the soil, it gradually becomes reverted phosphoric acid. It is often termed *water-soluble phosphoric acid.*

Reverted (reduced or precipitated) Phosphoric acid means strictly, phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid. In present usage the term signifies the phosphoric acid (of various phosphates) that is freely taken up by a strong solution of ammonium citrate, which is therefore used in analysis to determine its quantity. It may also be designated *citrate-soluble phosphoric acid*. "Reverted phosphoric acid" implies phosphates that are readily assimilated by crops.

Recent investigation tends to show that soluble and reverted phosphoric acid are on the whole about equally valuable as plant food, and of nearly equal commercial value. In some cases, indeed, the soluble gives better results on crops, in others the reverted is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric acid implies various phosphates not soluble in water or ammonium citrate. In some cases the phosphoric acid is too insoluble to be readily available as plant food. This is especially true of the crystallized green Canada Apatite. Bone-black, bone-ash, South Carolina Rock and Navassa Phosphate when in coarse powder are commonly of little repute as fertilizers though good results are occasionally reported from their use. When *very finely pulverized* ("floats") they more often act well, especially in connection with abundance of decaying vegetable matters. The phosphate of calcium in raw bones is nearly insoluble, because of the animal matter of the bones, which envelopes it; but when the latter decays in the soil, the phosphate remains in essentially the "reverted" form. The phosphoric acid of "Thomas-Slag" and of "Grand Cayman's Phosphate" is in some soils as freely taken up by crops as the water-soluble phosphoric acid but in other soils is much less available.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid," (P_2O_5), also termed among chemists, phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

POTASSIUM is the constituent of fertilizers, which ranks third in costliness. In plants, soils and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the form of muriate (potassium chloride).

The Valuation of a Fertilizer, as practised at this Station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and similar articles, for which $30 to $50 per ton are paid, depend chiefly for their trade-value on the three substances, *nitrogen*, *phosphoric acid* and *potash*, which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above named ingredients*, a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

The average Trade-value or retail cost in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash, as found in New England, New York and New Jersey markets, are as follows:

THE TRADE-VALUES FOR 1893 OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

The average Trade-values or *retail cost per pound* of the ordinarily occurring forms of nitrogen, phosphoric acid and potash are as follows:

	Cts. per lb.
Nitrogen in ammonia salts	17
nitrates	15½
Organic nitrogen in dry and fine ground fish, meat and blood	17½
in cotton seed meal and castor pomace	16½
in fine bone and tankage	15
in fine-medium bone and tankage	12
in medium bone and tankage	9
in coarser bone and tankage	7
in hair, horn shavings and coarse fish scrap	7
Phosphoric acid, soluble in water	6½
in ammonium citrate*	6
in dry ground fine fish, bone and tankage	6
in fine-medium bone and tankage	5
in medium bone and tankage	4
in coarse bone and tankage	3
in fine ground fish, cotton seed meal, castor pomace and wood ashes	5
insoluble in ammonium citrate, in mixed fertilizers	2
Potash as high-grade sulphate and in forms free from muriate (or chlorides)	5½
as muriate	4½

* Dissolved from 2 grams of the unground phosphate previously extracted with pure water, by 100 c. c. neutral solution of ammonium citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

These Trade-values were agreed upon by the Experiment Stations of Massachusetts, New Jersey, Rhode Island, and Connecticut, for use in their respective States during 1893. They are the average prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those raw materials which are the regular source of supply. They also correspond to the average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the *average retail prices* at the large markets of standard raw materials, such as:

Sulphate of Ammonia,	Muriate of Potash,
Nitrate of Soda,	Sulphate of Potash,
Dried Blood,	Plain Superphosphates,
Azotin,	Dry Ground Fish,
Ammonite,	Bone and Tankage,

Ground South Carolina Rock.

Valuation of Superphosphates, Special Manures and Mixed Fertilizers of High Grade.

The Organic Nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality.

Insoluble Phosphoric Acid is reckoned at 2 cents per pound. Potash is rated at 4½ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, than this excess of Potash is reckoned at 5½ cents per pound.

In most cases the valuation of the ingredients in Superphosphates and Specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. The charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investments, bad debts, and finally, profits.

The majority of the manufacturers agree that the average cost of mixing, bagging, handling and cartage ranges from $3.00 to $4.50 per ton.

In 1893 the average selling price of Ammoniated Superphosphates and Guanos was $32.99 per ton, the average valuation was $23.48, and the difference $9.51, an advance of 40.5 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

In case of Special manures the average cost was $37.76, the average valuation $29.35 and the difference $8.41 or 28.6 per cent. advance on the valuation.

To obtain the Valuation of a Fertilizer we multiply the pounds per ton of nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

In case of *Ground Bone*, the sample is sifted into four grades and we separately compute the nitrogen-value of each grade by multiplying the pounds of nitrogen per ton, by the per cent. of each grade, taking $\frac{1}{100}$th of that product, multiplying it by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

The uses of the "Valuation" are two-fold:

1. To show whether a given lot or brand of fertilizers is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price; but in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

2. Comparisons of the valuation and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for analysis cannot decide accurately what is the *form* of nitrogen, etc., while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first-named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second-named use of valuation frequent changes of the trade-value are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth, when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at the beginning of the year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

The *Agricultural value* of a fertilizer is measured by the benefits received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that Peruvian guano superphosphates, fish-scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

CLASSIFICATION OF FERTILIZERS ANALYZED.

I. RAW MATERIALS OF HIGH GRADE CONTAINING NITROGEN AS THE CHIEF VALUABLE INGREDIENT.

NITRATE OF SODA.

Nitrate of Soda is mined in Chili and purified there before shipment. It usually contains about 16 per cent. of nitrogen, equivalent to 97 per cent. of pure nitrate of soda. It contains besides, a little salt and some moisture. The usual guarantee is "96 per cent." of nitrate of soda equivalent to 15.8 per cent. of nitrogen.

3964. From stock of L. Sanderson, New Haven.

ANALYSIS.

Moisture	3.51
Insoluble in water	.08
Sodium Chloride (Salt)	.66
Sodium Sulphate	.23
Pure Sodium Nitrate	95.52
	100.00
Equivalent Nitrogen	15.76
Cost per ton	$55.00
Nitrogen costs cents per pound	17.4

SULPHATE OF AMMONIA.

This article, now made on a large scale as a by-product of gas-works, usually contains over 20 per cent. of nitrogen, the equivalent of from 94 to 97 per cent. of sulphate of ammonia. The rest is chiefly moisture. The usual guarantee is 25 per cent. of ammonia, which is equivalent to 20.6 per cent. of nitrogen, but commercial sulphate of ammonia commonly contains less than that quantity.

3965. Stock of L. Sanderson, New Haven. **3968.** Sold by Quinnipiac Co., Boston. Stock of Olds & Whipple, Hartford.

ANALYSES.

	3965	3968
Nitrogen	20.58	20.78
Equivalent Ammonia	25.10	25.34
Cost per ton	$80.00	$75.00
Nitrogen costs cents per pound	19.4	18.1

COTTON SEED MEAL.

The seed of the cotton plant, after ginning to remove the fiber, passes through a mill which hulls or decorticates it. The hulled seed is ground and the oil expressed. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer.

Sometimes, however, hulls and seed are ground together, making "undecorticated meal" which contains considerably less nitrogen and has correspondingly less money value as a fertilizer or as a feed. When the meal has undergone heating or fermentation, its color changes from a deep yellow to brown or reddish-brown. It is then unfit for cattle food and is sold at a cheaper rate as a fertilizer.

The following analyses of Cotton Seed Meal have been made at this Station during the present year.

While they were made in the interest of those who were buying the meal to use as a fertilizer, they are worth the attention also of those who are now using or who intend during the winter season, to use Cotton Seed Meal as feed for stock.

The eight analyses which have the first place in the table represent decorticated meal of fair quality made from upland cotton.

The per cent. of nitrogen found in No. **3781** is higher than has been previously observed in any sample analyzed here, 8.08 per cent.

The per cent. of nitrogen found in No. **3832** is very low for pure meal, but the sample does not appear to be adulterated. The other differences in nitrogen, among these eight samples, are such as occur constantly and are due to differences of soil and fertilizers on which the cotton was raised and to differences in the thoroughness of the hulling.

Owing to increased foreign demand the price of cotton seed meal has advanced sharply so that it is no more our cheapest source of available nitrogen. Thus the average cost of nitrogen in these eight samples, analyzed in 1893, was $17\frac{1}{2}$ cents per pound.

Last year the average cost was only about 15 cents, nevertheless meal of prime quality is still a profitable fertilizer to use if bought at $30 or even $31 per ton.

Special attention is called to the three samples, **3833, 3827** and **3856.** They contain somewhat more than half as much nitrogen and considerably less phosphoric acid and potash than the other samples, but were sold for only a dollar or two less per ton.

These are "Cotton Seed Meal" as well as the others but are made from the seed of Sea Island Cotton *ground with the hulls.* They are readily distinguished by their dark color and the presence of hard black fragments of hulls.

As fertilizers they are not worth more than $18.00 per ton when bright decorticated meal can be bought for $30.00.

It is quite likely that this sort of meal will be put on our market more commonly than heretofore.

In ordering Meal to use as a Feed or as a Fertilizer, purchasers should require Decorticated, Upland Cotton Seed Meal containing at least 6.5 per cent. of Nitrogen, unless they are willing to use the other, greatly inferior meal, which cannot be economically done unless it can be got for a greatly reduced price.

There is no evidence that the undecorticated meal is in any way injurious to stock; indeed some feeders prefer it to the clear decorticated meal on the ground that it is less likely to cloy cattle if fed in large quantity.

But both its manurial and its feed value are much less than those of decorticated meal.

Description of Samples.

3848. Sold by A. H. Rice, Granby. Sampled by H. A. Sheldon, West Suffield.

4025. Sold by Olds & Whipple, Hartford, in the fall of 1892. Sampled by Eugene Brown, Poquonock.

3781. Bought at the south by A. Pouleur, Windsor, and sampled by him.

3881. Sold by Olds & Whipple. Sampled by Station Agent from stock of J. A. DuBon.

3858. Sold by Olds & Whipple, Hartford, in spring of 1893. Sampled by Eugene Brown, Poquonock.

3861. Sold by Edward Austin, Suffield. Sampled by O. E. Pitcher, Enfield.

3924. Sold by C. H. Dexter & Sons, Windsor Locks. Sampled by Eugene Brown and T. B. Hathaway from stock sold to several purchasers.

3832. Sold by J. H. Viets, Copper Hill. Sampled by S. D. Viets.

3833. Sold by J. H. Viets. Sampled by S. D. Viets.

3827. Sold by C. H. Dexter & Sons, Windsor Locks. Sampled by Eugene Brown, Poquonock.

3856. Sold by E. S. Hough, Poquonock. Sampled by Eugene Brown, Poquonock.

3941. Sold by Horace Griffin, East Granby. Sampled by B. L. Alderman, West Suffield.

3943. Sold by J. H. Viets, Copper Hill. Sampled by S. D. Viets.

ANALYSES OF COTTON SEED MEAL.

	3848	4025	3781	3881	3858	3861	3924	3832	3833	3827	3856	3941	3943
Nitrogen	6.90	7.01	8.08	6.74	6.76	6.64	6.65	6.10	4.49	3.97	3.71	7.01	6.86
Phosphoric acid	3.31	3.28	2.65	3.04	3.04	3.29	3.43	3.15	1.83	1.75	1.66	---	---
Potash	1.99	1.97	1.78	1.94	1.87	1.89	2.06	1.95	1.67	1.36	1.39	---	---
Cost per ton	$26.00	27.00	30.00	27.00	30.00	30.00	31.00	30.00	28.00	29.00	29.50		
Nitrogen costs cents per pound	14.9	15.4	15.7	16.2	18.4	18.5	19.0	20.2	27.1	32.4	35.4		

CASTOR POMACE.

The ground residue of castor beans from which castor oil has been extracted. An excellent fertilizer but extremely poisonous to cattle if they get access to it.

3807. Made by H. J. Baker & Bro., N. Y. Stock of W. F. Andross, East Hartford.

3925. Made by H. J. Baker & Bro., N. Y. Stock of F. S. Bidwell, Windsor Locks. Sampled by T. B. Hathaway, Windsor.

3826. Collier Castor Pomace, sold by F. Ellsworth. Stock bought by J. A. DuBon, Poquonock.

3808. Made by Red Seal Castor Oil Co., St. Louis, Mo. Stock of J. A. Warner, Tylerville.

ANALYSES.

	3807	3925	3826	3808
Nitrogen	5.39	4.58	4.62	4.40
Phosphoric Acid	1.85	1.66	1.45	1.34
Potash	1.28	1.20	1.09	1.12
Cost per ton	$24.00	$24.00	$22.00	$25.00
Nitrogen costs cents per pound	19.2	22.9	20.9	25.4

As the analyses show, the castor pomace sold this year in Connecticut has contained much less nitrogen than formerly and in consequence it has been a very expensive source of nitrogen.

HORN DUST.

4058. Made by the Salisbury Cutlery Handle Co., Salisbury. Sent by Henry Belden, Falls Village.

This sample contained 14.48 per cent. of nitrogen. It consisted partly of turnings and partly of fine horn dust. While the nitrogen of horn is by no means as available to plants as that of dried blood or fine ground bone, experiments have shown that it has considerable agricultural value. The horn may be composted with horse manure or lime. If applied to land without previous composting it should be used in the fall rather than in the spring.

DISSOLVED BONE BLACK AND DISSOLVED BONE.

Superphosphates made by treating waste and spent bone black from the sugar refineries, or bone dust, with oil of vitriol which renders the phosphoric acid largely soluble in water.

Dissolved Bone Black.

3993. Stock of L. Sanderson, New Haven. **3994.** Sold by Quinnipiac Co., Boston. Stock of Olds & Whipple, Hartford.

Dissolved Bone.

3739. Sold by C. E. Stagg, Stratford. Sampled and sent by S. E. Curtiss, Stratford.

ANALYSES.

	3993	3994	3739
Soluble Phosphoric Acid	16.38	12.34	6.67
Reverted " "	.35	3.46	6.72
Insoluble " "	trace	trace	1.33
Cost per ton	$26.00	27.00	16.00†
Soluble phosphoric acid costs cents per pound*	7.8	9.3	5.6

The dissolved bone black is particularly convenient to handle because it never cakes in the bag or heap.

But it will well repay those who are using any considerable quantity of phosphates to get quotations of dissolved South Carolina or Florida rock phosphate. This material, which should contain 12–14 per cent. of soluble and reverted acid, if freshly made is apt to cake on lying, but if mixed promptly with nitrogenous matter and especially if the mixture is used soon after mixing there should be no difficulty in handling it. The soluble phosphoric acid of rock phosphate is as valuable for plant food as in any other form of superphosphate and dissolved rock phosphate is very decidedly cheaper than dissolved bone black. When the available phosphoric acid of dissolved bone black costs 8 cents per pound, it can probably be got in dissolved phosphate for from 5 to 5½ cents.

III. RAW MATERIALS OF HIGH GRADE CONTAINING POTASH.

HIGH GRADE SULPHATE OF POTASH.

This material should contain over 90 per cent. of pure sulphate of potash or about the same quantity of actual potash as the muriate, but no more than a trace of chlorine.

3797. Sold by Leander Wilcox, Mystic. Sampled by H. H. Austin, Suffield.

3862. Sold by Wm. R. Peters & Co., New York. Sampled by O. E. Pitcher, Enfield Bridge.

* Allow for reverted and insoluble phosphoric acid 6 and 2 cents per pound respectively.

† In eight ton lot.

3896. Sold by L. Sanderson, New Haven. Sampled by W. E. Russell, Suffield.

3926. Sold by L. Sanderson, New Haven, Sampled by A. P. Hills, Silver Lane.

3963. Sold by G. B. Alderman, Suffield. Sampled by S. D. Viets, Copper Hill.

3966. Sold by Quinnipiac Co., Boston. Stock of Olds & Whipple, Hartford.

(For analyses see the table on page 24.)

DOUBLE SULPHATE OF POTASH AND MAGNESIA.

This material is usually sold as "sulphate of potash" or "manure salts," on a guarantee of "48–50 per cent. sulphate," which is equivalent to 25.9–27.0 per cent. of actual potash. Besides some 46–50 per cent. of sulphate of potash it contains over 30 per cent. of sulphate of magnesia, chlorine equivalent to 3 per cent. of common salt, a little sulphate of soda and lime, with varying quantities of moisture.

3927. Sold by National Fertilizer Co., Bridgeport, to G. W. & H. B. Williams, East Hartford. Sampled by A. P. Hills, Silver Lane. The goods represented by this sample were bought for high grade sulphate the price charged being $54 per ton. On receipt of the analysis showing that the goods were not high grade sulphate, the purchaser protested. The National Fertilizer Co. writes in explanation "We entered the order correctly and it was called to the factory and checked off after shipment, but for all that, the factory book now shows that the two kinds were sent as above." (A part of the invoice was high grade sulphate.) "We have explained to Messrs. Williams and sent them a 'corrected bill.'" The price finally paid was $30 per ton.

MURIATE OF POTASH.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride) 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water. It is generally retailed on a guarantee of 80 per cent. muriate, which is equivalent to 50.5 per cent. of actual potash.

3967. Sold by Quinnipiac Co., Boston. Stock of Olds & Whipple, Hartford.

ANALYSES.

	3797	3862	3896	3926	3963	3966	3927	3967
Potash soluble in water,	49.15	51.92	48.36	50.46	48.67	48.40	25.96	49.76
Equivalent sulphate of potash	90.92	96.06	89.47	93.35	90.04	89.50	48.03	----
Equivalent muriate of potash	----	----	----	----	----	----	----	79.11
Cost per ton	$55.00	$53.25	$55.00	$54.00	$59.00	$55.00	$30.00	$48.00
Potash costs cents per pound	**5.58**	**5.13**	**5.68**	**5.35**	**6.6**	**5.7**	**5.8**	**4.8**

The cost of actual potash in the samples of sulphate has been from 5.13 to 6.6 cents per pound. The high cost of potash in certain samples is explained by the abnormally low per cent. of potash in the goods, in some cases more than two per cent. lower than the average. Four out of the six samples of the high grade sulphate have less than 50 per cent. of potash.

The frequent objections of manufacturers this year to the per cent. of potash found in the various brands of mixed fertilizers may have their explanation also in this deficiency of potash in the raw material used as a source of potash.

For all crops except tobacco, sugar beets and possibly potatoes, muriate of potash is altogether the most economical source of supply.

If muriate is applied in moderate quantity in the fall or very early spring to potato land no damage to the quality or productiveness of the crop need be feared.

IV. Raw Materials containing Nitrogen and Phosphoric Acid.

Bone Manures.

The terms "Bone Dust," "Ground Bone," "Bone Meal" and "Bone" applied to fertilizers, sometimes signify material made from dry, clean and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon, and grease—and if taken from garbage or ash heaps, with ashes or soil adhering; again they denote mixtures of bone, blood, meat and other slaughter-house refuse which have been cooked in steam-tanks to recover grease, and are then dried and sometimes sold as "tankage;" or, finally, they apply to bone from which a large share of the nitrogenous substance has been extracted in the glue manufacture. The nitrogen of all these varieties of bone when they are in the same state of mechanical subdivision has essentially the same fertilizing value.

1. *Sampled by Station Agents.*

On following pages are tabulated eighteen analyses of samples of this class.

The average cost of these bone manures is $31.70 and the average valuation $32.01 per ton. This close agreement of cost and valuation in the case of bone indicates that the Station's schedule of valuation is in substantial agreement with the actual market prices.

There has been no cheaper form of readily available organic nitrogen in the market the past year than fine ground bone and tankage.

2. *Sampled by manufacturers; and* 3. *Sampled by private individuals.*

The following samples, deposited at the Station by manufacturers in compliance with the law, are analyzed to meet the requirement of the law which calls for an annual analysis of each brand. The sampling agents of the station did not succeed in finding these brands on sale in the State.

3911. Crocker's Ground Bone Meal. Made by the Crocker Fertilizer and Chemical Co., Buffalo, N. Y. Sampled by the manufacturer.

3917. Crocker's Pure Ground Bone. Sampled by the manufacturer.

3912. Lister's Celebrated Ground Bone. Made by Lister's Agricultural Chemical Works, Newark, N. J. Sampled by the manufacturer.

3860. Cooper's No. 2 Bone. Made by Peter Cooper's Glue Factory, N. Y. Sampled by O. E. Pitcher, Enfield, Conn., from stock purchased by him.

4059. Clean Bone Dust. Made by the Salisbury Cutlery Handle Co., Salisbury. Sampled and sent by Henry Belden, Falls Village.

BONE MANURES SAMPLED BY THE STATION.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
4031	Peter Cooper's Bone Dust.	Peter Cooper's Glue Factory, 17 Burling Slip, N.Y.	Geo. W. Hall, Hadlyme.	$28.00
3920	Peter Cooper's Bone Dust.	Peter Cooper's Glue Factory, 17 Burling Slip, N.Y.	Beaumont Bros., Wallingford.	27.00
3794	Ground Bone.	Reed Co., Brooklyn, N. Y.	*E. O. Wakeman, Westport.	30.00
4029	Bone Meal.	Danbury Fertilizer Co., Danbury.	Manufacturer.	30.00
3802	Ground Bone.	Florence Manufacturing Co, Florence, Mass.	*J. A. Warner, Tylerville.	35.00
4032	Pure Ground Bone.	Rogers Manufacturing Co, Rockfall.	F. Ellsworth, Hartford.	35.00
			J. A. Lewis, Willimantic.	30.00
			Manufacturer.	30.00
3921	Pure Raw Ground Bone.	H. J. Baker & Bro., 93 William St., N. Y.	Saxton & Strong, Bristol.	35.00
3916	Bone Meal.	Quinnipiac Co., 92 State St., Boston, Mass.	A. P. Wakeman, Fairfield.	29.00
3919	Fine Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	W. W. Cooper, Suffield.	38 00
			H. K. Brainard, Thompsonville.	32.00
			J. A. Lewis, Willimantic.	31.00
3804	Strictly Pure Fine Bone.	The Rogers & Hubbard Co, Middletown.	E. L. Strong, Colchester.	30.00
			Geo. Butler, Cromwell.	30.00
3803	Pure Ground Raw Knuckle Bone Meal.	The Rogers & Hubbard Co., Middletown.	Geo. Butler, Cromwell.	37.00
3800	Swift-Sure Bone Meal.	M. L. Shoemaker & Co, Philadelphia, Pa.	F. Ellsworth, Hartford.	40.00
3918	Bone Fertilizer.	Plumb & Winton, Bridgeport.	Manufacturer.	30.00
3799	Fine Ground Bone.	Bradley Fertilizer Co., 92 State St., Boston, Mass.	L. F. Judson, Stratford.	32.00
			G. A. Dickenson, Haddam.	35.00
3928	Pure Ground Bone.	Peck Brothers, Northfield.	Strong & Tanner, Winsted.	30.00
3914	Pure Bone Meal.	Williams & Clark Fertilizer Co., N. Y.	N. P. Burr, Kensington.	38.00
			W. H. Smith & Co., Norwalk.	35.00
3915	Ground Bone.	Downs & Griffin, Birmingham.	Hallock & Co., Birmingham.	35.00
3913	Pure Ground Bone.	G. W. Miller, Middlefield.	Manufacturer.	28 00

* Purchaser.

ANALYSES OF BONE MANURES.—SAMPLED BY THE STATION.

Station No.	Name or Brand.	Chemical Analysis.		Mechanical Analysis.				Cost per ton.	Valuation per ton.	Percentage difference between cost and valuation.
		Nitrogen.	Phos. Acid.	Finer than 1/50 inch.	Finer than 1/25 inch.	Finer than 1/12 inch.	Coarser than 1/12 inch.			Valuation exceeds cost.
4031	Peter Cooper's Bone Dust	1.97	26.29	93	3	2	2	$28.00	$36.63	23.6
3920	Peter Cooper's Bone Dust	2.01	29.97	38	20	25	17	27.00	33.35	19.0
3794	Reed Co's Bone	1.37	31.57	47	20	21	12	30.00	35.04	14.4
4029	Danbury Fertilizer Co's Bone Meal	3.90	22.58	49	28	21	2	30.00	33.60	10.7
3802	Florence Manufacturing Co's Ground Bone	3.81	26.84	58	27	13	2	35.00	39.14	10.6
4032	Rogers Manufacturing Co's Pure Ground Bone	4.22	22.22	25	29	42	4	30.00	32.52	7 7
3921	H. J. Baker & Bro's Pure Raw Ground Bone	3.71	24.43	62	37	1	--	35.00	37.67	7.0
3916	Quinnipiac Co's Bone Meal	4.05	21.54	31	29	38	2	29.00	30.54	5.0
3919	Darling's Fine Ground Bone	2.76	22.52	68	22	10	--	32.00	32.71	2.1
3804	The Rogers & Hubbard Co's Strictly Pure Fine Bone	3.91	23.09	27	25	34	14	30.00	30.14	.4
3803	The Rogers & Hubbard Co's Pure Ground Raw Knuckle Bone Meal	4.11	25.52	37	49	14	--	37.00	37.04	.1
										Cost exceeds valuation.
3800	Shoemaker & Co's Swift-Sure Bone Meal	5.34	23.14	58	33	9	--	40.00	39.80	.5
3918	Plumb & Winton's Bone Fertilizer	3.94	21.82	35	23	24	18	30.00	29.74	.9
3799	Bradley Fertilizer Co's Fine Ground Bone	3.32	20.75	53	30	17	--	32.00	30.93	3.4
3928	Peck Brothers' Pure Ground Bone	4.22	20.60	8	21	39	32	28.00	24.68	13.5
3914	Williams & Clark's Pure Bone Meal	3.46	20.97	51	24	23	2	35.00	30.80	13.6
3915	Downs & Griffin's Ground Bone	4.47	22.07	22	23	32	23	35.00	29.03	20.6
3913	G. W. Miller's Pure Ground Bone	4.24	20.55	4	12	39	45	28.00	22.79	22.9

MECHANICAL ANALYSES.

	3911	3917	3912	3860	4059
Fine, smaller than $\frac{1}{50}$ inch	67	41	38	50	66
Fine medium, smaller than $\frac{1}{25}$ inch	18	27	24	20	29
Medium, smaller than $\frac{1}{12}$ inch	13	26	20	18	5
Coarse, larger than $\frac{1}{12}$ inch	2	6	18	12	--
	100	100	100	100	100

CHEMICAL ANALYSES.

	3911	3917	3912	3860	4059
Nitrogen	1.76	4.08	4.36	1.52	4.39
Phosphoric acid	26.46	25.27	15.45	31.23	24.86
Valuation per ton	$33.87	35.33	25.04	35.49	40.03
Cost per ton	----	----	----	23.00	----

QUINNIPIAC BONE MEAL.

A sample of this article, No. **3806,** drawn from stock of J. W. Gardner, Cromwell, was analyzed with the results given below. The manufacturers protested that the analysis did not fairly represent the average quality of the brand and at their request an analysis was made of another sample, drawn from stock of A. P. Wakeman, Fairfield. This later analysis, No. **3916,** is tabulated with others on page 27 and is here reproduced for comparison.

MECHANICAL ANALYSES.

	3806	3916
Fine, smaller than $\frac{1}{50}$ inch	55	31
Fine medium, smaller than $\frac{1}{25}$ inch	27	29
Medium, smaller than $\frac{1}{12}$ inch	18	38
Coarse, larger than $\frac{1}{12}$ inch	--	2
	100	100

CHEMICAL ANALYSES AND VALUATIONS.

	3806	3916
Nitrogen	3 16	4.05
Phosphoric acid	19.25	21.54
Cost per ton	$33.00	29.00
Valuation per ton	$28.96	30.54

TANKAGE.

This name is properly applied only to the sediment remaining in tanks where meat scrap with some bone is rendered to separate the fat. After boiling or superheating with steam, the fat rises to the surface of the water and is removed, the soup is run off, and the settlings at the bottom are dried and sold as tankage.

Such material contains a percentage of nitrogen as large as or larger than that of phosphoric acid. But the name tankage is also applied to mixtures that consist largely of bone and do not differ greatly in composition from pure bone.

Sampled by Station Agent.

3801. Blood, Bone and Meat. Sold by L. Sanderson, New Haven. Sampled from stock of E. P. Carroll, East Hartford.

3805. Ground Tankage. Sold by Quinnipiac Co. Sampled from stock of Olds & Whipple, Hartford.

4026. Made by Danbury Fertilizer Co., Danbury, Ct. Stock of L. P. Russell, Orange.

MECHANICAL ANALYSES.

	3801	3805	4026
Fine, smaller than $\frac{1}{50}$ inch	47	62	47
Fine medium, smaller than $\frac{1}{25}$ inch	29	22	23
Medium, smaller than $\frac{1}{12}$ inch	20	16	17
Coarse, larger than $\frac{1}{12}$ inch	4		13
	100	100	100

CHEMICAL ANALYSES AND VALUATIONS.

	3801	3805	4026
Nitrogen	7.07	4.53	5.13
Phosphoric acid	9.59	19.15	16.71
Cost per ton	$35.00	32.00	30.00
Valuation per ton	$27.65	33.03	29.41

DRY GROUND FISH.

This material is often mixed with oil of vitriol to hinder decay during drying, and the bones of the fish are as a result dissolved to some extent.

3992. Made by the Quinnipiac Co. Sampled from stock of Olin Wheeler, Buckland, and Olds & Whipple, Hartford.

ANALYSIS.

	3992
Nitrogen as ammonia	.25
Organic Nitrogen	8.44
Soluble phosphoric acid	.66
Reverted phosphoric acid	4.22
Insoluble phosphoric acid	2.17
Cost per ton	$40.00
Valuation per ton	$37.19

Mixed Fertilizers.

I. Bone and Potash.

The following brands, though sold under a variety of names, consist of bone or tankage mixed with potash salts.

3750. "Ground Bone." Made by Preston Fertilizer Co., Greenpoint, N. Y. Stock of F. M. Raymond, Westport.

3997. Circle Brand Bone and Potash. Made by Bradley Fertilizer Co., Boston. *Manufacturer's sample.*

4004. "Self-recommending Fertilizer." Made by F. Nuhn, Waterbury. Sampled by Station agent.

4006. "Ground Bone." Made by E. F. Coe, N. Y. Sampled by Station agent from stock of Wheeler & Howe, Bridgeport, and J. O. Fox, Putnam.

Mechanical Analyses.

	3750	3997	4004	4006
Fine, smaller than $\frac{1}{50}$ inch	37	54	45	31
Fine medium, smaller than $\frac{1}{25}$ inch	28	31	28	24
Medium, smaller than $\frac{1}{12}$ inch	26	15	18	18
Coarse, larger than $\frac{1}{12}$ inch	9	--	9	27
	100	100	100	100

Chemical Analyses.

	3750	3997	4004	4006
Nitrogen	3.52	2.49	3.57	2.87
Phosphoric acid	7.33	18.52	21.10	20.24
Potash	3.50	3.04	2.09	3.31
Cost per ton	$29.00	---	28.00	32.50
Valuation per ton	$19.40	29.26	32.19	28.24

Two samples of G. W. Miller's Bone Phosphate were drawn and sent for analysis by D. W. Patten, Clintonville, from stock shipped directly from the manufacturer to Clintonville.

3851 cost $37.00 per ton and had a minimum guarantee of 4.66 per cent. nitrogen, 4.9 per cent. potash, and 12.50 per cent. phosphoric acid.

3852 cost $36.00 and was guaranteed to contain 3.5 per cent. of nitrogen, 4.5 of potash and 11.0 of phosphoric acid.

The percentages found were as follows:

	3851	3852
Nitrogen as nitrates	1.30	1.75
as ammonia	.20	.17
organic	1.90	1.31
Total nitrogen	3.40	3.23
Total phosphoric acid	9.67	10.41
Total Potash	6.48	4.51

II. Nitrogenous Superphosphates and Guanos.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid and in most cases potash, which are not designed by their manufacturers for use on any special crop. "Special Manures" are noticed further on.

1. *Samples drawn by Station agents.*

In the tables on pages 32 to 39 are tabulated the analyses of forty-nine brands, made on samples collected by the Station agents.

Notes on Particular Analyses.

No. **3815,** Farmers' New Method Fertilizer, made by the Bradley Fertilizer Co., Boston, Mass., was objected to by the manufacturer on account of the low percentage of potash. It represented a mixture of samples from the stock of Wilson & Burr, Middletown, L. F. Judson, Stratford, W. F. Andross, East Hartford, D. N. Clark & Sons, Milford. On account of this protest another sample of this brand was drawn, No. **3950,** the analysis of which is given in the table on page 38 and is here reproduced for comparison.

Analyses of Bradley's Farmers' New Method Fertilizer.

	3815	3950
Total nitrogen	2.25	2.30
Phosphoric acid	11.32	11.03
Potash	2.42	2.68
Valuation	$23.45	23.48

Neither of these analyses shows the quantity of potash claimed by the manufacturer. A possible explanation of this discrepancy is given on page 24.

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3798	Fine Dissolved Bone.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., N. Y. City.	Wilson & Burr, Middletown.	$33.00
3961	Ammoniated Bone Phosphate.	Preston Fertilizer Co, Greenpoint, L. I.	F. M. Raymond, Westport.	32.00
			Dean & Horton, Stamford.	30.00
4028	Nameless Fertilizer.	Danbury Fertilizer Co., Danbury.	Manufacturer.	30.00
			L. P. Russell, Orange.	30.00
3934	Complete Manure for General Use.	Mapes' Formula & Peruvian Guano Co., N. Y. City.	G. K. Mason, Willimantic.	40.00
			W. H. Childs, Manchester.	41.00
			Mapes' Branch, Hartford.	38.00
3837	Swift Sure Superphosphate.	M. L. Shoemaker & Co., Philadelphia, Pa.	F. Ellsworth, Hartford.	38.00
			F. S. Bidwell, Windsor Locks.	40.00
			J. P. Barstow & Co., Norwich.	37.00
3933	Complete Manure, A Brand.	Mapes' Formula & Peruvian Guano Co., N. Y. City.	Wm. C. Buckley, Forestville.	37.00
			Quinnebaug Store, Danielsonville.	37.00
			F. S. Bidwell, Windsor Locks.	36.00
			Wilson & Burr, Middletown.	36.00
			Mapes' Branch, Hartford.	35.00
3937	Ammoniated Dissolved Bone.	Lister's Agricultural Chemical Works, Newark, N. J.	A. N. Clark, Milford.	27.00
3970	Formula A.	L. Sanderson, New Haven.	A. P. Wakeman, Fairfield.	35.00
			E. B. Clark & Sons, Milford.	36.00
3880	Ammoniated Bone Phosphate, No. 1.	L. Wilcox, Mystic.	F. Gallup, New London.	33.00
			Manufacturer.	33.00
			W. C. Reynolds, Goodspeeds.	32.00
3991	New England Favorite.	J. S. Reese & Co., 10 South St., Baltimore, Md.	W. H. Anderson, Putnam.	33.00
			Donald Gunn, Groton.	36.00
3816	High Grade Ammoniated Bone Superphosphate.	The E. Frank Coe Co., 16 Burling Slip, New York City.	Wm T. Andrews, Orange.	36.00
			W. A. Burr, West Hartford.	38.00
			W. C. Reynolds, Goodspeeds.	32.00
			F. P. Burr, Middletown.	32.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3869	Hill and Drill Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. E. Collins, Wapping.	$36.00
			J. M. Williams, Manchester.	35.00
			M. McNamara, New Milford.	38.00
			F. Hallock & Co., Birmingham.	35.00
			C. H. Bell, Portland.	42.00
3935	Standard Pure Bone Superphosphate.	Lister's Agricultural Chemical Works. Newark, N. J.	A. N. Clark, Milford.	32.00
3883	Chittenden's Ammoniated Bone Superphosphate.	National Fertilizer Co, Bridgeport.	G. A. & H. B. Williams, East Hartford.	31.00
			W. F. Colton, Kensington.	32.00
			T. E. Eldridge, Norwich.	34.00
			Manufacturer.	30.00
			L. W. Currier, Bridgeport.	35.00
			E. A. Buck & Co., Willimantic.	32.00
			F. S. Leighton & Co., Wallingford.	35.00
3972	Ammoniated Bone Phosphate, No. 2.	Leander Wilcox, Mystic.	Fred. Gallup, New London.	30.00
			Manufacturer.	30.00
3889	A. A. Ammoniated Superphosphate.	H. J. Baker & Bro., 93 William St., N. Y. City.	S. J. Hall, Meriden.	37.50
			E. F. Hawley, Newtown.	37.50
			H. K. Brainard, Thompsonville.	34.00
3907	Bay State Fertilizer.	Clark's Cove Fertilizer Co., State St, Boston, Mass.	J. M. Burke, South Manchester.	32.00
			H. H. Davenport, Pomfret.	31.00
3903	Ammoniated Bone Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	J. E. Leonard, Jewett City.	35.00
			C. A. Young, Danielsonville.	35.00
3814	Bradley's Superphosphate.	Bradley Fertilizer Co., 92 State St., Boston, Mass.	E. L. Strong, Colchester.	34.00
			H. R. Merriam, Rocky Hill.	35.00
			G. A. Dickenson, Haddam.	35.00
			Bulkley & Hanmer, Wethersfield.	35.00
			A. C. Sternberg, Hartford.	35.00
			W. F. Andross, East Hartford.	32.00
			L. F. Judson, Stratford.	36.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3895	Sea Fowl Guano.	Bradley Fertilizer Co., 92 State St., Hartford.	W. W. Cooper, Suffield.	$33.00
3893	Sure Crop Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	W. Tillinghast, Plainfield.	28.00
			J. A. Paine, Danielsonville.	30.00
			Henry Davis, Durham Center.	27.00
3812	Americus Brand Ammoniated Bone Superphosphate.	Williams & Clark Fertilizer Co., 71 Fulton St., N. Y.	Bulkley & Hanmer, Wethersfield.	35.00
			John Bransfield, Portland.	36.00
			E. L. Strong, Colchester.	33.00
			S. D. Woodruff & Sons, Orange.	32.00
3950	Farmers' New Method Fertilizer.	Bradley Fertilizer Co., 92 State St., Boston, Mass.	J. H. Ray & Son, Greenwich.	36.00
			F. S. Bidwell, Windsor Locks.	32.00
			J. M. Young, Norwich.	30.00
			W. J. Starr, Groton.	34.00
			E. N. Pierce & Co., Plainville.	37.00
			M. Beach & Son, New Milford.	33.00
			Carter & Strong, Manchester.	33.00
			Henry Davis, Durham Center.	32.00
			F. H. & L. C. Root, Farmington.	33.00
			J. H. Lewis, Willimantic.	30.00
			S. A. Billings, Meriden.	35.00
			G. W. Carver & Son, Putnam.	31.00
			H. H. Davenport, Pomfret.	
			S. E. Brown, Collinsville.	32.00
			S. T. Welden, Simsbury.	31.00
			Quinnebaug Store, Danielsonville.	33.00
			G. W. Eaton, Bristol.	33.00
3960	Fish and Potash, Plain Brand.	Quinnipiac Co., 92 State St., Boston, Mass.	J. W. Gardner, Cromwell.	*30.00*
3952	Ammoniated Dissolved Bone.	Quinnipiac Co., 92 State St., Boston, Mass.	B. F. Silliman, New Canaan.	*33.00*
3975	High Grade Farmers' Friend.	Read Fertilizer Co., Box 3121, N. Y. City	G. B. Alderman, Suffield.	*40.00*
3904	Practical Phosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	J. R. Babcock, Old Mystic.	*30.00*

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3836	High Grade Fish and Potash.	The E. Frank Coe Co., 16 Burling Slip, N. Y. City.	W. T. Andrews, Orange.	$30.00
			W. A. Burr, West Hartford.	34.20
			D. N. Clark, Shelton.	30.00
3899	Cumberland Superphosphate.	Cumberland Bone Phosphate Co., Portland, Me.	L. D. Post, Andover.	31.00
3818	Quinnipiac Phosphate.	Quinnipiac Co., 92 State St., Boston, Mass.	D. C. Wood, Stratford.	37.00
			Olds & Whipple, Hartford.	36.00
			J. W. Gardner, Cromwell.	36.00
			Bailey & Markham, Cobalt.	35.00
3891	Harvest Home Phosphate.	H J. Baker & Bro., 93 William St., N. Y. City.	S. J. Hall, Meriden.	29.00
3885	Chittenden's Fish and Potash.	National Fertilizer Co., Bridgeport.	G. A. & H. B. Williams, East Hartford.	31.00
			E. P. Carroll, East Hartford.	31.00
			T. E. Eldridge, Norwich.	34.00
3939	Animal Fertilizer.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	F. S. Bidwell, Windsor Locks.	36.00
			W. W. Cooper, Suffield.	38.00
3971	Fish and Potash.	Leander Wilcox, Mystic.	Manufacturer.	33.00
3877	Soluble Pacific Guano.	Soluble Pacific Guano Co., Boston, Mass.	W. F. Andross, East Hartford.	35.00
			R. F. Woodford, Plainville.	35.00
			G. E. Pratt, Silver Lane.	34.00
			A. H. Skinner, South Manchester.	35.00
			L. J. Grant, Wapping.	35.00
			A. S. Russell, Meriden.	35.00
			John Bransfield, Portland.	36.00
3876	Alkaline Bone.	The E. Frank Coe Co., 16 Burling Slip, N. Y. City.	W. A. Burr, West Hartford.	34.20
			H. L. Hall, 2d, Wallingford.	32.00
			J. O. Fox & Co., Putnam.	30.00
			Hillhouse & Taylor, Willimantic.	30.00
			F. P. Burr, Middletown.	32.00
3900	Chicopee Farmers' Reliable Fertilizer.	Chicopee Guano Co., 140 Maiden Lane, N. Y. City.	L. D. Post, Andover.	30.00
			F. L. Grange, Jr., Bloomfield.	35.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3888	Standard UnXLD Fertilizer.	H. J. Baker & Bro., 93 William St., N. Y. City.	W. F. Andross, East Hartford.	$32.00
3874	Farm and Garden, or Ammoniated Bone Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Henry Davis, Durham Center.	32.00
			E. B. Clark & Sons, Milford.	29.00
			B. Curtiss & Son, Stepney.	33.00
			J. E. Leonard, Jewett City.	32.00
			E. L. Strong, Colchester.	31.00
			J. A. Lewis, Willimantic.	32.00
3974	Vegetable, Vine and Fruit Fertilizer.	Read Fertilizer Co., Box 3121, N. Y. City.	B. F. Silliman, New Canaan.	38.00
			G. B. Alderman, Suffield.	37.00
3908	King Philip Alkaline Bone.	Clark's Cove Fertilizer Co., State St., Boston, Mass.	P. Platt, Milford.	30.00
			J. M. Burke, South Manchester.	26.00
			H. H. Davenport, Pomfret.	27.00
3884	Russell Coe's Phosphate.	National Fertilizer Co., Bridgeport.	T. E. Eldridge, Norwich.	34.00
3977	Fish, Bone and Potash.	Read Fertilizer Co., Box 3121, N. Y. City.	S. F. Palmer, Jewett City.	32.00
			G. B. Alderman, Suffield.	32.00
			Waldo Tillinghast, Plainfield.	29.00
			B. F. Silliman, New Canaan.	33.00
3940	Fish and Potash, Triangle A. Brand.	Bradley Fertilizer Co., 92 State St., Boston, Mass.	Carter & Strong, Manchester.	31.00
3902	New Rival Ammoniated Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	E. H. Talcott, Torrington.	32.00
3978	Pine Island Phosphate.	Quinnipiac Co., 92 State St., Boston, Mass.	Olin Wheeler, Buckland.	34.00
3954	Fish and Potash, Crossed Fishes Brand.	Quinnipiac Co., 92 State St., Boston, Mass.	Olin Wheeler, Buckland.	35.00
			Olds & Whipple, Hartford.	34.00
3990	Pilgrim Fertilizer.	J. S. Reese & Co., 10 South St., Baltimore, Md.	W. H. Anderson, Putnam.	32.00
3976	Standard Phosphate.	Read Fertilizer Co., Box 3121, N. Y. City.	*F. & F. W. Tillinghast, Central Village.*	*32.00*
			Waldo Tillinghast, Plainfield.	*29.00*
			S. F. Palmer, Jewett City.	*32.00*

ANALYSES OF NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.			Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		As Muriate.	Total.				
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.		Found.	Guaranteed.			
3798	Mapes' Fine Dissolved Bone	....	....	3.13	3.13	*2.1*	2.66	14.06	3.72	20.44	....	16.72	*12.0*	....	....	....	$33.00	$32.78	.7
3961	Preston's Ammoniated Bone Phosphate	....	.19	3.03	3.22	*2.5*	5.46	3.94	1.63	11.03	....	9.40	*9.0*	1.53	3.27	*2.0*	31.00	27.03	14.7
4028	Danbury Fertilizer Co's Nameless Fertilizer	....	.78	2.30	3.08	*2.1*	1.57	6.27	2.71	10.55	*8.0*	7.84	....	5.21	5.21	*3.0*	30.00	26.03	15.3
3934	Mapes' Complete Manure for General Use	.38	1.48	1.77	3.63	*3.3*	7.23	3.95	.97	12.15	*10.0*	11.18	*8.0*	5.01	5.01	*4.0*	38.00	31.45	20.8
3837	Shoemaker's Swift Sure Superphosphate	.66	....	2.23	2.89	*2.5*	9.17	2.79	2.43	14.39	*14.0*	11.96	*9.0*	....	4.72	*4.0*	38.00	31.29	21.4
3933	Mapes' Complete Manure A Brand	.32	.62	2.18	3.12	*2.5*	8.72	3.19	.73	12.64	*12.0*	11.91	*10.0*	3.06	3.06	*2.5*	36.00	28.94	24.4
3937	Lister's Ammoniated Dissolved Bone	....	.35	1.70	2.05	*1.7*	6.59	2.55	1.93	11.07	*11.0*	9.14	*9.0*	1.94	1.94	*1.5*	27.00	21.29	26.8
3970	Sanderson's Formula A	.68	.06	2.44	3.18	*3.3*	4.61	3.12	2.45	10.18	*10.0*	7.73	*6.0*	4.85	6.12	*6.0*	35.00	27.35	27.9
3880	Wilcox's Ammoniated Bone Phosphate No. 1	....	.17	2.65	2.82	*2.5*	4.32	2.84	2.10	9.26	*7.0*	7.16	*6.0*	5.43	5.43	*5.0*	32.00	24.62	30.0
3991	Reese's New England Favorite	....	.82	1.93	2.75	*2.5*	5.04	5.13	.19	10.36	*11.0*	10.17	*9.0*	2.69	2.69	*2.0*	33.00	24.76	33.3
3816	Coe's Ammoniated Bone Phosphate	....	.74	1.43	2.17	*2.1*	7.30	2.36	2.34	12.00	*9.0*	9.66	*7.0*	.20	2.74	*1.9*	32.00	23.76	34.7
3869	Bowker's Hill and Drill Phosphate	1.06	....	1.74	2.80	*2.5*	7.46	2.89	3.35	13.70	*12.0*	10.35	*10.0*	2.25	2.25	*2.0*	35.00	25.92	35.0
3935	Lister's Standard Superphosphate	....	.37	2.00	2.37	*2.3*	8.17	2.02	1.81	12.00	*12.0*	10.19	*10.0*	1.78	1.78	*2.0*	32.00	23.63	35.4
3883	Chittenden's Ammoniated Bone Superphosphate	....	....	2.54	2.54	*1.7*	4.51	3.88	3.06	11.45	....	8.39	*7.0*	3.29	3.29	*2.0*	32.00	23.59	35.6
3972	Wilcox's Ammoniated Bone Phosphate No. 2	....	....	2.07	2.07	*1.6*	5.86	3.62	1.71	11.19	*10.0*	9.48	*9.0*	2.47	2.47	*2.0*	30.00	22.12	35.6

Analyses of Nitrogenous Superphosphates and Guanos Sampled by the Station.—*Continued.*

Station No.	Name or Brand.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. As Muriate.	Total. Found.	Total. Guaranteed.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
3889	Baker's A. A. Superphosphate	.23	2.01	.61	2.85	*2.5*	9.70	1.72	.80	12.22	*11.0*	11.42	*10.0*	3.21	3.21	*2.0*	$37.50	$27.56	36.0
3907	Clark's Cove Bay State Fertilizer	----	----	2.39	2.39	*2.3*	7.28	2.53	1.10	10.91	*10.0*	9.81	*8.5*	2.12	2.12	*2.0*	32.00	23.22	37.8
3903	Crocker's Ammoniated Superphosphate	----	----	3.20	3.20	*2.9*	7.30	2.43	1.07	10.80	*10.0*	9.73	*9.0*	1.37	1.37	*1.0*	35.00	25.27	38.4
3814	Bradley's Superphosphate	.22	.16	2.42	2.80	*2.3*	7.42	3.00	1.41	11.83	*11.0*	10.42	*9.0*	1.95	1.95	*1.5*	35.00	25.26	38.6
3895	Bradley's Sea Fowl Guano	----	----	2.30	2.30	*2.1*	6.98	3.43	2.23	12.64	*10.0*	10.41	*8.0*	1.87	1.87	*1.5*	33.00	23.81	38.6
3893	Bowker's Sure Crop Phosphate	.06	----	.97	1.03	*.8*	7.02	3.22	2.46	12.70	*10.0*	10.24	*8.0*	1.00	1.00	*1.0*	28.00	20.13	39.1
3812	Americus Ammoniated Superphosphate	----	----	2.62	2.62	*2.5*	6.67	3.62	1.06	11.35	*10.0*	10.29	*9.0*	1.83	1.83	*2.0*	34.00	24.25	40.2
3950	Bradley's New Method Fertilizer	----	----	2.30	2.30	*1.7*	7.31	2.54	1.18	11.03	*10.0*	9.85	*8.0*	2.68	2.68	*3.0*	33.00	23.48	40.5
3960	Quinnipiac Fish and Potash, Plain Brand	----	.16	2.28	2.44	*2.1*	3.15	2.90	.93	6.98	*8.0*	6.05	*4.0*	5.14	5.14	*4.0*	30.00	21.10	42.1
3952	Quinnipiac Amm'd Dissolved Bone	----	----	1.91	1.91	*2.0*	4.41	6.04	3.60	14.05	*10.0*	10.45	*9.0*	.48	1.93	*2.0*	33.00	23.14	42.6
3975	Read's High Grade Farmer's Friend	----	.12	3.45	3.57	*3.3*	2.83	2.26	1.73	6.82	----	5.09	*5.0*	9.14	9.14	*10.0*	40.00	27.80	43.9
3904	Crocker's Practical Phosphate	----	----	2.13	2.13	*1.0*	5.78	3.41	1.30	10.49	*8.0*	9.19	*8.0*	1.29	1.29	*1.0*	30.00	20.74	44.6
3836	Coe's High Grade Fish and Potash	----	----	2.73	2.73	*3.0*	3.46	3.07	3.13	9.66	*6.0*	6.53	*4.0*	1.88	1.88	*2.7*	30.00	20.67	45.1
3899	Cumberland Superphosphate	----	----	2.54	2.54	----	7.23	2.42	1.33	10.98	----	9.65	*8.0*	1.85	1.85	*4.0*	34.00	23.40	45.3
3818	Quinnipiac Phosphate	----	.16	2.48	2.64	*2.5*	6.90	3.56	1.23	11.69	*10.0*	10.46	*9.0*	1.91	1.91	*2.0*	36.00	24.67	45.9
3891	Baker's Harvest Home Phosphate	----	.89	.67	1.56	*.8*	4.80	4.03	2.24	11.07	----	8.83	*8.0*	2.71	2.71	*2.0*	*29.00*	*19.80*	*46.5*

Analyses of Nitrogenous Superphosphates and Guanos Sampled by the Station.—*Concluded.*

Station No.	Name or Brand.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. As Muriate.	Total. Found.	Total. Guaranteed.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
3885	Chittenden's Fish and Potash	----	----	2.91	2.91	*3.3*	1.81	1.67	4.25	7.73	*6.0*	3.48	----	.92	5.25	*5.0*	$32.00	$21.84	46.5
3939	Darling's Animal Fertilizer	.41	.21	2.70	3.32	*3.3*	3.28	4.06	2.00	9.34	*10.0*	7.34	*6.0*	3.38	3.38	*4.0*	36.00	24.42	47.4
3971	Wilcox's Fish and Potash	----	.33	3.16	3.49	*3.3*	3.15	2.37	1.09	6.61	*6.0*	5.52	*5.0*	4.64	4.64	*4.0*	35.00	23.74	47.4
2877	Soluble Pacific Guano	----	----	2.61	2.61	*2.3*	6.72	3.01	1.21	10.94	*10.5*	9.73	*8.5*	1.91	1.91	*2.0*	35.00	23.69	47.7
3876	Coe's Alkaline Bone	----	.12	1.32	1.44	*1.0*	6.88	2.73	2.39	12.00	*9.0*	9.61	*9.0*	----	2.48	*3.0*	31.00	20.94	48.1
3900	Chicopee Farmer's Reliable Fertilizer	----	.37	1.76	2.13	*1.7*	6.27	3.17	1.54	10.98	*10.0*	9.44	*8.0*	1.29	1.62	*2.0*	32.00	21.52	48.7
3888	Baker's Standard UnXLD Fertilizer	----	1.11	.98	2.09	*1.9*	7.04	1.73	.90	9.67	----	8.77	*8.0*	2.97	2.97	*2.3*	32.00	21.47	49.0
3874	Bowker's Farm and Garden Phosphate	.67	----	1.22	1.89	*1.5*	7.89	1.56	2.15	11.60	*10.0*	9.45	*8.0*	2.15	2.15	*2.0*	32.00	21.28	50.3
3974	Read's Vegetable, Vine and Fruit Fertilizer	.09	----	2.23	2.32	*1.6*	4.08	3.30	1.28	8.66	*7.0*	7.38	*6.0*	7.28	7.28	*8.0*	37.00	24.42	51.5
3908	Clark's Cove Co's King Philip Alkaline Bone	----	----	1.34	1.34	*1.5*	6.08	2.14	1.29	9.51	*7.0*	8.22	*6.0*	2.32	2.32	*3.0*	27.00	17.78	51.8
3884	National Fertilizer Co's Russell Coe's Phosphate	----	.28	2.00	2.28	*1.7*	2.53	4.55	4.13	11.21	*9.0*	7.08	*8.0*	4.25	4.25	*1.0*	34.00	22.18	53.2
3977	Read's Fish, Bone and Potash	.28	.12	2.36	2.76	*2.5*	2.30	2.10	1.33	5.73	*6.0*	4.40	*4.0*	5.87	5.87	*4.0*	32.00	20.86	53.4
3940	Bradley's Fish and Potash, Triangle A. Brand	----	.15	2.31	2.46	*2.0*	2.82	3.07	1.12	7.01	*6.0*	5.89	*4.0*	3.98	3.98	*4.0*	31.00	19.98	55.1
3902	Crocker's New Rival Superphosphate	----	----	1.35	1.35	*1.2*	5.89	3.80	1.99	11.68	*11.0*	9.69	*10.0*	1.84	1.84	*1.8*	32.00	19.41	64.9
3978	Quinnipiac Pine Island Phosphate	----	.12	1.98	2.10	*2.5*	5.01	3.78	2.10	10.89	*10.0*	8.79	*9.0*	1.37	1.37	*1.0*	34.00	20.46	66.1
3954	Quinnipiac Fish and Potash, Crossed Fishes Brand	----	.37	2.73	3.10	*3.3*	.27	3.58	3.80	7.65	*5.0*	3.85	*3.0*	3.99	3.99	*3.0*	35.00	20.58	70.0
3990	Reese's Pilgrim Fertilizer	----	.08	1.31	1.39	*1.2*	4.16	4.42	.78	9.36	*7.5*	8.58	*6.5*	2.94	2.94	*3.0*	32.00	18.53	72.7
3976	Read's Standard Phosphate	----	----	1.17	1.17	*.8*	4.85	2.99	1.47	9.31	*10.0*	7.84	*8.0*	4.16	4.16	*4.0*	32.00	18.33	74.6

The Guarantees.

The law of Connecticut requires every package of fertilizer to bear a statement of the actual composition of the goods. This usually expresses the quantities of nitrogen, phosphoric acid and potash within certain limits, as "nitrogen 2–4 per cent."

If a fertilizer with such a guarantee actually contains 2 per cent. of nitrogen, it is within the manufacturer's guarantee.

It is the lowest figures of the guarantee therefore that purchasers should regard.

Of the forty-nine brands here reported seventeen are below their minimum guarantee in respect of one ingredient, and three in respect of two ingredients. That is, considerably more than one-third of all the nitrogenous superphosphates in our market contain less of one or of two ingredients than they are claimed to contain.

It is urged that an excess of one ingredient over the guarantee should be held to make good the deficiency of another. But with reasonable care and skill in the manufacture and in the sampling and analysis of the goods the actual analysis should not fall below the minimum guaranteed in any respect particularly when wide limits are allowed in the guarantees themselves.

Cost and Valuation.

Cost.

The method used to ascertain the retail cash price of the phosphates is as follows:

The sampling agents inquire and note the price at the time each sample is drawn. The analysis when done is reported to each dealer from whom a sample was taken, with an enclosed postal card addressed to the Station, and a request to note on it whether the retail cash price is correctly given and to mail to the Station.

From these data the average prices are computed.

Valuation.

The valuation has been computed in all cases in the usual manner.

Percentage Difference given in the last column of the table shows the percentage excess of the cost price over the average retail cost of the nitrogen, phosphoric acid and potash contained in the fertilizer.

This information puts the purchaser in a position where he can figure as to the probable relative value of the different brands and the probable relative economy of buying fertilizers mixed or unmixed.

Which method of buying is preferable can only be determined by each individual farmer, who should know best what his soil and crops need and what his facilities for purchase and payment are.

No general rule can be given. In one case ready-mixed, in another, home-mixed fertilizers may be found the more profitable to use.

The average cost of the nitrogenous superphosphates is $32.99. The average valuation, $23.48, and the percentage difference 40.5.

Last year the corresponding figures were:

Average cost $34.80, Average valuation $26.25, Percentage difference 32.6.

2. *Sampled by Manufacturers and* 3. *Sampled by private individuals.*

(For tabulated analyses see page 42.)

2. *Sampled by Manufacturers.*

These samples were sent to the Station in compliance with the terms of the Fertilizer Law and were analyzed because no samples of the brands named were found in market by our sampling agents:

3987. Anchor Brand Fish and Potash. Made by the Bradley Fertilizer Co., Boston.

3999. Original Coe's Superphosphate. Made by the Bradley Fertilizer Co.

3984. Vegetable Bone Superphosphate. Made by the Crocker Fertilizer and Chemical Co. Buffalo, N. Y.

3983. Bone, Fish and Potash. Made by E. R. Kelsey, Branford.

3986. Lister's "Success" Fertilizer. Made by Lister Fertilizer Chemical Works, Newark, N. J.

4000. Banner Fertilizer. Made by Walker, Stratman & Co., Pittsburg, Pa.

4001. Four Fold Fertilizer. Made by Walker, Stratman & Co.

3. *Sampled by private individuals.*

3834. "Conn. Valley Orchard Co's Fertilizer." Made by Quinnipiac Co., New York. Sampled by Conn. Valley Orchard Co., New Britain.

3774. G. W. Miller's Flour of Bone Phosphate. Made by G. W. Miller, Middlefield. Sampled by C. P. Augur, Middlefield.

3942. Sanderson's Formula A. Made by L. Sanderson, New Haven. Sampled by Josiah Hawkins, Southport.

4011. Sanderson's Formula A. Made by L. Sanderson, New Haven. Sampled by W. S. Clark, Stephenson.

ANALYSES AND VALUATIONS.

	3987	3999	3984	3983	3986	4000	4001	3834	3774	3942	4011
Nitrogen as nitrates	....	.13	....	....	....	....	....	.65	1.22	.82	.20
as ammonia	....	....	....	.66	.25	....	....	.45	.26	.06	.08
organic	3.53	2.30	4.67	2.69	1.22	1.62	1.27	2.44	1.83	2.35	2.55
Total nitrogen found	3.53	2.43	4.67	3.35	1.47	1.62	1.27	3.54	3.31	3.23	2.83
Nitrogen guaranteed	**2.2**	**1.7**	**5.0**	**3.3**	**1.0**	**2.0**	**1.6**	....	....	**3.2**	**3.2**
Phosphoric acid, soluble	3.12	6.90	5.54	2.86	5.34	6.69	5.86	4.48	7.36	4.82	3.52
reverted	2.84	3.26	2.08	3.19	3.20	1.80	1.90	3.22	2.33	2.94	3.70
insoluble	2.10	1.48	.93	1.56	2.62	4.41	3.91	2.28	1.02	1.95	2.48
Total phosphoric acid found	8.06	11.64	8.55	7.61	11.16	12.90	11.67	9.98	10.71	9.71	9.70
Phosphoric acid guaranteed	**5.0**	**12.0**	**7.0**	**4.0**	....	**11.0**	**10.0**	....	....	....	....
"Available" phosphoric acid found	5.96	10.16	7.62	6.05	8.54	8.49	7.76	7.70	9.69	7.76	7.22
Available phosphoric acid guaranteed	**3.0**	**10.0**	**6.0**	....	**10.5**	**9.0**	**8.0**	....	....	**6.00**	**6.0**
Potash	3.81	1.53	6.87	3.65	1.56	2.11	7.02	2.26	4.51	6.99	6.89
Potash guaranteed	**3.0**	**1.0**	**6.0**	**3.0**	**1.5**	**1.0**	**2.0**	....	....	**6.00**	**6.0**
Valuation per ton	$24.26	23.07	32.60	23.82	18.36	20.29	22.23	24.71	27.91	27.83	26.71

III. Special Manures.

1. *Sampled by Station Agents.*

For Analyses and Valuations see pages 44 to 51.

Here are included such Nitrogenous Superphosphates as are claimed by their manufacturers to be specially adapted to the needs of particular crops.

Notice of Particular Analyses.

The following analyses are here tabulated by themselves, because in each case the manufacturer protested that the analysis did not represent the average quality of the brand as it was sold in this State.

The Station endeavored in each case to obtain other samples of the goods for analysis, but was not able to secure them in all cases. The Station does not consider itself at liberty to withhold such analyses from publication altogether, but prints them in connection with the manufacturer's statement or protest. It is quite possible that improper storage may alter considerably the composition of a fertilizer, and in cases where the retailer re-bags a given brand of goods there is a possibility that the new bags may bear another brand, and thus make confusion in the sampling. For these and other reasons the Station has in all cases where it has been asked, and has been possible, repeated the analysis on new samples.

3892. Tobacco Manure, made by H. J. Baker & Bro., N. Y. City. It is claimed by the manufacturer that this brand contains at least 5 per cent. more potash and less chlorine than our analysis shows. A new sample of this brand, No. **3951,** was drawn from stock of Strong & Tanner, Winsted. The analysis of this is given on page 49, and is here reproduced for comparison. It contains over two per cent. more of potash than No. **3892.**

3910. Complete Onion Manure, made by H. J. Baker & Bro., N. Y. City. It is stated by the manufacturers that the analysis conforms exactly to that of their complete Potato Manure but shows one per cent. less nitrogen and five per cent. more potash than their Onion Manure contains.

Special Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3996	Seeding Down Manure.	Mapes' Formula and Peruvian Guano Co., New York.	Mapes Branch, Hartford.	$37.50
3809	Grass and Grain Fertilizer.	Rogers & Hubbard Co., Middletown.	E. L. Strong, Colchester.	36.50
			George S. Butler, Cromwell.	37.50
4027	Tobacco Manure.	Danbury Fertilizer Co., Danbury.	Manufacturer.	35.00
3989	Soluble Potato Manure.	Rogers & Hubbard Co., Middletown.	E. L. Strong, Colchester.	38.00
4030	Potato Fertilizer.	Danbury Fertilizer Co., Danbury.	S. D. Woodruff & Sons, Orange.	36.00
			T. P. Russell, Orange.	35.00
			Raymond Bros., South Norwalk.	33.00
3875	High Grade Tobacco Manure.	Bradley Fertilizer Co., 92 State St., Boston, Mass.	Carter & Strong, Manchester.	48.00
			H. K. Brainard, Thompsonville.	46.00
			A. C. Sternberg, Hartford.	48.00
3872	Stockbridge Manure for Tobacco.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. Fred. Hutchinson, Windsor.	50.00
			J. C. Collins, Wapping.	50.00
3853	Connecticut Wrapper Fertilizer, Pinney's Formula.	Cleveland Linseed Oil Co., Cleveland, O.	H. O. Warner, New Milford.	38.00
			Geo. E. Pierce, Roxbury.	38.00
3951	Special Tobacco Manure.	H. J. Baker & Bro., 93 William St., N.Y.	Strong & Tanner, Winsted.	39.00
3932	Fruit and Vine Manure.	Mapes' F. & P. G. Co., N. Y.	Birdsey & Foster, Meriden.	39.00
3931	Tobacco Starter.	Mapes' F. & P. G. Co., N. Y.	S. T. Welden, Simsbury.	35.00
			Southington Lumber and Feed Co., Southington.	40.00
3995	Wrapper Brand Tobacco Manure.	Mapes' F. & P. G. Co., N. Y.	Mapes Branch, Hartford.	48.00
3929	Grass & Grain Spring Top Dressing	Mapes' F. & P. G. Co., N. Y.	Mapes Branch, Hartford.	39.00
			F. S. Bidwell, Windsor Locks.	40.00
			J. P. Barstow & Co., Norwich.	40.00
			Birdsey & Foster, Meriden.	40.00
			Jno. H. Ray & Son, Greenwich.	43.00

Special Manures Sampled by the Station.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3839	Manure for Corn.	Mapes' F. & P. G. Co., N. Y.	Mapes Branch, Hartford.	$39.00
			C. W. Beardsley, Milford.	41.00
			E. W. Pierce & Co., Plainville.	41.00
			J. P. Barstow & Co., Norwich.	40.00
3845	Stockbridge Manure for Potatoes and Vegetables.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	C. H. Bell, Portland.	38.00
			City Coal & Wood Co., New Britain.	37.00
			E. L. Strong, Colchester.	37.00
			J. F. Hutchinson, Windsor.	41.00
			H. K. Brainard, Thompsonville.	38.00
3890	Potato Manure.	H. J. Baker & Bro., N. Y.	E. F. Hawley, Newtown.	40.00
			H. K. Brainard, Thompsonville.	40.00
			W. F. Andross, E. Hartford.	43.00
3835	Complete Manure for Light Soils.	Mapes' F. & P. G. Co., N. Y.	J. P. Barstow & Co., Norwich.	43.00
			C. W. Beardsley, Milford.	44.00
			Mapes Branch, Hartford.	42.00
			Wilson & Burr, Middletown.	43.00
3840	Manure for Potatoes.	Mapes' F. & P. G. Co., N. Y.	Mapes Branch, Hartford.	41.00
			Wilson & Burr, Middletown.	42.00
			C. W. Beardsley, Milford.	43.00
			F. S. Bidwell, Windsor Locks.	42.00
			E. N. Pierce & Co., Plainville.	43.00
			W. W. Cooper, Suffield.	43.00
			J. P. Barstow & Co., Norwich.	42.00
3887	Complete Corn Manure.	H. J. Baker & Bro., N. Y.	W. F. Andross, E. Hartford.	38.00
			W. C. Reynolds, Goodspeeds.	36.00
3973	Potato, Onion and Tobacco Manure.	L. Wilcox, Mystic.	Fred. Gallup, N. London.	35.00
			Manufacturer.	36.00
			Waldo Tillinghast.	34.00
3873	Stockbridge Manure for Top Dressing.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. M. Williams, Manchester.	40.00
			J. A. Lewis, Willimantic.	40.00
			J. F. Hutchinson, Windsor.	41.00
			H. K. Brainard, Thompsonville.	38.00

SPECIAL MANURES SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3953	Havana Tobacco Fertilizer.	Quinnipiac Co., 92 State St., Boston, Mass.	J. W. Gardner, Cromwell.	$48.00
3879	High Grade Special for Potatoes, Tobacco, etc.	Williams & Clark Fertilizer Co., 71 Fulton St., N. Y.	Dan. Morgan, Poquonock.	39.00
			J. G. Grant, Wapping.	40.00
			S. D. Woodruff & Sons, Orange.	37.00
			John Bransfield. Portland.	40.00
3936	Potato Manure.	Lister's Agricultural Chemical Works, Newark, N. J.	A. N. Clark, Milford.	38.00
3905	Special Potato Manure.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	J. C. Lincoln, Berlin.	38.00
			W. H. Anderson, Putnam.	38.00
3871	Stockbridge Manure for Potatoes.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. A. Lewis, Willimantic.	40.00
			City Coal & Wood Co., New Britian.	37.00
			W. F. Andross, E Hartford.	40.00
			F. Hallock & Co., Birmingham.	38.00
			J. M. Williams. Manchester.	40.00
			W. H. Anderson. Putnam.	40.00
			E. B. Clark & Sons, Milford.	38.00
3886	Complete Manure for Corn & Grain	Bradley Fertilizer Co., Boston, Mass.	D. N. Clark & Sons, Milford.	39.00
			M. Beach & Son. New Milford.	40.00
3844	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., Boston, Mass.	L. F. Judson, Stratford.	38.00
			Bulkley & Tanner, Wethersfield.	40.00
			H. K. Brainard. Thompsonville.	38.00
			R. A. Parker, Warehouse Point.	38.00
3813	Potato Manure.	Bradley Fertilizer Co., Boston, Mass.	L. F. Judson, Stratford.	37.00
			Wilson & Burr. Middletown.	36.00
			A. C. Sternberg, Hartford.	35 00
			Bulkley & Hanmar, Wethersfield.	37.00
			W. F. Andross, E. Hartford.	37.00
			G. A. Dickinson, Haddam.	36.00
			E. L. Strong, Colchester.	34.00
			D. N. Clark & Sons, Milford.	34.00
3909	Tobacco Grower.	Bradley Fertilizer Co., Boston, Mass.	M. McNamara, New Milford.	40.00

SPECIAL MANURES SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3980	Reese's Potato Special.	J. S. Reese & Co., Baltimore.	W. H. Anderson, Putnam.	$34.00
			Donald Gunn, Groton.	38.00
3956	Vegetable, Vine, and Tobacco Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	S. C. Lewis, Stratford.	33.00
			Fred Morton, Rocky Hill.	35.00
			Lyman W. Hall, Goshen.	33 00
			Wm. Barr & Sons, Fairfield.	33.00
3870	Stockbridge Manure for Grain.	Bowker Fertilizer Co., Boston, Mass.	A. J. Payne, Danielsonville.	40.00
			J. A. Lewis. Willimantic.	40.00
			J. M. Williams, Manchester.	40.00
			City Coal & Wood Co., New Britain.	37.00
3906	Potato and Tobacco Fertilizer.	Clark's Cove Fertilizer Co, Boston, Mass.	J. M. Burke, So. Manchester.	33 00
3938	Potato and Root Crop Manure.	Darling Fertilizer Co., Pawtucket R. I.	Treat & Clark. Orange.	39.00
3957	Grass and Grain Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	B. C Bradley, South Britain.	34.00
			C. L Stearns, Andover.	30.00
			Fred. Morton, Rocky Hill.	35.00
3878	Potato Manure.	Williams & Clark Fertilizer Co., 71 Fulton St., N. Y.	Daniel Morgan, Poquonock.	34.00
			Beaumont Bros., Wallingford.	35.00
			Terrill Betts, Sandy Hook.	40.00
			N. P. Burr, Kensington.	38.00
			H. K. Brainard, Thompsonville.	35 00
			E. L. Strong, Colchester.	34.00
			L. J. Grant. Wapping.	36.00
3843	High Grade Potato Fertilizer.	The E. Frank Coe Co., 16 Burling Slip, N. Y.	F. P. Burr, Middletown.	34.00
			W. C. Reynolds. Goodspeeds.	36.00
			W. A. Burr. West Hartford.	40.00
			J. W. Denison, Mystic.	35.00
3842	Potato, Hop and Tobacco Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	John Wells, Hebron.	26.00
			J. C. Lincoln, Berlin.	34.00
			H. Fish, Newington.	35.00
			J. E. Leonard, Jewett City.	35.00

SPECIAL MANURES SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3959	Special Potato Manure.	Soluble Pacific Guano Co., Boston, Mass.	W. F. Andross, E. Hartford.	$36.00
			George E. G. Pratt, Silver Lane.	35.00
			A. S. Russell, Meriden.	38.00
			P. J. Bolan, Waterbury.	35.00
3838	Chittenden's Complete Fertilizer.	National Fertilizer Co, Bridgeport.	David Fitzgerald, Stratford.	40.00
			G. A. & H. B. Williams, E. Hartford.	39.00
			F. Hallock & Co., Birmingham.	38.00
3955	Cumberland Potato Fertilizer.	Cumberland Bone Phosphate Co., Portland, Me.	L D. Post, Andover.	35.00
3979	Quinnipiac Corn Manure.	Quinnipiac Co., Boston, Mass.	M. B. Sharpe, South Windham.	32.00
			F. S. Bidwell, Windsor Locks.	35.00
			Bailey & Markham, Cobalt.	37.00
3817	Quinnipiac Potato Manure.	Quinnipiac Co, Boston, Mass.	D. C. Wood, Stratford.	38.00
			Olds & Whipple, Hartford.	38.00
			J. W. Gardner, Cromwell.	36.00
			Bailey & Markham Cobalt.	
3969	Americus Corn Phosphate.	Williams & Clark Fertilizer Co., N. Y.	W. B. Martin, Rockville.	36 00
3841	Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	J. C. Lincoln, Berlin	32.00
			J. H. Fish, Newington.	35.00
			John Wells, Hebron.	33.00
			J. E. Leonard, Jewett City.	32.00
3901	Chicopee Potato Manure.	Chicopee Guano Co., 140 Maiden Lane, N. Y.	L. D. Post, Andover.	40.00
			F. L. Granger, Jr., Bloomfield.	40.00
			Patrick Barrett, Jr., Brookfield.	34.00
			C. K. Ranney, Cromwell.	38.00
4033	Potato Manure.	Davidge Fertilizer Co., 140 Maiden Lane, N. Y.	H. S. Benedict, Newtown.	
			George W. Eaton, Plainville.	39.00
3958	Oats, Buckwheat and Seeding Down Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	C. B. Stearns, Andover.	*32.00*
			B. C. Bradley, So Britain.	*32.00*
4034	Special Favorite.	Davidge Fertilizer Co., N. Y.	*H. S. Benedict, Newtown.*	
			Geo. W. Eaton, Plainville.	*33.00*

ANALYSES OF SPECIAL MANURES SAMPLED BY THE STATION.

Station No.	Name or Brand.	Nitrogen: Nitrogen as Nitrates.	Nitrogen: Nitrogen as Ammonia.	Nitrogen: Nitrogen, Organic.	Nitrogen: Total Nitrogen, Found.	Nitrogen: Total Nitrogen, Guaranteed.	Phosphoric Acid: Soluble.	Phosphoric Acid: Reverted.	Phosphoric Acid: Insoluble.	Phosphoric Acid: Total, Found.	Phosphoric Acid: Total, Guaranteed.	Phosphoric Acid: Available, Found.	Phosphoric Acid: Available, Guaranteed.	Potash: Found, As Muriate.	Potash: Found, Total.	Potash: Guaranteed.	Cost per ton.	Valuation per Ton.	Percentage difference between Cost and Valuation.
3996	Mapes' Seeding Down Manure	.89	.08	1.57	2.54	*2.5*	....	....	....	18.29	*18.0*	....	....	12.12	12.12	*10.0*	$37.50	$37.84	*.9
3809	Rogers & Hubbard Co's Grass and Grain Fertilizer	....	....	2.58	2.58	*2.5*	....	....	....	14.65	*16.0*	....	....	17.85	17.85	*12.5*	36.50	36.29	.6
4027	Danbury Fertilizer Co's Tobacco Manure	....	.16	3.32	3.48	*3.3*	3.09	8.80	6.58	18.47	*6.0*	11.89	....	....	3.55	*5.0*	35.00	33.29	5.1
3989	Rogers & Hubbard Co's Soluble Potato Manure	1.09	.53	3.63	5.25	*5.0*	1.04	6.20	4.11	11.35	*10.0*	7.24	....	.58	5.33	*5.0*	38.00	34.07	11.5
4030	Danbury Potato Fertilizer	....	.29	3.15	3.44	*2.9*	1.95	7.51	2.45	11.91	*8.0*	9.46	....	6.90	6.90	*7.0*	35.00	30.76	13.8
3875	Bradley's High Grade Tobacco Manure	....	3.03	3.06	6.09	*5.8*	1.81	2.23	1.97	6.01	*4.0*	4.04	....	.92	12.09	*10.8*	46.00	39.95	15 1
3872	Stockbridge Manure for Tobacco	3.69	....	2.79	6.48	*5.7*	.10	4.01	5.00	9.11	*6.0*	4.11	*4.0*	1.42	13.57	*10.0*	50.00	42.80	16.8
3853	Pinney's Formula, Connecticut Wrapper Fertilizer	....	....	4.29	4.29	*4.5*	....	....	....	6.03	*5.7*	....	....	....	9.34	*10.0*	38.00	32.53	16.8
3951	Baker's Special Tobacco Manure	....	3.92	.47	4.40	*4.5*	3.58	1.02	.68	5.28	....	4.60	*3.5*	.81	11.70	*10.0*	40.00	33.86	18.1
3932	Mapes' Fruit and Vine Manure	.19	.82	1.63	2.64	*1.6*	3.65	3.31	1.04	8.00	*7.0*	6.96	*5.0*	.29	12.96	*11.0*	39.00	32.42	20.3
3931	Mapes' Tobacco Starter	.62	.60	2.08	3.30	*2.5*	6.34	4.56	1.68	12.58	*12.0*	10.90	*8.0*	.44	3.20	*2.5*	35.00	29.06	20.4
3995	Mapes' Wrapper Brand Tobacco Manure	1.27	2.50	2.67	6.44	*6.2*	....	3.43	1.96	5.39	*4.5*	3.42	....	.27	11.87	*10.5*	48.00	39.69	20.9
3929	Mapes' Grass and Grain Spring Top Dressing	1.14	1.54	2.16	4.84	*4.1*	4.66	3.29	.77	8.72	*7.0*	7.95	*5.0*	6.23	6.23	*5.0*	39.00	32.26	20.9
3839	Mapes' Manure for Corn	.83	1.16	2.27	4.26	*3.7*	6.59	2 91	1.57	11.07	*10.0*	9.50	*8.0*	6.44	6.44	*6.0*	40.00	32.95	21.4
3845	Stockbridge Manure for Potatoes and Vegetables	1.86	....	1.79	3.65	*3.3*	5.76	4.07	1.90	11.73	*8.0*	9.83	*7.0*	6.42	6.42	*5.0*	38.00	30.96	22.8
3890	Baker's Potato Manure	.17	2.99	.74	3.90	*3.3*	5.14	1.08	.82	7.04	....	6.22	*5.7*	3.78	10.61	*10.0*	40.00	32.51	23.0
3835	Mapes' Complete Manure for Light Soils	.71	1.98	2.68	5.37	*5.0*	4.74	2.72	1.52	8.98	*8.0*	7.46	*6.0*	6.82	6.82	*6.0*	43.00	34.48	24.7

* Valuation exceeds cost.

Analyses of Special Manures Sampled by the Station.—*Continued.*

Station No.	Name or Brand.	Nitrogen, Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found. As Muriate.	Found. Total.	Guaranteed.	Cost per ton.	Valuation per Ton.	Percentage difference between Cost and Valuation.
3840	Mapes' Manure for Potatoes	1.02	.75	2.21	3.98	3.7	6.56	2.50	.87	9.93	8.0	9.06	8.0	.74	7.55	6.0	$42.00	$33.49	25.4
3887	Baker's Complete Corn Manure	----	3.62	.50	4.12	5.0	6.72	.62	----	7.34	----	7.32	6.3	7.41	7.41	7.0	38.00	30.22	25.7
3973	Wilcox's Potato, Onion and Tobacco Manure	.58	.21	2.57	3.36	3.3	4.88	2.32	1.65	8.85	8.0	7.20	8.0	3.76	6.65	6.0	35.00	27.86	25.7
3873	Stockbridge Manure for Top Dressing	3.36	----	1.75	5.11	5.0	3.78	3.02	3.09	9.89	6.0	6.80	3.0	6.03	6.03	5.0	40.00	31.75	25.9
3953	Quinnipiac Co's Havana Tobacco Fertilizer	----	3.08	2.77	5.85	5.8	1.39	3 09	1.49	5.97	6.0	4.48	5.0	.81	10.80	10.0	48.00	38.01	26.3
3879	Williams & Clark Co's High Grade Special for Potatoes, Tobacco, etc.	.14	1.28	2.19	3.61	3.7	6.14	2.88	.96	9.98	8.0	9.02	7.0	7.13	7.13	7.0	39.00	30.71	27.0
3936	Lister Chemical Works' Potato Manure	----	2.30	1.47	3.77	2.5	6.02	1.51	1.13	8.66	----	7.53	7.5	7.48	7.48	7.0	38.00	29.79	27.5
3905	Crocker Special Potato Manure	----	.08	3.53	3.61	3.7	6.82	1.46	.36	8.64	9.0	8.28	8.0	7.02	7.02	5.4	38.00	29.71	27.9
3871	Stockbridge Manure for Potatoes	2.33	----	1.52	3.85	3.3	5.49	4.48	2.03	12.00	8.0	9.97	7.0	5.12	5.12	5.0	39.00	30.48	27.9
3886	Bradley's Manure for Corn and Grain	.77	trace	2.76	3.53	3.3	4.32	7.21	4.26	15.79	13.0	11.53	12.0	2.43	2.43	3.0	39.00	30.22	29.0
3844	Bradley's Manure for Potatoes and Vegetables	.79	.62	2.27	3.68	3.7	6 48	2,03	1.21	9.72	9.0	8.51	8.0	5.94	5.94	6.0	38.00	29.21	30.1
3813	Bradley's Potato Manure	.24	----	3.60	3.84	2.5	4.40	2.37	1.95	8.72	8.0	6.77	8.0	5.26	5.26	5.0	36.00	27.41	31.3
3909	Bradley's Tobacco Grower	1.75	----	1.13	2.88	2.5	6.88	3.42	1.02	11.32	12.0	10.30	8.0	1.57	6.78	7.0	40.00	29.98	33.4
3980	Reese's Potato Special	----	.70	1.83	2.53	2.9	4.46	3.55	.71	8.72	7.0	8.01	6.0	8.42	8.42	7.5	36.00	26.71	34.8
3956	Great Eastern Vegetable, Vine and Tobacco Fertilizer	.35	----	1.91	2.26	2.0	6.76	1.80	.59	9.15	----	8.56	8.0	5.87	5.87	6.0	33.00	24.24	36.1
3870	Stockbridge Manure for Grain	1.13	----	2.38	3.51	3.3	6.74	3.50	2.05	12.29	9.0	10.24	8.0	4.06	4.06	4.2	40.00	29.27	36.6

Analyses of Special Manures Sampled by the Station.—*Continued.*

Station No.	Name or Brand.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found. As Muriate.	Found. Total.	Guaranteed.	Cost per ton.	Valuation per Ton.	Percentage difference between Cost and Valuation.
3906	Clark's Cove Potato and Tobacco Fertilizer	----	----	2.09	2.09	2.0	7.44	2.39	1.81	11.64	9.0	9.83	8.0	3.80	3.80	3.0	$33.00	$24.00	37.5
3938	Darling's Potato and Root Fertilizer	.12	.53	1.93	2.58	3.0	5.22	4.84	2.43	12.49	10.0	10.06	6.0	6.41	6.41	7.0	39.00	28.27	37.9
3957	Great Eastern Grass and Grain Fertilizer	.46	----	2.59	3.05	2.9	5.79	2.56	1.04	9.39	9.0	8.35	8.0	2.22	2.22	2.0	33.00	23.51	40.4
3878	Williams & Clark Co's Potato Manure	.12	----	2.77	2.89	2.5	5.57	1.94	.68	8.19	7.0	7.51	6.0	3.85	5.48	5.0	36.00	25.16	43.1
3843	Coe's High Grade Potato Fertilizer	----	.43	1.70	2.13	2.0	6.13	2.18	2.08	10 39	----	8.31	8.0	.49	5.16	5.9	35.00	24.41	43.4
3842	Crocker's Potato, Hop and Tobacco Phosphate	..	----	2.13	2.13	0.0	7.79	1.83	.73	10.35	----	9.62	10.0	4.39	4.39	3.2	35.00	24.03	45.7
3959	Pacific Guano Co. Special Potato Manure	.13	.07	2.55	2.75	2.5	5.17	2.30	.81	8.28	7.0	7.47	5.0	4.72	5.09	5.0	35.00	24.04	45.7
3838	Chittenden's Complete Fertilizer	----	.79	2.22	3.01	3.3	6.19	2.83	1.24	10.26	10.0	9.02	8.0	4.66	4.66	6 0	39.00	26.61	46.5
3955	Cumberland Potato Fertilizer	.26	----	1.96	2.22	2.0	6.88	2.68	1.79	11.35	----	9.56	9.0	3.65	3.65	3.3	35.00	23.85	46.7
3979	Quinnipiac Corn Manure	----	----	2.22	2.22	2.0	7.18	2.79	2.22	12.19	10.0	9.97	9.0	1.75	1.75	1.5	34.00	22.92	48.4
3817	Quinnipiac Potato Manure	.16	.08	2.36	2.60	2.5	5.26	3.34	1.16	8.76	7.0	7.60	6.0	4.90	5.35	5.0	36.00	24.05	49.7
3969	Williams & Clark Co's Americus Corn Phosphate	----	----	2.46	2.46	2.0	7.49	2.73	1.72	11.94	13.5	10.22	9.0	1.68	1.68	1.5	36.00	23.83	51.1
3841	Crocker's Ammoniated Wheat and Corn Phosphate	----	----	2.20	2.20	2.0	6.98	2.41	1.20	10.59	11.0	9.39	10.0	1.78	1.78	1.6	33.00	21.75	51.7
3901	Chicopee Potato Manure	----	.37	2.25	2.62	2.9	6.67	1.67	1.32	9.66	9.0	8.34	7.0	4.69	4.69	5.0	38.00	24.56	54.7
4033	Davidge's Potato Manure	----	1.76	1.08	2.84	2.9	7.79	.87	.44	9.10	10.0	8.66	9.0	.36	3.58	4.0	39.00	25.00	56.0
3958	Great Eastern Oat, Buckwheat and Seeding Down Fertilizer	----	----	1.21	1.21	.8	6.34	2.25	.80	9.39	9.0	6.59	8.0	3.83	3.83	4.0	32.00	18.95	68.7
4034	Davidge's Special Favorite	----	.70	1.02	1.72	1.2	4.78	2.00	1.87	8.65	11.0	6.78	10.0	.33	2.38	1.5	33.00	17.88	84.5

3930. Mapes' Tobacco Manure, Wrapper brand. On account of a protest from the manufacturer to the effect that the per cent. of nitrogen found was abnormally low, another sample was drawn and analyzed. This is No. **3995,** given on page 49, and here reproduced for comparison. It contains .8 per cent. more nitrogen than the first analysis.

3962. Market Garden Manure, made by the Quinnipiac Co. of Boston. The manufacturer objects to this analysis because both nitrogen and potash are below the minimum guarantee and below the average quality of the goods. An attempt to find other samples of the brand after the protest was received proved unsuccessful.

4005. Fairchild's Formula for Corn and General Crops, made by the Rogers & Hubbard Co., Middletown. A protest was made by the manufacturer against this analysis on account of the deficiency of both potash and phosphoric acid.

ANALYSES.

	3892	3951	3910	3930	3995	3962	4005
Nitrogen as nitrates	----	----	----	1.23	1.27	.12	4.92
as ammonia	3.76	3.92	3.06	2.42	2.50	.78	----
organic	1.01	.47	.66	1.96	2.67	2.36	1.45
Total nitrogen found	4.77	4.40	3.72	5.61	6.44	3.26	6.37
guaranteed	4.5	4.5	----	6.2	6.2	3.3	5.5
Soluble phosphoric acid	4.61	3.58	4.83	.37	----	5.26	----
Reverted phosphoric acid	1.06	1.02	1.10	3.74	3.43	3.81	----
Insoluble phosphoric acid	.56	.68	.66	2.09	1.96	1.47	----
Total phosphoric acid found	6.23	5.28	6.59	6.20	5.39	10.54	11.49
guaranteed	----	----	----	4.5	4.5	9.0	12.0
Potash as muriate	.82	.81	7.45	.61	.27	6.63	11.61
Total potash found	9.51	11.70	11.71	11.57	11.87	6.63	11.61
guaranteed	10.0	10.0	----	10.5	10.5	7.0	12.5

GUARANTEES.

Of the fifty brands of Special Manures analyzed, thirteen are quite below the manufacturer's minimum guarantee in respect of one ingredient, and nine are below in respect of two ingredients.

COST, VALUATION, AND PERCENTAGE DIFFERENCE.

The average cost per ton of the Special Manures has been $37.76. The average valuation, $29.35, and the percentage difference 28.6 per cent. Last year the corresponding figures were, average cost, $38.28, average valuation, $30.70, percentage difference, 25.0 per cent.

2. Sampled by Manufacturers, and 3. Sampled by Private Individuals.

2. Manufacturers' Samples.

These samples were sent to the Station in compliance with the terms of the Fertilizer Law and were analyzed because no samples of the brands named were found in market by our sampling agents.

3998. Complete Manure for Top Dressing Grass and Grain. Made by the Bradley Fertilizer Co., Boston, Mass.

3985. Special Connecticut Tobacco Manure. Made by Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

3988. Darling's Tobacco Grower. Made by the L. B. Darling Fertilizer Co., Providence, R. I.

4002. Special Tobacco Manure. Made by Walker, Stratman & Co., Pittsburg, Pa.

4003. Potato Special Fertilizer. Made by Walker, Stratman & Co.

3. Samples drawn by Private Individuals.

4013. Chittenden's Complete Fertilizer for Tobacco. Made by the National Fertilizer Co., Bridgeport. Sampled by T. J. Stroud, Shaker Station.

3751. Potato Fertilizer. Made by Preston Fertilizer Co., Greenpoint, N. Y. Sampled by John Mick, Westport.

3752. Onion Fertilizer. Made by Preston Fertilizer Co. Sampled by John Mick, Westport.

4012. Mixed Formula for Top Dressing. Made by L. Sanderson, New Haven. Sampled by W. S. Clark, Stephenson.

Analyses and Valuations.

	3998	3985	3988	4002	4003	4013	3751	3752	4012
Nitrogen as nitrates	5.66	.86	....	....	....	....	....	....	.29
as ammonia	....	.16	.20	.11	....	2.13	3.23	3.91	....
organic	....	5.99	4.34	1.68	1.56	3.00	.47	.27	.75
Total nitrogen found	5.66	7.01	4.54	1.79	1.56	5.13	3.70	4.18	1.04
Nitrogen guaranteed	....	**5.75**	....	**2.4**	**2.4**	**3.3**	**3.3**	**3.5**	**4.0**
Soluble phosphoric acid	.32	6.66	2.69	5.09	4.80	9.60	7.54	7.70	11.95
Reverted	5.01	1.06	3.07	1.81	1.94	1.27	.72	.89	.73
Insoluble	1.94	.25	1.85	5.61	5.95	.39	.18	.10	.39
Total phosphoric acid found	7.29	7.97	7.61	12.51	12.69	11.26	8.44	8.69	13.07
Phosphoric acid guaranteed	....	....	....	**10.0**	**12.0**	**10.0**	....	....	....
Available phosphoric acid found	5.33	7.72	5.76	6.90	6.74	10.87	8.26	8.59	12.68
Available phosphoric acid guaranteed	....	**5.0**	....	**8.0**	**10.0**	**8.0**	**8.0**	**7.0**	**7.0**
Potash	2.94	9.41	10.95	3.87	6.96	7.97	7.74	7.65	8.93
Potash guaranteed	....	**10.0**	....	**6.0**	**10.0**	**10.0**	**7.0**	**7.0**	**7.0**
Valuation per ton	$27.92	44.46	34.65	20.76	22.67	40.62	30.79	32.24	29.13

IV. Home Mixtures.

Here are included fertilizers which have been home-made from chemicals or raw materials bought of wholesale dealers. This method of preparing mixed fertilizers is steadily growing in favor, particularly with those who study most closely the special requirement of their particular soils and crops. The formulas by which the mixtures are made are first given, followed by the analyses.

3819. Potato Fertilizer, made by D. Fenn, Milford.

Formula.

1000 pounds Blood, Bone and Meat.
600 " Dissolved Bone Black.
200 " Muriate of Potash.
200 " Nitrate of Soda.
2000 "

Cost of materials $36.05 per ton, delivered.

4007. For General Use, made by N. D. Platt, Milford.

2000 pounds Blood, Bone and Meat.
2000 " Dissolved Bone Black.
500 " Muriate of Potash.
500 " Sulphate of Potash.
300 " Sulphate of Ammonia.
200 " Nitrate of Soda.
500 " Ground Bone.
6000 "

Cost of materials $35.96 per ton, delivered.

4008. For Corn, made by Dennis Fenn, Milford.

600 pounds Bone Black.
600 " Blood, Bone and Meat.
200 " Nitrate of Soda.
250 " Ground Bone.
150 " Muriate of Potash.
1800 "

Cost of materials $35.60 per ton, delivered.

4009. For Potatoes, made by Waldo Miller, Middlefield.

800 pounds Tankage.
800 " Acid Phosphate.
400 " Muriate of Potash.
2000 "

Cost not given.

4010. For Potatoes, made by G. F. Platt, Milford.

800	pounds Blood, Bone and Meat.
400	" Ground Bone.
550	" Dissolved Bone Black.
50	" Sulphate of Ammonia.
100	" Nitrate of Soda.
50	" Sulphate of Potash.
50	" Muriate of Potash.
2000	"

Cost of materials $35.31 per ton, delivered.

In the following table is given the actual cost of the ingredients, at *regular retail cash rates*, delivered at the purchasers' freight station. If to this is added $2.00 per ton as the cost of mixing on the farm we find the average cost of the four fertilizers to be $37.74 per ton and the average valuation $33.30. The percentage difference between cost and valuation is 6.8. That is, the valuation is very much nearer the cost price than it is in most factory-mixed goods.

HOME-MIXED FERTILIZERS.—ANALYSES AND VALUATIONS.

Station No.,	3819	4007	4008	4009	4010
Nitrogen as nitrates	1.89	.46	1.61	----	.60
as ammonia	----	1.14	----	----	.49
organic	3.47	2.62	3.18	2.87	3.87
Total nitrogen	5.36	4.22	4.80	2.87	4.96
Soluble phosphoric acid	3.92	6.40	6.08	5.75	4.48
Reverted phosphoric acid	4.55	3.11	2.76	2.27	4.10
Insoluble phosphoric acid	2.21	1.95	2.78	1.34	5.04
Total phosphoric acid	10.68	11.46	11.64	9.36	13.62
Potash as muriate	5.37	6.40	5.61	9.30	1.32
Total potash	5.37	7.23	5.61	9.30	2.07
Cost per ton	$36.05	35.96	35.60	----	35.31
Valuation per ton	$34.07	33.76	33.53	29.16	31.86

COTTON HULL ASHES.

In the following table are given 28 analyses of this material which were made on samples sent to the Station during the present year. They show the usual differences in quality, the per cent. of potash soluble in water ranging from 15.30 to 27.40. The average per cent. is 21.91.

ANALYSES OF COTTON HULL ASHES.

Station No.	Dealer or Purchaser.	Sampled by	Soluble Phosphoric Acid.	"Reverted" Phosphoric Acid.	Insoluble Phosphoric Acid.	Potash Soluble in Water.	Cost per ton.	Valuation per ton.	Potash, costs per pound in cents.
3735	G. H. & J. H. Hale, South Glastonbury	J. H. Hale	.83	7.86	1.20	19.77	$17.00*	$32.73	1.5
4018	Olds & Whipple, Hartford	Station Agent	3.09	6.65	2.30	27.44	40.00	43.10	4.9
3784	Geo. Douglass, Suffield	Luke F. Woodworth, Thompsonville	.83	5.88	1.75	26.21	35.00	37.67	5.0
3846	Olds & Whipple, Hartford	John Giligan, Windsor	1.50	5.79	2.92	24.90	40.00	37.46	6.0
3773	I. Luther Spencer, Suffield	E. S. Seymour, Windsor Locks	1.58	7.63	2.56	23.34	40.00	37.90	6.0
3868	I. Luther Spencer, Suffield	O. W. Kellogg	1.50	7.01	2.66	23.68	40.00	37.47	6.0
4017	Olds & Whipple, Hartford	Station Agent	.82	6.50	1.69	25.20	40.00	37.27	6.0
3741	Olds & Whipple, Hartford	L. L. Bedortha, Windsor	.32	8.23	1.07	24.15	40.00	37.30	6.1
3788	Olds & Whipple, Hartford	Station Agent	.45	8.51	.94	23.32	40.00	36.83	6.2
3792	T. Soule & Co., New Milford	T. Soule & Co., New Milford	.66	6.18	.99	24.66	40.00	35.81	6.4
3825	Olds & Whipple, Hartford	John DuBon, Poquonock	trace	6.31	1.56	22.76	39.00	33.86	6.6
4016	Olds & Whipple, Hartford	Station Agent	.64	4.48	.85	24.21	40.00	33.18	6.9
3863	W. W. Cooper, Suffield	Robert Obram	.48	5.16	2.64	25.18	43.00	35.57	7.0
3981	Olds & Whipple, Hartford	†F. H. Whipple	.62	6.69	.69	24.96	45.00	36.58	7.2
3847	A. H. Rice, Granby	H. A. Sheldon, West Suffield	.56	5.66	2.22	19.13	36.00	29.45	7.2
3866	Edward Austin, Suffield	Dexter F. Remington, Suffield	.78	7.41	2.66	24.24	48.00	37.63	7.6
4063	Olds & Whipple, Hartford, stock sold to Messrs. Lamphear, Alvord & Clark, Poquonock	Station Agent	.19	3.46	1.52	23.15	41.00	30.48	7.8
3810	R. A. Parker, Warehouse Point	G. S. Phelps, Warehouse Point	.96	4.96	1.70	22.42	43.00	32.54	7.8
3864	Olds & Whipple, Hartford	Chas. M. Owen, Suffield	.62	5.86	2.42	19.64	40.00	30.41	7.9
3849	Olds & Whipple. Hartford	Louis Clapp	none	5.30	2.55	20.40	40.00	29.82	8.0
3789	Olds & Whipple, Hartford	Station Agent	trace	5.75	1.47	19.87	40.00	29.35	8.1
3923	Olds & Whipple, Hartford	Station Agent	.83	6.35	2.03	17.45	39.00	28.71	8.4
3982	W. F. Fletcher, Southwick, Mass.	A. H. Griffin, Granby	.21	5.19	2 53	22.04	47.00	31.75	9.0
3922‡	Edward Austin, Suffield	‡E. G. Hastings, Silas L. Wood, and Wm. H. Lillie, West Suffield	.56	6.29	2.00	19.78	48.00	30.84	9.8
3865	Edward Austin, Suffield	Dexter F. Remington, Suffield	.40	5.94	2.85	17.60	48.00	28.15	11.1
3867	E. S. Hough, Poquonock	Eugene Brown, Poquonock	.46	3.78	1.30	15.30	40.00	22.49	11.2
3897	E. S. Hough, Poquonock	W. H. Harvey, Windsor	trace	2.75	1.60	15.84	40.00	21.36	11.4
3850	F. W. Brodie & Co., Memphis, Tenn.	S. O. Griswold, Poquonock	----	----	----	16.78	----	----	----

* In car lots. † In presence of P. P. Hickey, Burnside. ‡ Mixture of three samples.

The cost of potash per pound at retail in cotton-hull ashes has ranged from 4.9 to 11.4 cents per pound and has averaged 6.9 cents. Cotton-hull ash has ceased to be a cheap source of potash.

On the average, potash has cost, this year, over a cent per pound more in this form than in high grade sulphate. It is, however, a favorite fertilizer with many tobacco growers and is chiefly used on the tobacco crop.

SPURIOUS COTTON HULL ASHES.

On March 17, the Station reported Analysis No. **3753** made on a sample drawn by A. E. Holcomb, Poquonock, from stock purchased of Olds & Whipple, Hartford.

On March 23, analysis No. **3780** was reported. The sample was drawn by H. C. Griswold, Poquonock, from stock purchased by him out of the same car as Mr. Holcomb's stock.

In order that there might be no possible question as to the sampling, the Station, at the request of Messrs. Olds & Whipple sent an agent to Windsor who drew samples from five different lots of ashes that came from the same car as the samples just mentioned which had been bought by Clark Brothers, H. C. Griswold, M. Larney, F. G. Strickland and A. E. Holcomb. A mixture was prepared of equal parts of these samples, making the Station sample, No. **3785**, whose composition is given below.

ANALYSES OF SPURIOUS COTTON HULL ASHES.

	3753	3780	3785
Potash	9.85†	7.21*	10.06
Soda	1.38	----	1.84
Lime	32.79	31.97	32.14
Magnesia	3.63	4.74	3.17
Oxide of iron and alumina	5.76	6.03	6.15
Phosphoric acid	1.54	----	1.30
Sulphuric acid	----	----	1.61
Carbonic acid	18.66	20.01	19.58
Sand and silica	23.45	23.59	22.58
Water, free and combined	1.89	----	1.51
	98.95		99.94
"Valuation"	$9.08	----	$8.59

These "Cotton Hull Ashes" were possibly from a heap that had been partially leached by rain and mixed with sand, earth, or coal ashes.

* Soluble in water. † Soluble in acid.

The dealers, Messrs. Olds & Whipple, as soon as they were made aware of the character of the goods, immediately recalled them, settled with those who had bought them and returned the car to the south.

How difficult it is to judge of the quality of cotton hull ashes by simple inspection is shown by the analyses of the following samples.

4014. "This sample is drawn from one of four bags we found in a four-ton lot. I am curious to know if these are what they purport to be or if they are only 'boiler cleanings.' We have set them aside as almost worthless."

The analysis given below shows that they were exceptionally good, containing over 28 per cent. of water-soluble potash.

4015. "This is from one bag of four in the same lot as the above. The color is quite dark brown."

The analysis shows that our correspondent's suspicions were well founded in this case, for these ashes were of very inferior quality.

	4014	4015
Potash soluble in water	28.49	9.30
Soluble phosphoric acid	.19	.32
Reverted phosphoric acid	5.42	2.40
Insoluble phosphoric acid	.42	.32
Cost per ton	$39.00	39.00
Valuation per ton	38.27	13.66

UNLEACHED WOOD ASHES.

3787. "Common House Ashes from my own stove." Sent by J. B. Cannon, West Suffield.

3772. From Monroe, Deforest & Co., Oswego, N. Y. A small sample sent by the manufacturer.

3778. Sold by Monroe, Deforest & Co., Oswego, N. Y. Sample of a car lot, sent by S. O. Griswold, Poquonock.

4051. Sold by Monroe, Deforest & Co., Oswego, N. Y. Sampled and sent by Herbert Barnes, New Haven.

3779. Sold by Allison, Stroup & Co., New York. Sampled and sent by J. E. Mansfield, North Haven.

3783. Sold by Allison, Stroup & Co., New York. Sampled and sent by A. P. Wakeman, Fairfield.

3855. Sold by Allison, Stroup & Co., New York. Sampled and sent by D. W. Patton, Clintonville.

3732. Sold by F. R. Lalor, Dunville, Ontario. Sampled and sent by Stephen Smith, Montowese.

3733. Sold by F. R. Lalor, Dunville, Ontario. Sampled and sent by A. P. Wakeman, Fairfield.

3786. Sold by F. R. Lalor, Dunville, Ontario. Sampled and sent by J. B. Cannon, West Suffield.

3811. Sold by F. R. Lalor, Dunville, Ontario. Sampled and sent by S. A. Smith, Clintonville.

4053. Sold by F. R. Lalor, Dunville, Ontario. Sampled and sent by Julius Moss, West Cheshire.

3859. Sold by Chas. Stevens, Napanee, Ontario. Sampled and sent by O. E. Pitcher, Enfield Bridge.

3796. Sampled and sent by T. D. Barclay, Kent.

3857. Sold by E. N. Phelps, Windsor. Sampled and sent by Eugene Brown, Windsor.

3898. Sold by parties in London, Canada. Sampled and sent by C. A. Corey, Suffield.

4065. Sold by W. F. Fyfe & Co., Clinton, Mass. Sampled and sent by S. D. Woodruff & Sons, Orange.

4066 and **4067.** Domestic Wood Ashes. Sampled and sent by S. D. Woodruff & Sons, Orange.

These analyses show the varying quality of Canada Ashes. Two of the samples, **3811** and **3898**, were very wet, which helps explain the low percentage of potash.

For analyses see the next page.

Blood Albumin.

3730. A sample of this material, which is used in dyeing processes, sent to the Station from the farm of C. M. Beach, West Hartford, contained

Nitrogen	4.25
Phosphoric acid	.09
Potash	.16

Waste Peaches.

A sample of immature peaches was sent to the Station by the Conn. Valley Orchard Co. on the 18th of July, with the following explanation:

"I send you a sample of our peaches which we are now picking from our trees, for the sake of thinning the crop and because the peaches themselves are imperfect, largely as the result of the work of the curculio. I desire to know the likelihood of the

ANALYSES.

	3787	3772	3778	4051	3779	3783	3855	3732	3733	3786	3811	4053	3859	3796	3857	3898	4065	4066	4067
Potash soluble in water	7.03	4.06	5.61	4.85	6.69	4.64	5.39	3.38	4.85	5.42	2.81	3.51	7.19	4.85	6.16	4.63	3.35	2.93	6.41
Phosphoric acid	4.86	....	1.06	1.09	1.18	.78	1.19	.91	1.57	1.45	2.88	1.28	1.47	1.36	1.41	1.14	1.37	1.79	2.11
Moisture	....	....	14.10	....	....	....	....	....	....	....	24.72	....	....	....	....	26.70	....	....	....
Cost per ton	....	....	$11.50	11.50	....	11.40	11.50	11.00	10.00*	12.50	11.00	11.50	13.00	11.00	11.00	11.00	....	....	....

* Car lot.

danger arising from these, if dropped on the ground under the trees, from insect life, which would come from them; I also desire to know their manurial value if they are put in heaps and allowed to decay. This will at the same time show how much they are drawing from the ground."

To allow curculio-infected fruit to drop and remain on the ground under the trees is the most effective method of securing their presence in the orchard the coming season. Soon after the fruit has fallen the grub or worm crawls out of it into the ground, pupates and comes out as a fully developed beetle either the same season or early the next. All such fruit should be removed from the orchards and so treated as to insure the destruction of the grubs or the pupæ. Probably if they are buried deeply enough the insects will be destroyed.

In one ton (of 2000 pounds) of this immature fruit there are,

Potash	**7.3**	lbs.
Soda	.16	"
Lime	.56	"
Magnesia	.59	"
Oxide of iron and alumina	.16	"
Phosphoric acid	**1.80**	"
Sulphuric acid	.38	"
Chlorine	.20	"
Sand and silica	.47	"
Nitrogen	**6.40**	"

It appears that a ton of this fruit contains about as much nitrogen and potash as 200 pounds of a nitrogenous superphosphate of average quality, but much less phosphoric acid. The best economy will consist in the certain destruction of all curculio in the fruit even if it is not available afterwards as a fertilizer.

Peat Moss and Swamp Muck.

3731. Peat Moss. An imported article, used as bedding and absorbent in city stables. It is much more efficient than straw for the latter purpose, besides acting as a deodorizer. It comes in bales of from 300 to 500 pounds weight. Sent from farm of C. M. Beach, West Hartford.

3791. Swamp Muck. Sent by Mrs. E. M. Lea, Plantsville.

4037. Swamp Muck. Sent by C. A. Satterlee, Gales Ferry. This material consists chiefly of sand with just sufficient vegetable mold to give it a dark color.

Analyses.

	Fresh substance.			Water-free substance.		
	3731	**3791**	**4037**	**3731**	**3791**	**4037**
Moisture	25.47	9.70	43.75	----	----	----
Organic and volatile matter	73.54	88.55	7.22	98.63	98.02	12.85
Ash	.99	1.75	49.03	1.37	1.98	87.15
	100.00	100.00	100.00	100.00	100.00	100.00
Nitrogen	.65	1.34	.30	.87	1.48	.53
Phosphoric acid	.25	----	.08	.34	----	.14
Potash	.13	----	.15	.17	----	.24
Sand and silica	.36	----	45.84	.48	----	81.59

The nitrogen of the peat moss is of very little if any immediate agricultural value.

"Saltpeter Waste."

This material, sent to the Station by T. J. Stroud, Shaker Station, is a waste from the powder factory at Enfield.

The analysis, **4039,** showed such a high per cent. of nitrogen and potash that it was suggested to Mr. Stroud that it would be wise to have another sample drawn with the greatest care, as it was hard to believe that a product having this composition would be sold at the price quoted. The second analysis, however, confirms the first.

Analyses.

	4039	**4056**
Potash soluble in water	37.35	34.64
Nitrogen as nitrates	4.14	5.25
Chlorine	3.47	----

The composition of the salt is about the following:

Moisture and combined water	11.89
Sand and insoluble matters	1.86
Nitrate of potash	30.33
Sulphate of potash	42.66
Sulphates and chlorides of soda, lime and magnesia	13.26
	100.00

If the actual potash and the nitrogen are valued as in commercial fertilizers, the valuation of this material per ton will be $53.90. It is offered by the manufacturers at $25.00 per ton.

Curd from Buttermilk.

A sample of the curd which separates from buttermilk on standing, was sent by T. M. Totman of Putnam Landing to ascertain its value as a fertilizer.

The quantity sent, stated to be the yield from one gallon of buttermilk, weighed just one pound, and contained more than 70 per cent of water.

Its value as a fertilizer consists wholly in nitrogen, of which it contained in the fresh state 3.3 per cent., that is, as much as the average superphosphate.

If a gallon of buttermilk contains a pound of curd, every 100 gallons of buttermilk will contain 3.3 pounds of nitrogen which, at the current prices of nitrogenous matters, might be reckoned as worth about 57 cents.

But it would be more economical to feed the buttermilk or the curd from it to pigs, or mixed with other feed in moderate quantity to cows.

REVIEW OF THE FERTILIZER MARKET.

For the Ten Months ending November 1st, 1893.

Nitrogen.

Nitric Nitrogen.

The *wholesale* New York quotation of nitrogen in nitrate of soda was 13.8 cents per pound in January last. The short stock of nitrate in dealers' hands and the slow winter voyages of freighters from South America, together with the usual increased spring demand, drove the quotation up to 14.7 cents in March. It fell then to 13 cents in May and 11 cents in June. Since then it has risen considerably: to 11.4 cents in August, 11.6 cents in September, and 11.9 in October. The average wholesale quotation for the ten months has been 12.7 cents per pound. For the years 1892, 1891 and 1890 it was 12.1 cents, 12.9 cents and 11.5 cents respectively.

The *retail* ton price of nitrogen in nitrate of soda, in this State during the last season has been about 17.4 cents per pound.

Ammonic Nitrogen.

The quotations of sulphate of ammonia have fluctuated considerably during the year, and have ruled high. There is no immediate prospect of its being obtainable at as low rates as have prevailed during past years. The reasons for this are to be found in the increased demand for ammonia for ice machines and manufacturing processes, as well as in the diminished production of sulphate of ammonia owing to the increased use of water gas and the electric light. It is obtained chiefly as a by-product in the production of illuminating gas.

The *wholesale* price in New York of nitrogen in the form of sulphate of ammonia was 14 cents per pound, in January last. It rose to 17.1 cents in April and May, fell again in July to 14.9, and since then has been rising considerably; being quoted at 15.6 cents in August, 15.9 in September, and 16.4 in October. The average wholesale quotation for the ten months has been 15.7 cents per pound. The average for the years 1892, 1891 and 1890 has been 14.5, 15.6 and 16 cents respectively.

The *retail* price of nitrogen in sulphate of ammonia in Connecticut has been between 18 and 19 cents per pound for the whole season.

Organic Nitrogen.

The wholesale quotations of nitrogen in organic form have been subject to great fluctuations during the year and have reached higher figures than for some years previously. The causes are the larger home consumption, and the extreme scarcity of raw materials. The menhaden fishery this year has been, for the most part, a failure. The high prices of corn last year have had their effect on the number of hogs butchered, and this in turn has greatly diminished the output of tankage from the slaughtering establishments. The short cotton crop last year also diminished the quantity of meal available for fertilizing purposes. It was estimated last spring that the supply of ammoniates had been reduced 50 per cent. A remarkable feature of the market was, that 2500 tons of nitrogenous matters were imported into this country within two or three months, whereas in other years there has been a considerable export trade. Among these materials has been ground offal from European slaughters, also an article called whale meat meal, claimed to consist of the flesh of whales finely ground. There was also imported a good deal of "tankage" and "animal matter" which looked and reacted remarkably like ground leather scrap and pulverized wool.

The *wholesale* New York quotation of nitrogen in red blood, low grade blood, azotin, and concentrated tankage, for each month of the year is given in detail on page 71. The quotations of blood in February and March of this year are higher than at any time previous for ten years. The quotations of these various nitrogenous matters, which had begun to rise already in June or July of 1892, rose even more rapidly during the first months of 1893 and in March last reached the highest figure of the year; the nitrogen of red blood being then quoted at 20 cents per pound, that of low grade blood at 19.8 cents, of azotin at 19.6 cents, and of concentrated tankage at 19.3 cents. Since then prices have fallen steadily till September, but quotations have risen again sharply since October 1. The quotations of dry fish have fluctuated during the last ten months between $24.00 and $30.00.

Dried blood, azotin, and concentrated tankage do not figure at all in our retail market, and no retail quotations can be given. Those who compound their own fertilizers chiefly use as a source of nitrogen either bone or a low grade of tankage which differs little in composition from bone. Neither bone nor this low grade tankage advanced greatly in price, when concentrated nitrogenous matters advanced sharply. There are also used, chiefly by tobacco growers, both cotton seed meal and castor pomace. Nitrogen in both these sources has been very expensive this year. As is seen by reference to page 20 the nitrogen of decorticated meal has cost at retail from 14.9 cents to 19 cents per pound, as against 14 to 16.3 cents last year. The nitrogen of castor pomace as is shown on page 21 has cost from 19.2 cents to 25.4 cents per pound. The high cost of nitrogen in cotton seed meal is due to the increased cost of the article which we understand is being shipped abroad in large quantity as a cattle food, while the still higher cost of nitrogen in castor pomace is due to the inferior quality of the article itself.

Phosphatic Materials.

Bone black and rough bone have been quoted throughout the last ten months at $19.50 per ton. Ground bone has been quoted during the same period at $22.25 per ton. Bone meal quoted in January last at $22.75 per ton, rose to $24.50 in April and May, and since then has fallen to $23.75. Ground Charleston rock, quoted in January last at $8.75 per ton, fell in February to $8.37½, at which figure it has ever since been quoted. Sulphuric acid of 66 degrees quoted in January last at 111.25, has since fallen to 106 in May, 101.25 in September, and 100 in October. Acid phosphate, 14 per cent. available, quoted in January last at 66¾, fell in February to 61¼, at which figure it has been quoted ever since. This latter quotation is equivalent to 3.09 cents per pound for available phosphoric acid at wholesale. It thus appears that phosphates have remained tolerably steady during the year, with a slight downward tendency. The retail price in Connecticut of available phosphoric acid in dissolved bone black has been from 7.5 to 8.0 cents per pound. Acid phosphate made from Charleston rock, though much cheaper, does not come into our market.

Potash.

Muriate of Potash.

The wholesale price of actual potash in this form has advanced from 3.51 cents per pound in January to 3.56 in February, and 3.75 in June, at which figure it has been quoted ever since. It has been retailed in Connecticut during the year for about 4½ cents per pound.

Double Sulphate of Potash and Magnesia.

The wholesale quotation of potash in this form has fluctuated during the ten months between 4.25 cents and 4.32 cents per pound. It has retailed in Connecticut at about 5.8 cents per pound.

High Grade Sulphate of Potash.

The wholesale quotation of potash in this form, which was 4.7 cents per pound in January, has remained quite steady since that time at 4.16 cents. It has been sold at retail in Connecticut during the last year at prices ranging from 5.13 to 6.6 cents per pound.

Kainit.

The New York wholesale quotation of this article which opened in January at $9.17\frac{1}{2}$ per ton, has been quite steady ever since at $9.12\frac{1}{2}$.

The market quotations given above are taken from the "Oil, Paint and Drug Reporter," published in New York. The weekly quotations for each month are averaged, and this average is taken as the quotation for the month.

The following explanations will help in the examination of the market quotations, and will also show the basis on which they have been interpreted in this review:

Phosphate rock, kainit, bone, fish-scrap, tankage and some other articles are quoted and sold by the ton. The seller usually has an analysis of his stock and purchasers often control this by an analysis at the time of purchase.

Sulphate of ammonia, nitrate of soda and muriate of potash are quoted and sold by the pound, and generally their wholesale and retail rates do not differ very widely.

Blood, azotin and ammonite are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by the decimal .824 (or multiply the percentage of ammonia by 14 and divide that product by 17). A "unit of ammonia" is one per cent., or 20 pounds per ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to 8.5 per cent. of ammonia, it is said to contain $8\frac{1}{2}$ units of ammonia, and if quoted at $2.25 per unit, a ton of it will cost $8\frac{1}{2} \times 2.25 = \$19.13$.

The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given:

Ammonia at	$3.00	per unit is	equivalent to	nitrogen at	18.2	cts. per lb.
"	2.90	"	"	"	17.6	"
"	2.80	"	"	"	17.0	"
"	2.70	"	"	"	16.4	"
"	2.60	"	"	"	15.8	"
"	2.50	"	"	"	15.2	"
"	2.40	"	"	"	14.6	"
"	2.30	"	"	"	14.0	"
"	2.20	"	"	"	13.4	"
"	2.10	"	"	"	12.8	"
"	2.00	"	"	"	12.2	"
"	1.90	"	"	"	11.6	"
"	1.80	"	"	"	11.0	"

Commercial sulphate of ammonia contains on an average 20.5 per cent. of nitrogen, though it varies considerably in quality. With that per cent. of nitrogen (equivalent to 24.3 per cent. of ammonia),

At 4	cents per pound.	Nitrogen	costs	19.5	cents per lb.
" $3\frac{7}{8}$	"	"	"	18.9	"
" $3\frac{3}{4}$	"	"	"	18.3	"
" $3\frac{5}{8}$	"	"	"	17.6	"
" $3\frac{1}{2}$	"	"	"	17.0	"
" $3\frac{3}{8}$	"	"	"	16.4	"
" $3\frac{1}{4}$	"	"	"	15.8	"
" $3\frac{1}{8}$	"	"	"	15.2	"
" 3	"	"	"	14.6	"
" $2\frac{7}{8}$	"	"	"	14.0	"
" $2\frac{3}{4}$	"	"	"	13.4	"

Commercial Nitrate of Soda averages 95 per cent. of pure salt or 16.0 per cent. of nitrogen.

If quoted at	3.0	cents per pound,	Nitrogen costs	18.8	cents per lb.
"	2.9	"	"	18.2	"
"	2.8	"	"	17.5	"
"	2.7	"	"	16.9	"
"	2.6	"	"	16.2	"
"	2.5	"	"	15.6	"

If quoted at 2.4 cents per pound,	Nitrogen costs	15.0	cents per lb.
" 2.3	"	"	14.4	"
" 2.2	"	"	13.8	"
" 2.1	"	"	13.2	"
" 2.0	"	"	12.5	"
" 1.9	"	"	11.9	"
" 1.8	"	"	11.3	"
" 1.7	"	"	10.6	"

Commercial Muriate of Potash and also High Grade, 98 per cent., Sulphate of Potash usually contain 50½ per cent. of actual potash.

If quoted at 2.60 cents per lb.	Actual potash costs		5.15	cents per lb.
" 2.50	"	"	" 4.95	"
" 2.40	"	"	" 4.75	"
" 2.30	"	"	" 4.55	"
" 2.25	"	"	" 4.45	"
" 2.20	"	"	" 4.35	"
" 2.15	"	"	" 4.25	"
" 2.10	"	"	" 4.15	"
" 2.05	"	"	" 4.06	"
" 2.00	"	"	" 3.96	"
" 1.95	"	"	" 3.86	"
" 1.90	"	"	" 3.76	"
" 1.85	"	"	" 3.66	"
" 1.80	"	"	" 3.56	"
" 1.75	"	"	" 3.46	"
" 1.70	"	"	" 3.36	"

The Double Sulphate of Potash and Magnesia has about 26½ per cent. of actual potash.

If quoted at 1.00 cent per lb.	Actual Potash costs		3.77	cents per lb.
" 1.05	"	"	" 3.96	"
" 1.10	"	"	" 4.15	"
" 1.15	"	"	" 4.34	"
" 1.20	"	"	" 4.53	"

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since January, 1890. The price given for each month is the average of the four weekly quotations of that month. Sulphate of ammonia is assumed to contain 20.5 per cent. and nitrate of soda 16.0 per cent. nitrogen, and muriate of potash 50½ per cent. of actual potash or 80 per cent. of the pure salt.

Wholesale Prices of Fertilizing Materials.

		Cost of Nitrogen at wholesale in						Cost of Potash at Wholesale in			
		Dried Blood.									
		Red. Cents per pound.	Black or low grade. Cents per pound.	Azotin or Ammonite. Cents per pound.	Concentrated Tankage. Cents per pound.	Nitrate of Soda. Cents per pound.	Sulphate of Ammonia. Cents per pound.	Muriate of Potash. Cents per pound.	Double Manure Salt. Cents per pound.	High Grade Sulphate Potash. Cents per pound.	Available Phosphoric Acid in Dissolved South Carolina Rock. Cents per pound.
1890.	January	12.4	11.9	12.7	----	12.1	15.4	3.64	4.44	4.97	4.06
	February	12.4	11.8	12.5	----	12.0	15.4	3.64	4.44	4.97	4.06
	March	12.1	11.8	12.2	----	11.9	15.4	3.64	4.44	4.89	4.06
	April	12.0	11.7	12.2	----	11.2	15.4	3.64	4.42	4.77	4.06
	May	11.9	11.3	12.2	----	11.2	15.3	3.62	4.42	4.77	4.05
	June	11.9	11.4	12.1	----	11.2	15.8	3.62	4.42	4.77	4.00
	July	11.9	11.4	12.0	----	11.2	16.6	3.62	4.42	4.77	3.69
	August	11.6	11.0	11.5	----	11.0	16.6	3.62	4.42	4.77	3 69
	September	11.3	10.7	11.3	----	11.1	16.6	3.62	4.42	4.77	3.69
	October	11.4	10.8	11.7	----	11.6	16.5	3.62	4.42	4.17	3.69
	November	11.5	10.9	11.4	----	11.6	16.5	3.55	4.27	4.06	3.69
	December	11.5	10.9	11.4	----	11.6	16.5	3.62	4.53	4.31	3.69
1891.	January	11.0	10.5	11.5	----	10.9	16.5	3.58	4.53	4.33	3.69
	February	12.0	11.0	11.5	----	12.5	16.5	3.58	4.53	4.33	3.69
	March	12.5	11.9	11.5	----	14.3	16.5	3.68	4.53	4.33	3.69
	April	12.4	12.0	11.5	----	14.4	16.5	3.68	4.53	4.33	3.69
	May	12.3	11.7	11.5	----	13.6	16.0	3.68	4.53	4.33	3.69
	June	12.3	11.7	11.5	----	13.2	15.5	3.68	4.53	4.33	3.69
	July	12.2	11.6	11.5	----	12.2	15.4	3.68	4.53	4.33	3.69
	August	12.3	11.8	11.5	----	11.3	15.4	3.68	4.53	4.33	3.69
	September	12.3	12.0	11.5	----	12.2	14 8	3.68	4.53	4 33	3.69
	October	12.3	12.0	11.5	----	13.6	14.7	3.68	4.53	4.33	3.69
	November	12.6	12.3	11.5	----	13.5	14.7	3.68	4.53	4.33	3.69
	December	12.4	12.1	11.5	----	13.3	14.7	3.63	4.63	4.41	3.69
1892.	January	12.2	11.5	11.5	----	12.9	14.7	3.62	4.79	4.45	3.69
	February	11.6	11.3	11.5	----	12.0	14.7	3.64	4.77	4.48	3.69
	March	11.5	11.0	11.2	----	12.1	14.7	3.71	4.77	4.48	3.69
	April	11.8	11.3	11.2	----	11.0	14.7	3.78	4.77	4.48	3.69
	May	12.0	11.5	11.2	----	10.5	14.7	3.78	4.77	4.48	3.69
	June	11.7	11.2	11.2	----	10.6	14.7	3.78	4.77	4.48	3.69
	July	12.1	11.7	11.2	----	11.1	14.7	3.78	4.77	4.48	3.69
	August	12.3	12.1	11.2	----	11.7	14.7	3.78	4.77	4.48	3.60
	September	12.4	12.0	12.0	----	12.4	14.2	3.78	4.77	4.48	3.30
	October	13.0	12.6	12.6	----	12.9	14.0	3.78	4.77	4.48	3.30
	November	14.1	13.8	13.7	----	13.7	14.0	3.78	4.77	4.48	3.30
	December	14.6	14 2	14.8	----	13.7	14.0	3.78	4.77	4.48	3.30
1893.	January	16.2	15.8	15.9	12.3	13.8	14.0	3.51	4.25	4.70	3.33
	February	18.5	18.0	17.9	15.7	14.1	14.0	3.56	4.32	4.16	3.09
	March	20.0	19.8	19.6	19.3	14.7	15.6	3.56	4.32	4.16	3.09
	April	18.0	17.7	18.1	19.3	14.6	17.1	3.56	4.32	4.16	3.09
	May	16.2	15.4	16.4	18.3	13.0	17.1	3.56	4.32	4.16	3.09
	June	14.5	14.0	14.8	14.2	11.0	15.9	3.75	4.32	4.16	3.09
	July	13.7	13.1	13.7	14.2	11.1	14.9	3.75	4.32	4.16	3.09
	August	13.5	12.1	13.9	14.2	11.4	15.6	3.75	4.25	4.16	3.09
	September	12.5	12.2	13.2	14.2	11.6	15.9	3.75	4.32	4.16	3.09
	October	16.2	15.3	15.3	17.1	11.9	16.4	3.75	4.32	4.16	3.09

REPORT OF THE MYCOLOGIST,

W. C. STURGIS.

It is rarely that a Station mycologist has to report for two successive seasons any decided paucity of actual results owing to lack of conditions favorable to field experiments. Nevertheless such has been the case in Connecticut during the last two seasons. The summer of 1893 was marked by a long continued period of dry weather in June and July, when under favorable conditions parasitic fungi begin their most serious depredations, while the memorable gales of August and early September largely denuded fruit-trees of their crop and made it impossible to obtain accurate data as to the results of comparative spraying experiments.

SPRAYING FOR "SCAB" OF APPLE AND PEAR.

The experiments undertaken under this head were designed to test the comparative value of winter and summer treatment for the prevention of the "scab" fungi, *Fusicladium dendriticum*, (Wallr.) Fckl., and *F. pyrinum*, (Lib.) Fckl. The experiment upon apples was made in the orchard of Mr. A. J. Coe of Meriden, and that upon pears in the orchard of Mr. A. E. Plant of Branford.

The same plan was adopted for both experiments. The portion of the orchard selected for the purpose was divided into four equal parts; the first received during the last week in March a spray consisting of a simple solution of copper sulphate in the proportion of one pound to twenty-five gallons of water; the second received the same, and in addition was sprayed with Bordeaux mixture as usual during the summer; the third was kept as a check and received no treatment whatever; and the fourth received only the summer treatment with Bordeaux mixture.

Both sets of experiments progressed favorably until August, when a succession of violent storms almost completely stripped the trees of fruit, and it was impossible to obtain conclusive results. Enough was seen however to warrant our recommending the use of the simple copper solution early in the spring before the buds begin to swell.

The following is Mr. Plant's report of the experiment in his pear orchard: "The gales destroyed the opportunity of seeing the best results; at the same time we could readily see the benefit to the foliage and the remaining fruit. One thing is certain, and that is that wherever the Bordeaux mixture is used it shows good results. The plot where the winter treatment was used alone, seemed to me a failure as the fruit was not as nice and the leaves began falling in August. The plots upon which Bordeaux mixture was used were much better. It was applied first just before the blossoms opened, and again when the pears were as large as peas. I think it would have been of benefit to have given them three and perhaps four treatments as the fungus forms very fast on the fruit. I could see little difference between the plot which received both the winter and summer treatment and that which received the latter only. The check plot showed fungus by the wholesale, fruit and foliage being destroyed entirely. I hope next year to have better results."

On the whole the winter treatment would seem to be of little advantage, but it must be remembered that in this case the check rows infested with "scab" were in the midst of the treated rows and were naturally a fruitful source of infection throughout the summer. The fungus produces several crops of spores during the season, any one of which might serve to infect the trees which did not receive the Bordeaux mixture. If there had not been this adjacent source of infection the beneficial effect of the winter treatment would have been more apparent. Again, countless spores of the "scab" fungi live throughout the winter in the inequalities of the bark of infested trees; these are to a large extent destroyed by the early application of the copper sulphate solution, and we start at least with our orchard comparatively free from the germs of disease. Finally, inasmuch as sources of infection are unfortunately never absent, this initial treatment is not sufficient of itself, but must be followed by at least three applications of Bordeaux mixture during the summer.

These experiments will be repeated next season.

POTATO "ROT" AND METHODS OF APPLYING BORDEAUX MIXTURE. Plate I.

Our experiments upon potato "rot" (*Phytophthora infestans*, (Mont.) D. By.) this year were not designed so much to confirm the fact of the value of Bordeaux mixture, a fact already abundantly proved, as to encourage its more general use, and to test the value of a new apparatus for applying the mixture to potatoes on a large scale. The experiments were tried at the suggestion of Mr. Thomas J. Stroud, on an eight-acre field of potatoes at Shaker Station. As a demonstration of the value of Bordeaux mixture the experiment could hardly be called a success. The vines suffered so severely from the excessive drought of June and July that though there was no *Phytophthora* present either on the sprayed vines or on those left as checks, they all succumbed and were past recovery by the time August came with more frequent rains.

The vines were also damaged by the "flea-beetle" (*Crepidodera cucumeris*), which usually accompanies a season of severe dry weather; large numbers of plant-lice (aphides), which originated on the abundant "pig-weed" (*Amarantus*); and by a species of blight similar in general appearance and effects to that supposed to be caused by the fungus *Macrosporium Solani*, El. & Mart.* Whether or not the latter is a case of primary cause and effect must still be considered an open question. The blight usually appears first on the tips and margins of the leaflets, and around the eroded edges of the holes caused by the attacks of the Crepidodera. Leaves obtained from many localities throughout the State, and exhibiting the blight in every stage of development, were submitted to the most careful microscopic examination, but in very few instances was the Macrosporium found, and then in hardly sufficient quantity to warrant the assumption that it was the sole cause of the blighted appearance, especially in view of the fact that in no case was it found associated with the most seriously damaged leaflets. Chester† however, claims to have produced the blight by artificial infection with the Macrosporium spores, though he has as yet given no details of the experiment.

Whatever the cause, Bordeaux mixture seemed inefficient in preventing it, and experiments on the subject will be undertaken another season with added interest.

Apparatus for Spraying Potatoes.

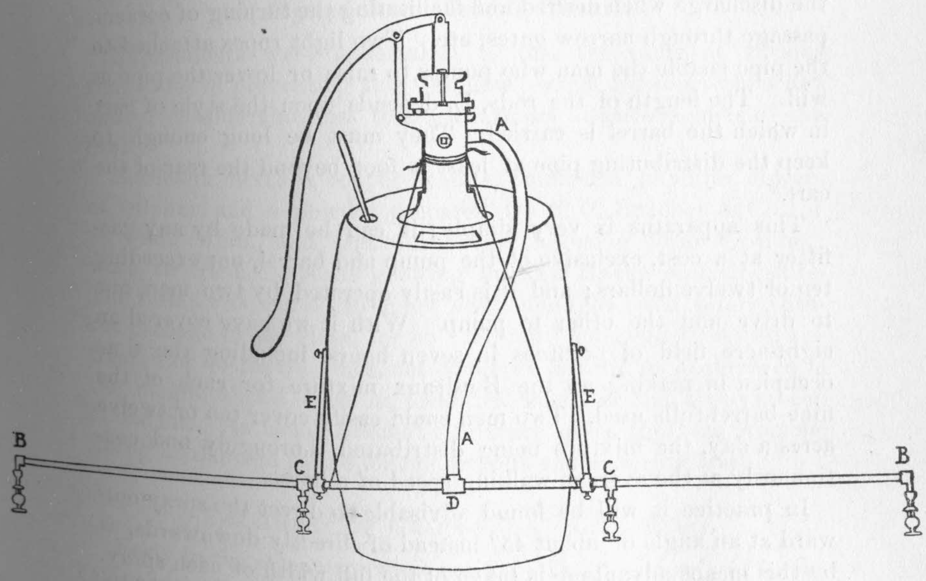
The need has long been felt of some mechanical device for applying fungicides or insecticides to low-growing plants, especially when the latter are planted at regular intervals, either in

* *Cf.* Sixth Annual Report Vt. Agr. Exp. Sta., 1893, p. 66 refs.

† Bull. XV. Del. Agr. Exp. Station, Jan., 1892, p. 14.

rows or otherwise. A knapsack sprayer is thoroughly satisfactory only over small areas, as it requires frequent refilling, and when filled is too heavy to carry continuously for more than a few hours. The barrel pump mounted on a cart is far more satisfactory for spraying potato-fields of five acres and upwards, but even with two discharge-pipes the work is slow and requires at least three men to do it properly. What is needed is an apparatus which will cover four or five rows at a time, the spray being delivered from fixed nozzles, one directly over each row, and requiring for its operation only one man to pump and one to drive. Such an apparatus is shown in the accompanying cut and in Plate I, and after testing it severely for one season we can vouch for its capabilities.

It consists essentially of a cask upon which is mounted a force-pump of considerable power fitted with one discharge carrying a one-inch rubber discharge-pipe, A. This pipe is from two to



three feet long and connects directly with the distributing pipe, BB. The latter is composed of half-inch brass tubing cut into four joints, two of them measuring three feet in length, the others eighteen inches each. Elbow-connections at B, and T-connections at C, connect the joints of the pipe and carry quarter-inch couplings fitted with Vermorel nozzles. Each nozzle thus covers one row of potatoes when the rows are planted three feet apart as is customary. The pipe may be lengthened to twelve feet and carry five nozzles, but except where some special conditions render it advisable, as when five rows of potatoes occupy the space between rows of trees in an orchard, the longer pipe will be found inconvenient. A T-connection at D unites the two shorter joints of the pipe and connects the pipe with the discharge-tube A. This allows each half of the distributing pipe to be turned and the sprays directed either downwards or outwards. The distributing pipe is connected with the barrel by two iron rods, E. These rods are clamped to the sides of the barrel with thumb-screws, and where they connect with the distributing pipe they screw into brass collars. When these collars are set by means of thumb-screws the pipe becomes fixed in the desired position. When the thumb-screws on the barrel are loosened the whole distributing pipe can be raised up over the barrel thus checking the discharge when desired and facilitating the turning of corners, passage through narrow gates, etc. Two light ropes attached to the pipe enable the man who pumps to raise or lower the pipe at will. The length of the rods, E, depends upon the style of cart in which the barrel is carried. They must be long enough to keep the distributing pipe at least a foot beyond the rear of the cart.*

This apparatus is very simple; it can be made by any gas-fitter at a cost, exclusive of the pump and barrel, not exceeding ten or twelve dollars; and it is easily operated by two men, one to drive and the other to pump. With it we have covered an eight-acre field of potatoes in seven hours, including the time occupied in making up the Bordeaux mixture for each of the nine barrel-fulls used. Two men could easily cover ten or twelve acres a day, the mixture being distributed thoroughly and continuously at the average walking speed of a horse.

In practice it will be found advisable to direct the spray outward at an angle of about 45° instead of directly downwards, as by this means advantage is taken of the full width of each spray. For the same reason, when the potatoes are almost or fully grown, the distributing pipe should be raised and fastened in a

* In ordering Vermorel nozzles for use with this apparatus it is well to have them fitted with a spiral spring to hold back the degorger; otherwise the position of the nozzle allows the degorger to fall forward, choking the aperture and causing much delay in readjusting it.

position not less than three feet above the tops of the plants. In this connection it should be stated that an apparatus very similar to that described was this year devised quite independently of us by Mr. Wm. Platt of Milford. The distributing pipe is made precisely like ours, but instead of being permanently fixed to the barrel, it is connected to the latter only by two quarter-inch rubber discharge-pipes, and is carried by a man walking behind the cart. It requires one additional man, but it is somewhat cheaper than our apparatus and quite as serviceable. The delivery-pipe can be made to carry five nozzles without inconvenience, and it is more completely under the control of the operator. Either apparatus serves its purpose well and is certainly an improvement over the methods heretofore used. Our apparatus in use is illustrated in Plate I.

Mildew of Lima Beans.

(*Phytophthora Phaseoli*, Thaxter.)

Experiments were undertaken to test the value of various fungicides in preventing this "mildew" which for some years has caused considerable loss to truck-farmers in various parts of the State.

Bordeaux mixture, copper acetate, potassium sulphide, flowers of sulphur, and a powder prepared by F. C. Boucher & Co., of St. Paul, Minn., and sent out under the name "Par 'Oidium," were all tried on beans growing in New Haven and Cheshire. The result was merely to show what could be used safely without damage to the vines, for no "mildew" appeared either on the treated or untreated vines, nor could we hear of its occurrence in the neighborhood even in localities where it has always been abundant. As usual Bordeaux mixture gives the best promise, doing no damage to the foliage or pods and adhering well.

Treatment of Grape-vines under Glass.

Early in the season we were notified that "mildew" (*Plasmopara viticola*, (B. & C.) Berl. & DeTon.) had made its appearance on Hamburg grapes grown under glass by Miss M. M. Augur of Whitneyville. A visit to the greenhouse resulted in a recommendation to apply Bordeaux mixture. The vines at this time were in very full leaf, and the flowers in bud; the former were badly mildewed and already beginning to turn brown. The Bordeaux mixture was applied twice, the proportion used being 6 lbs. of copper sulphate and 45 galls. of water, but notwithstanding this small proportion of copper the vines were badly burned, and by July it seemed as though they would prove a total loss. We then had the remains of the Bordeaux mixture thoroughly washed off with water, and as every leaf and young cluster which the mixture had spared was still more or less affected with the fungus we recommended sulphur fumes. The greenhouse was closed and the sulphur allowed to boil in a shallow dish for about five minutes. The result was the complete recovery of the vines, and a good crop of sound fruit. Our experience is worth recording as illustrating not only the deleterious effect of even weak Bordeaux mixture on the delicate foliage of greenhouse grapes, but also of the value of sulphur fumes in the treatment of plants under glass. It should also be mentioned that the previous liberal use of dry sulphur dusted on the vines had had little or no effect on the "mildew."

Quince Diseases.

"Black rot" (*Sphaeropsis Malorum*, Peck).

Last year we mentioned the occurrence of this wide-spread decay in a quince orchard in Cheshire, and recommended late spraying with Bordeaux mixture or the ammonia solution of copper carbonate. Pressure of other work prevented our proposed experiments in preventing this disease, but a study was made of the fungus itself. As has already been pointed out by Halsted,* the rot is not confined to the quince, but is common upon apples and pears, upon both of which we found it growing very abundantly. That the fungus is one and the same on all three fruits is abundantly proved by our inoculation experiments which confirm those undertaken by Halsted (l. c.). These inoculations were made both in the laboratory and in the field; quinces were inoculated with spores of the fungus on apples and *vice versa*, and in every case where the spores were introduced under the skin, or the skin injured in any way before inoculation, the fungus grew and spread with great activity. When the skin was not broken, and the spores merely placed in a drop of water on the intact surface, they failed to effect an entrance and the fruit remained sound. The conclusion is obvious. Fruit affected with this rot

* Bull. 91, N. J. Agr. Coll. Exp. Station, Dec., 1892, pp. 8–10.

falls early and is allowed to remain where it falls, being merely "rotten fruit." From this fruit the wind or other agencies carry the fungous spores, and a single apple-tree may readily infect a whole quince orchard. It is therefore necessary to say again that all such "rotten fruit," whether of quince, apple, or pear, should be carefully gathered and burned. This year the "rot" appeared in the quince orchard even though the trees had been thoroughly sprayed with Bordeaux mixture, and it therefore seemed advisable to ascertain whether the fault lay in the fact that the treatment was not made late enough, or in the resistancy of the spores to solutions of copper salts. This was readily proved by sowing spores in water and in copper solutions of various degrees of strength in moist chambers or cells. The results showed that whereas the spores germinated within a few hours in clear water and produced a dense mycelium, in water containing 0.03 per cent. of copper sulphate they failed to germinate at all. In a 0.025 per cent. solution about 10 per cent. of the spores were found to have germinated at the end of 6 hours, and about 50 per cent. in 24 hours, but the hyphæ which they produced were short and much knotted and distorted, the solution being almost fatal; in a 0.02 per cent. solution about 50 per cent. of the spores germinated in 6 hours, but as in the previous case all growth ceased within 36 hours. It is evident then that a solution containing 0.03 per cent. or more of copper sulphate is fatal to the "rot" fungus of the quince, apple, and pear. Bordeaux mixture made in the proportion of 6 lbs. of copper sulphate to 50 galls. of water contains 1.5 per cent. of the copper salt, and though changed by the action of the lime to copper hydroxide, it would be sufficient in this case, if in any, to act as a very powerful fungicide if brought thoroughly into contact with the fungous spores.

"Scab" of Quinces.

(*Fusicladium* sp.)

It is always a matter of regret to be obliged to record either a new locality for a destructive fungus, or the harmful nature of a fungus hitherto considered of little economic importance, yet we have to make this record in the following instance. Early in June a number of quince-leaves were sent to us for examination from Tolland. Some of the leaves were completely brown and dead, in others the discoloration had just begun at the tips and was spreading downwards. The letter accompanying the leaves stated that "the bushes look as if something had been thrown over them." At first the trouble seemed due to some peculiar condition of the soil or atmosphere rather than to any fungus, but careful search revealed the presence of copious fungous threads rising from the surface of the leaf, and bearing upon their tips brown, two-celled spores. The fungus resembles the common "scab" fungus of the apple (*Fusicladium dendriticum*, (Wallr.) Fckl.). It was impossible to determine the fungus with any certainty, and until another season presents further opportunities for a critical study of the species and methods of treatment, we would merely call the attention of growers to this new trouble, and recommend Bordeaux mixture as in the case of the similar "scab" of apples and pears.

Quince-leaf Miner. Plate II.

(*Aspidisca splendoriferella*).

Although it is out of the province of the mycologist to treat of injuries due primarily to insects, the damage caused this season by the larvæ of this moth in at least one locality, was so serious as to call for some notice.

About the middle of September we received from Mr. N. S. Platt of Cheshire a number of quince-leaves completely riddled with holes varying from one-eighth to a quarter of an inch in diameter. Although noticed so late, a visit to the orchard showed that the larvæ had already worked great damage, and in the end the assimilative activity of the leaves was largely checked a month or more before the usual period. Specimens of the leaves were sent to the Department of Agriculture by Mr. Platt, and we quote the following from the reply of Prof. Howard of the Division of Entomology:

"The adult insect is a little moth which lays its eggs in the leaves of apple, quince, pear, and other rosaceous plants. The egg hatches into a minute larva which mines between the two surfaces of the leaf. It then cuts through both surfaces around the edges of its mine, and fastens the edges together, leaving an orifice for its head. Finally, cutting free entirely from the leaf and leaving a round hole, the larva migrates with its case to the leaves and branches of the tree, where it passes the winter.

There is ordinarily no necessity for any remedy against this insect, as its worst work is done comparatively late in the summer. When however, they occur in extraordinary numbers it is a comparatively easy matter to scrape the cases from the trunk and main limbs, and thus greatly reduce the numbers of the potential moths of next summer. If, instead of being scraped, the tree be sprayed with strong kerosene emulsion after the leaves have fallen, most of the cases will be penetrated by the oily mixture, and the enclosed larvæ killed."

In connection with this insect injury, there were constantly two species of fungi which further increased the damage to the leaves. The more noticeable of these was a fungus apparently belonging to the genus Phyllosticta, though it was in so immature a condition that accurate determination was impossible. It presented the appearance of minute black pimples occupying the centres of round grayish spots upon the upper surface of the leaves. The other fungus, known as *Hendersonia Cydoniae*, Cke. & Ell., invariably occupied the edges of the holes caused by the Aspidisca, and rapidly invaded the adjoining tissues. Both of these fungi probably attacked the leaves after the last treatment with Bordeaux mixture had been given; nevertheless much of the latter still adhered to the leaves, often on the very spots occupied by the fungus. We therefore hesitate to recommend any line of treatment at present, except the general one of gathering and burning all fallen leaves.

Leaf-Blight of Celery.

(*Cercospora Apii*, Fres.)

Experiments were repeated this year, under our direction, by Mr. G. T. Hubbard of Middletown, to check this blight by means of certain fungicides. The fungicides used were potassium sulphide solution, a dilute solution of copper sulphate, and dry sulphur dusted on the plants. The latter treatment proved the most efficacious last year, but it was thought advisable to repeat the test and secure, if possible, conclusive results. On September 8th we received from Mr. Hubbard a number of leaves taken from plants which had received the potassium sulphide and copper sulphate treatments; they all exhibited a copious growth of the fungus in an advanced stage. The letter accompanying the diseased specimens says: "The celery on which I dusted sulphur is perfect. I see no signs of blight and I am now using sulphur on

Through the kindness of Messrs. F. P. Burr & Co., of Middletown, field experiments were made this year, but they unfortunately proved inconclusive owing to the apparently sporadic nature of the nematode attacks. Asters were grown under the following conditions. (1) On a mixture of old garden soil, sand, and ground plaster, and fertilized with superphosphate; (2) on soil thoroughly impregnated with coal-ashes; (3) on new turf land, fertilized with horse-manure and peat-moss bedding.

On none of these plots was there any sign of either the "blue aphis" or the nematodes. Last year it was difficult to find anywhere a bed of asters quite free from disease; this year, under the same conditions, the reverse was true.

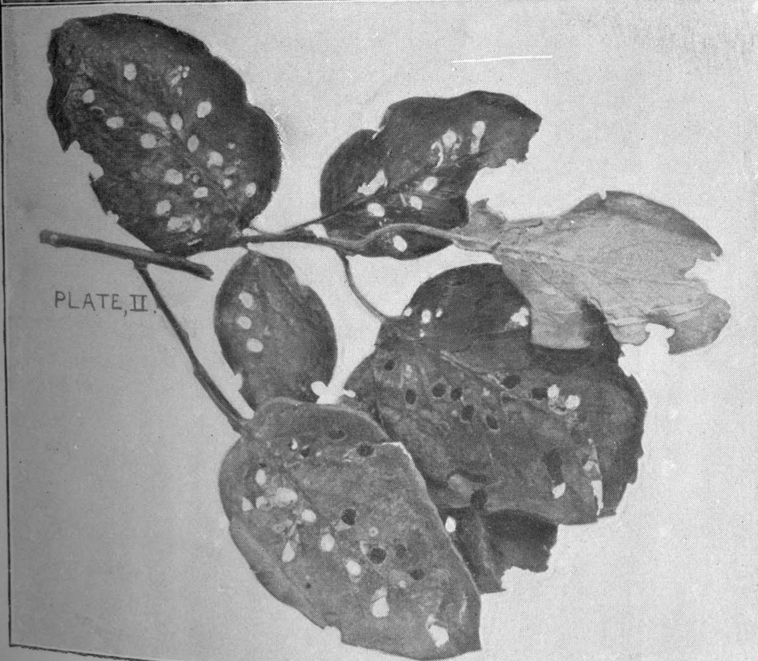
After long experience however, in the culture of asters, Mr. Burr comes to the following conclusions which are borne out by the results of recent investigations abroad. "Asters are very uncertain on old soil with stable manures, but are quite sure to prove good with *plenty* of lime and artificial manure on old land, and with artificial manure on new land."

Aster Beetles, (*Cantharis atrata.*)—This beetle was common during the past season on asters, causing great damage to the flower-heads. It is of a dull black color, of rather slender form, about half an inch in length, and provided with two long, knotted antennæ. When handled the beetles emit a yellowish fluid of disagreeable odor. They belong to the Cantharides, or "blister-beetle" family. They do not confine their depredations to asters, but are commonly found on certain species of golden-rod, and occasionally commit serious ravages on potatoes. None of the ordinary insecticides seem to be of much value in preventing the attacks of the Cantharis; a better method is to shake or brush the insects from the plants into shallow pans containing kerosene.

Fungi attacking roses.—Two fungi have been very prevalent this year on cultivated roses, the rose "rust" (*Phragmidium subcorticium*, (Schrank) Wint.), and the "black-spot" (*Actinonema Rosae*, (Lib.) Fr.). The former appears early in the season, producing on all the more delicate parts of the plant bright orange masses of spores, and characteristic distortions of the parts affected; the latter appears on the leaves as roundish black or gray spots and patches, sometimes involving the whole leaf.

Most of the "rusts" are peculiarly resistent to fungicides, but both the rose "rust" and the "black-spot" could probably be in

PLATE, I



PLATE, II.

a measure checked by the early application of the copper sulphate solution followed by Bordeaux mixture or the ammonia solution of copper carbonate, and in the case of the "rust" by cutting out unsparingly all the diseased parts of the plant.

Notes on the Bordeaux mixture.—The only trouble which, so far as we know, attends the use of Bordeaux mixture, is the clogging of the nozzle due to the large excess of lime in suspension, or rather to the presence of coarse particles in the lime. It is essential to use a large quantity of lime and for two reasons, viz:

1. To decompose all the blue vitriol, which itself would destroy the foliage it is desired to save, and to produce in its stead the mild poison—copper-hydroxide—which kills the fungus without injury to the host.

2. To take advantage of the cementing quality of slaked lime, which makes the copper-hydroxide adhere to the foliage for a considerable time.

To prevent clogging of the spraying nozzle, it is sufficient, after slaking the lime with six gallons of water and stirring well, to let the "milk of lime" stand a few minutes so that any grit or coarse matters may have time to settle, and to pour off only the fine slaked lime into the copper sulphate solution.

It was thought however, that all danger of clogging might be averted by slaking the lime with almost the whole quantity of water used for the mixture, allowing it to settle, and then pouring into the copper solution only the clear lime water. This would be feasible only if the quantity of water used to slake the lime could dissolve enough of the latter to precipitate all the copper sulphate. If any of the sulphate remains in solution there is, of course, danger of burning leaves to which it is applied. This method was tried, using the proportions most commonly recommended; the greater part of the water was used in the slaking of the lime, and only the clear solution after being allowed to settle for twenty minutes was poured into the sulphate solution. In no case was the latter completely precipitated. In order to test the adhesive quality, several gallons of the mixture were made up by this method; and a like quantity by the usual method, using a large excess of lime in suspension. The mixtures were applied simultaneously to two sets of vines, where the superiority of that containing an excess of lime was readily demonstrated in its adhesion to the foliage two weeks longer than the other and through one heavy rain.

COMMON FUNGOUS DISEASES AND THEIR TREATMENT.*

BY WILLIAM C. STURGIS.

Two years ago the demand on the part of the farmers and fruit-growers of the State, for a concise and untechnical statement concerning the more common fungous diseases, the means of recognizing them, and the methods of treatment, was answered by Bulletin No. 111. The science of economic mycology makes rapid progress, fungous diseases hitherto unknown in a certain locality become prevalent, and the experiments of a year may so far increase our knowledge, that in order to secure the best results from the use of fungicides, we must be prepared to keep abreast of the latest investigations, and modify our methods accordingly. It has therefore been decided to publish this revised edition of Bulletin 111, only such changes from the latter publication being made, as subsequent experience has proved advisable.

DISEASES OF THE APPLE.

"SCAB." [*Fusicladium dendriticum*, (Wallr.) Fckl.]

This disease attacks the leaves and fruit of the apple, producing roundish or irregular blotches on the upper surface of the leaves, and on the fruit. These blotches are of a dark greenish-brown color, and of a more or less velvety texture. The growth of the fungus causing these blotches does not tend to produce any rapid or widespread decay in the fruit, but it does stunt and distort the fruit, rendering it to a greater or less degree unsightly and unmarketable. The "scab" should not be confounded with the diseases known as "bitter-rot" and "black-rot," both of which tend to produce rotten areas in the fruit.

Treatment.

Inasmuch as the "spores" or fruit of the "scab" fungus pass the winter in the fallen leaves beneath the trees or in the cracks and

* The following matter regarding fungous diseases and their treatment was first published in 1892 as Bulletin No. 111. It was revised and issued as Bulletin No. 115 in March, 1893. It is now made part of this Report with such slight emendations and changes as seem desirable.

crevices of the bark, collecting and burning the leaves in winter is of great assistance in controlling the disease, and a winter treatment in the form of a strong wash or spray applied to the trees is most desirable. The material used is a strong solution of either sulphate of copper, 1 lb. to 25 galls. of water, or sulphate of iron, 1 lb. to 5 galls. of water. This application is best made by means of some form of spraying apparatus, and should be used in early spring before the buds have begun to swell.

This should be followed up by a summer treatment, consisting in the application of either the Bordeaux mixture or modified Eau céleste. Formulas and directions for the preparation of these and other fungicides are given on pp. 103–105. The Bordeaux mixture presents one very decided advantage over the modified Eau céleste, in that it contains no ammonia, hence does not dissolve the arsenic compounds, and can therefore be used in conjunction with Paris green or London purple to prevent the attacks of the codling moth as well as of the "scab" fungus. The mixture should be made in the proportion of one pound of the arsenic compound (Paris green or London purple) to 100 gallons of the Bordeaux mixture, the former being stirred to a smooth paste with a little water and added to the latter.

Time of application.

In applying fungicides for apple "scab," it should be remembered that early treatment is extremely important. The winter treatment with sulphate of copper or of iron should take place late in March or very early in April, before the buds begin to swell. The first application in the summer treatment should be made just before the flowers open, a second as soon as the fruit is set (for this application and the following, Paris green may be mixed with the fungicide to destroy the eggs of the codling moth), and a third when the fruit is half grown. The winter treatment, followed by these early summer applications, if carefully and thoroughly made, will be found as efficient as a number of applications later in the season. Prevention is always better than an attempted cure.

DISEASES OF THE PEAR.

"LEAF-SPOT." (*Entomosporium maculatum*, Lév.)

This disease attacks the leaves and fruit of both the pear and the quince, producing on the leaf yellowish or reddish spots marked in the center by minute black pimples. The affected leaves fall prematurely, generally by the first part of July, the tree suffers in consequence, and may eventually die from the effects of repeated premature defoliation. Upon the fruit the spots produced by the fungus are not usually as prominent as upon the leaf, but the early falling of the leaves, and the presence of the fungus upon the fruit, causes the latter to become stunted, often badly cracked, and quite unfit for the market. In this State more damage is done to pears by the pear "scab," while quinces suffer more seriously from this "leaf-spot."

Treatment.

Collecting and burning the fallen leaves and fruit after harvest, and a treatment of the trees early in April with a strong solution of sulphate of copper as recommended for apple "scab," tends largely to check the spread of the disease. For the summer treatment either the Bordeaux mixture or the modified Eau céleste will be found effective. The latter is more expensive than the former, and as stated above it cannot be used in connection with the arsenical insecticides without seriously endangering the foliage, but, being a clear solution, it can be applied with great ease, and for late applications is to be preferred to Bordeaux mixture as it does not spot the fruit.

Time of application.

The winter treatment should be made early in April; the first spraying with the Bordeaux mixture or the modified Eau céleste should be made just before the blossoms open; a second, as soon as the blossoms have fallen; and either two or three more at intervals of ten days to three weeks according to the rainfall.

"SCAB." [*Fusicladium pyrinum*, (Lib.) Fckl.]

The fungus causing this disease is very closely related to that causing the apple "scab," and the effects of the two are very similar. Upon the pear, as upon the apple, the fungus produces dark brownish patches of a velvety texture on the leaves and fruit. Cool, damp weather is in both cases favorable to the spread of the disease.

Treatment.

A spray of sulphide of potassium, used in the proportion of one ounce to two gallons of water, has been recommended, but is probably not as effective as the Bordeaux mixture, or the modified Eau céleste. The first application should be made when the flowers are beginning to open, a second when the fruit is about the size of peas, and additional applications every two weeks until five or six in all have been made.

DISEASES OF THE QUINCE.

"LEAF-SPOT." (*Entomosporium maculatum*, Lèv.)

This is the same fungus which causes the "blight" or "spot" of the leaves of the pear, and the cracking of the fruit. In the case of the quince the most marked effect of the fungus is upon the leaves, which blight and fall prematurely, hence the first effect of remedial measures is seen in a vigorous, healthy leafage, and in severe cases a good set of fruit is only secured after spraying for two seasons.

Treatment.

In treating the disease as it occurs on quince trees, experience seems to show that in the end, and taking into consideration the much greater success attending its use, the Bordeaux mixture is preferable to any other fungicide. The use of the Bordeaux mixture is also to be recommended because it permits of admixture with Paris green as a remedy against the quince "maggot." The Paris green should be mixed to a smooth paste with a little water, and then stirred into the Bordeaux mixture in the proportion of one pound of Paris green to 100 gallons of the mixture.

This treatment should be supplemented by the gathering and burning of the fallen leaves, and by the winter treatment with sulphate of copper or sulphate of iron as recommended in other cases, p. 89.

The proper times for making the applications are the same as in the case of the "leaf-spot" of the pear, p. 90.

"BLACK-ROT." (*Sphæropsis Malorum*, Peck.)*

This disease, which also attacks apples and pears, has only recently made its appearance on quinces in this State, but it bids

* See Bull. 91, N J. Agr. Exp. Sta., p. 8.

fair to become a serious trouble to quince growers unless speedily checked. It makes its appearance in August, as a discolored spot, usually on the exposed side of the fruit. The spot spreads rapidly, both superficially and in the interior of the fruit, until the whole fruit becomes brown, decayed, and shrunken, and often badly cracked. The disease once seen, is unmistakable.

Treatment.

The fungus producing the disease in question is nearly related to others which have been carefully investigated, so that it is fair to presume, although the presumption rests upon no definite experiments as yet, that a continuation through August of the application of Bordeaux mixture will effectually prevent the disease. If it is found that this mixture is liable to remain upon the fruit at the time of harvest, the modified Eau céleste or the ammoniacal solution of copper carbonate may be substituted for the Bordeaux mixture with probably quite as good results.

All diseased fruit should be gathered and burned at and after the time of harvest, and if apples or pears are grown in the neighborhood the disease should be carefully looked for upon them and no diseased fruit should be allowed to lie on the ground or remain upon the trees.

DISEASES OF THE PEACH.

Practically the only disease of peach trees which at present seriously threatens the fruit interests of Connecticut is that known as "yellows." It is impossible to give within the limits of the present Bulletin even a brief outline of the investigations which have been made on the cause or causes of this malady. It is sufficient to say that as yet no definite cause has been ascertained with any certainty, and no means have proved effective in checking the spread of the disease except rooting out and destroying by fire every tree which shows the first symptoms of the disease. Constant study has however, given us certain general facts relative to the disease.

(1)* The first manifestation of "yellows" is the premature ripening of the fruit. The moment this symptom is seen, though the tree is to all appearance sound and healthy otherwise, it must go, if the spread of the disease is to be checked. There are no authentic instances of trees recovering after the appearance of this symptom.

* These conclusions are based upon the publications of Prof. E. F. Smith, referred to on the next page.

(2) The second evidence of a diseased condition is the premature development of winter buds, producing spindly growths and sickly green leaves. All the other symptoms of "yellows" are due primarily to these two.

(3) The period of incubation, i. e. the time elapsing between artificial inoculation and evident symptoms of disease, is considerable; after the appearance of symptoms the tree may live from one to five years, and even produce fruit during the early stages of the disease.

(4) The whole tree is affected when symptoms appear in any part of it, hence

(5) Pruning has little or no effect on the spread of the disease. If a single diseased tree is allowed to remain in the hope that it will bear fruit for at least one more year, not only are the adjoining trees endangered but the whole orchard and even adjoining orchards may become infected.

(6) There is no question that the disease can be communicated from one tree to another, though how it is communicated, that is, the nature of the contagion, is as yet unknown. It may be communicated even by apparently healthy buds when these are taken from diseased trees, but it is also conveyed in some other way than by bud inoculation, certainly in the case of old trees. Finally the trees are not infected through the blossoms.

(7) The use of special fertilizers has never cured a tree, though heavy fertilizing may, by increasing the vigor of the tree, enable it to withstand longer the effects of the disease.

(8) It is possible to grow healthy trees in the identical spot from which a diseased tree has been taken. This has been the practice of growers in Michigan and the disease has been almost completely eradicated. In other States however, notably in Delaware, the practice has not proved so advisable, and on the whole it seems to be at least unsafe to set out a new tree on the spot where a diseased tree has recently been rooted out.

For further details on this subject the reader is referred to Dr. Erwin F. Smith's exhaustive treatises, Bulletin No. 1, U. S. Dep't of Agric., Division of Veg. Path., and Bulletin No. 9, U. S. Dep't of Agric., Div. of Bot., to which publications we owe most of our knowledge concerning peach "yellows." A complete summary of the present status of the subject will be found in U. S. Dep't of Agric., Div. of Veg. Path., Report for 1892, p. 235 *e. s.*

DISEASES OF THE PLUM AND CHERRY.

"Black Knot." [*Plowrightia morbosa*, (Schw.) Sacc.]

This disease attacks the smaller limbs and twigs of wild cherries and plums as well as of the cultivated varieties, producing on them jet black, wart-like growths. At first these growths are small and do but little damage, but they increase rapidly in size; by inducing a morbidly active growth of the tissue of the branch on the side upon which they are growing, they produce a distortion of the branch; and finally, surrounding the branch completely, they produce death. It is not rare for a whole tree to be killed by this disease in the course of two seasons. The black "knots" are largely composed of the fruiting part of a fungus, the vegetative part of which is buried in the tissues of the branch, and occupies a distance of three to five inches above and below the "knot" itself.

Treatment.

After the disease has once obtained a good hold upon the larger branches of a tree it is well nigh impossible to eradicate it. Its spread can be stopped however, if it is taken in hand early, or when the "knots" are still small and few in number.

With a sharp knife the knots should be cut out, the portion removed extending three or four inches above and below the "knot" itself. The wound should then be washed, or the whole tree sprayed, with a strong solution of sulphate of copper, and then painted over with some oil paint.

In place of the oil paint, a paste made of kerosene and some colored pigment, or of turpentine and lime, has been used frequently with marked success even when applied directly upon the "knots" without cutting them out. It is always surer and safer however, first to cut the "knots" out and then to apply the paint or paste to the cut surfaces.

The spores of this fungus mature and are distributed from the latter part of December to February; the best season therefore for cutting out the "knots" is November or early in December.

The young "knots" appearing in the spring, bursting through the bark in greenish swellings, may be cut out at that season. If the whole tree is badly diseased it should be cut down at once and burned; and the same applies to the individual "knots." If allowed to remain on the ground they will infect healthy trees as readily as though they were still on a living tree. Wild cherries which are diseased should be subjected to the same treatment, or destroyed altogether.

"Mould." (*Monilia fructigena*, Pers.)

This disease attacks the stone-fruits, such as the peach, plum, and cherry, and sometimes the apple and pear. Its first effect is to induce a brown discoloration of the fruit accompanied by a copious production of ash-colored, dusty tufts on the surface of the fruit; these tufts are the fruiting threads of the fungus. Later the fruit becomes shrunken and dry, and in this "mummified" condition may remain for a long time without decay. Not infrequently the whole fruit becomes encased in a layer of brownish dust consisting almost entirely of the spores of the fungus.

Treatment.

The most practical method of checking the spread of the disease is by burning all diseased or "mummified" fruit. It is in this dried fruit that the fungus threads pass the winter. With the advent of warm weather the threads produce spores in immense quantities upon the remains of the fruit, and the fresh crop of fruit becomes readily infected. Hand-picking and burning all diseased fruit, both on the tree and on the ground, is therefore the surest method of combating the disease. It occasionally attacks both the leaves and twigs as well as the fruit, and in such a case again the best remedy is picking and burning the diseased parts.

Merely as an adjunct to this method of dealing with "brown-rot," treatment of the trees and subjacent ground with the simple solution of copper sulphate as recommended for apple "scab," etc., would undoubtedly be of benefit. This treatment should be given during the last of March or the first part of April, and may be followed during the summer by applications of the ammonia solution of copper carbonate, or weak Bordeaux mixture.

Note.

If Paris green in water is used upon plum-trees to prevent the destructive attacks of the curculio, the danger of burning the foliage can be avoided by adding lime to the insecticide, in the proportion of 1 lb. to 50 galls.

DISEASES OF THE GRAPE.

"BLACK-ROT." { *Phyllosticta Labruscæ*, Thüm.
Phoma uvicola, B. & C.
Læstadia Bidwellii, (Ell.) Viala & Ravaz.

This well known disease usually appears first upon the leaves and young shoots, producing reddish-brown or blackish spots. About two weeks later the berries are attacked, the first evidence of this being a black or brownish spot at one or more points on the surface. Soon the whole berry turns brown, then black, and finally becomes hard and leathery, while still remaining on the stalk. A magnifying glass reveals on the surface of the diseased berries minute black pimples, within which the several forms of spores produced by the fungus are borne.

Treatment.

Warm, damp weather is especially conducive to the spread of the disease, so that during such weather the vines will require constant care. The first precaution to be taken in the spring consists in ploughing or cultivating between the rows so as to turn under or cover any diseased grapes which may have fallen the previous year.

Treatment of the vines immediately after pruning, with the strong solution of sulphate of copper is advisable (p. 89); but more important is the summer spraying with the Bordeaux mixture.

Experiments conducted in 1891 by the U. S. Dep't of Agric. indicate that the Bordeaux mixture reduced to even one-sixth the usual strength (see Formula 2, p. 103, of this Report), is thoroughly effective against "black-rot," and of course the expense is much less.

If the Bordeaux mixture is used throughout the season there is danger of some of the dried copper compound remaining on the berries when harvested, and this damages the appearance of the ruit, though the quantity of copper is too small to produce any injurious effects from eating the grapes. This staining of the fruit may be remedied by using the ammoniacal carbonate of copper for the last two sprayings instead of the Bordeaux mixture.

Time of application.

Early treatment is indispensable to success. The appearance of the first leaves should be the signal to begin spraying. Make the first application then, repeat it just before the vines begin to bloom, follow it up with a third as soon as the vines have finished blooming, and repeat at intervals of twelve or fifteen days according to the weather, until the berries are half grown. The most critical period in this climate is about the last of June; the spraying at this time should therefore be especially thorough and careful. According to the experience of the Department of Agric., "six treatments, the last two after the grapes were practically grown, gave little better results than four, the last being made when the berries were the size of bird-shot." Of course the frequency of the applications must depend largely on the weather.

"DOWNY MILDEW." [*Plasmopara viticola*, (B. & C.) Berl. & De Ton.]

The fungus producing this disease is more disastrous to the vines themselves than the fungus of "black-rot," inasmuch as it attacks the leaves, causing them to turn brown and fall prematurely. Later it may attack the berries. The latter do not dry and shrivel as in the case of "black-rot," but they assume a grayish tint, the surface becomes discolored in places especially near the stem end, and finally, decay accompanied by a uniform brown color destroys the fruit. On the leaves the disease is readily recognized by the grayish, downy, or furred appearance produced on the under surface of the leaves by the fruiting threads of the fungus. This downy form of the disease may also attack the berries, and under such circumstances is unmistakable.

Treatment.

The same treatment is to be recommended for the "downy mildew" as for "black-rot." If the vines are treated for the latter the same treatment will suffice for both diseases.

"Anthracnose" (*Sphaceloma ampelinum*, DeBary).

This disease attacks the canes, leaves, and berries. On the leaves it produces small brownish spots with a slightly raised border. Later these spots become gray in the center and often separate from the surrounding healthy portions of the leaf, leaving the latter full of round ragged holes. On the canes the effect is similar except that the spots often become confluent, producing large elongated diseased areas of a grayish color and slightly flattened or depressed. On the berries the spots are more nearly circular, and their appearance, gray in the center with a reddish surrounding circle and a dark border, gives to the disease the common name of "bird's-eye rot."

Treatment.

The best remedy for "anthracnose" is to wash or spray the vines after pruning, and before the buds begin to swell in the spring, with a strong solution of sulphate of copper, using one pound to ten gallons of water. "Anthracnose" is not liable to do much damage in vineyards that are well treated for "mildew" or "black-rot," especially if the vines are severely trimmed.

DISEASES OF THE RASPBERRY AND BLACKBERRY.

"Anthracnose." (*Glœosporium Venetum*, Speg.)

The "anthracnose" produces on the canes, small round or elongated whitish patches, slightly flattened and bordered with a ring of dark purple. These patches gradually increase in size and number, and finally destroy the new growth or stunt it badly. Upon the leaves it is often visible as very small yellowish spots surrounded by a dark border, resembling those on the canes but much smaller. The fungus producing the disease passes the winter in the diseased canes and leaves, a fresh crop of spores is produced from the old spots in the spring, and the new canes and foliage are readily infected.

Treatment.

As in the case of the grape "anthracnose," cutting out all diseased wood and burning it will gradually eradicate the disease. It should be cut out in winter or very early spring, below the lowest diseased spot. If the canes are then sprayed with a solution of sulphate of copper, using one pound to twenty-five gallons of water, and if necessary sprayed two or three times during the summer with Bordeaux mixture, very little damage is to be feared from the "anthracnose."

DISEASES OF THE STRAWBERRY.

"Leaf-blight." (*Sphærella Fragariæ*, Sacc.)

This disease is characterized by the appearance of reddish areas on the upper surface of the leaves. Later there appear in the center of these discolored areas gray or whitish spots, upon which in autumn and winter are developed several forms of the reproductive bodies or spores of the fungus which causes the discoloration of the leaf.

Treatment.

By annually renewing the settings, and planting only in deep and thoroughly drained soil, the loss from blight will be very largely diminished. Removing and destroying all the old leaves after harvesting, followed by cultivation, and the application of a quick fertilizer, is a process which has produced good results.

A more simple method which has been adopted with complete success by certain growers in this State, is as follows:—As soon as the berries are picked, run a mowing machine over the bed, cutting all the leaves close above the ground. As soon as the leaves and old mulch are dry enough, set fire to them and burn the bed over. If necessary, loosen up the old mulch a little with a fork before burning and put on more where it is scanty, in order to secure as even a burn as possible. Unless a severe drought follows, the plants soon put up a new, vigorous, and healthy growth; mulch as usual in the autumn. In a dry season this method must be used with caution, but if the burning is followed by rain, the process has in all cases proved a complete cure for the "leaf-blight."

DISEASES OF THE ONION.

"Smut." (*Urocystis Cepulæ*, Frost.)

This disease attacks the onion seedling, appearing as dark spots or lines in the leaves. Later, and as other leaves develop and become attacked, these spots begin to crack open longitudinally, exposing the fungus with its spores as a black, powdery mass. If the disease is not checked by the natural withering of the leaf first attacked, it spreads throughout the plant, affecting even the bulb, on which it produces black, linear elevations, running down to the base of the bulb and extending up into the leaves.

Treatment.

The only treatment, except rotation and transplanting, which has ever been recommended for onion "smut," is that suggested in the Reports of this Station for 1889 and 1890. It consists in sowing in the drill, with the seed, either a mixture of equal parts of sulphur and lime, or of sulphide of potassium and lime. The experiments which led to this suggestion were made on very smutty land, and increased the yield in a ratio of about 5 to 1. They were merely preliminary and therefore not decisive, but the result certainly seems to warrant a repetition of the experiment. The details will be found in the Reports referred to. It seems probable now that the measure of success attending this treatment will hardly warrant its very extended adoption, and that onion growers in this State, as elsewhere, will have to adopt the method of starting the plants from seed in cold frames, and transplanting to the field. This method is laborious, but the additional labor is compensated for by an earlier harvest, and very superior bulbs.

To lessen the danger of spreading the disease it should be noted that all implements used in smutty ground should be thoroughly washed before being used in clean ground; that all refuse left on the field from a crop infected with "smut," should be collected and burned; that when it is possible, onion land should be burned over in the fall; and that at the second and subsequent hand-weedings, all onions which show the "smut" should be pulled and burned at once.

DISEASES OF THE POTATO.

"MILDEW" OR "ROT." [*Phytophthora infestans*, (Mont.) DeBary.]

This disease first appears as a premature wilting of the tops of the vines. The color rapidly changes to yellow and then to a dirty brown. On the under side of the leaf in these diseased portions, is seen a delicate whitish mould, the fruiting threads of the fungus. The disease spreads quickly, inducing a very rapid and characteristic decay in the plants, and if not checked, the fungus causing the decay makes its way to the tubers and affects them, producing the well-known "rot."

Treatment.

If applied in time, the Bordeaux mixture is an effectual preventive of potato "rot." It should be applied whether the disease appears or not, since it is a preventive rather than a cure. If the potatoes have been affected in previous years, or if the attack is sudden and severe, Formula No. 1, p. 103, should be used.

Time of application.

The first application should be made when the plants are about half grown, and it should be repeated every ten or twelve days until the tops begin to wither. If it is desired at the same time to treat the vines for the "potato bug," Paris green may be used with the Bordeaux mixture by stirring the former to a smooth paste in water and adding it to the latter in the proportion of one pound of Paris green to 100 gallons of the mixture. As a rule, treatment for the "potato bug" will have to be begun much earlier than for the "rot." It may be more convenient however, and it can do no harm, to begin treatment with the combined fungicide and insecticide at the earlier date when the "potato bug" first appears. There is no doubt that potato vines derive from the treatment with Bordeaux mixture an increase of vitality beyond that due to the prevention of the "rot" alone, although it is not yet fully known to what characteristic of the Bordeaux mixture this beneficial action is due.

"MOULD." (*Macrosporium Solani*, Ell. and Mart.)*

This fungus usually appears in connection with injuries to the leaves caused by the flea-beetle and other insects. Its most serious attacks are confined to early potatoes, and induce dead, blackened areas, usually beginning at the tips or edges of the leaves. The parts attacked soon die and become curled or shriveled. The fungus is confined to the tops, and does not directly affect the tubers.

* *Cf.* Vt. Agric. Exp't Station, Report for 1892, p. 66, *e. s.*

Treatment.

This disease can probably be held in check by early applications of Bordeaux mixture, though results of definite experiments to this end are as yet wanting.

"SCAB." (*Oospora scabies*, Thaxter.)*

The eroded pits on the surface of potato-tubers, caused by the growth of this minute fungus, are too familiar to require any extended description here.

Treatment.†

Dissolve two ounces of corrosive sublimate (bichloride of mercury) in fifteen gallons of water. Immerse the seed potatoes in this solution for 1½ hours. Spread them out to dry, then cut and plant as usual.

Note.—Corrosive sublimate is a fatal poison if taken internally. It also corrodes metallic substances, and the solution should therefore be made in wooden vessels.

DISEASES OF THE TOMATO.

"MOULD." (*Cladosporium fulvum*, Cke.)

This fungus forms rusty-brown patches on the under side of the leaves, inducing a yellowing and wilting, usually followed by the death of the leaf attacked.

Treatment.

Inasmuch as warmth, moisture, and insufficient circulation of air are all factors in the spread of this disease, training the plants on sticks or trellises to keep them off the ground, and pruning away all the lower branches and leaves so as to allow of the free access of sun and air, will to a great degree prevent the disease. Should it still prove harmful however, either the Bordeaux mixture or the ammoniacal carbonate of copper will be found effective.

* *Cf.* Conn. Agric. Exp't Station, Report for 1890, p. 81, *e. s.*

† *Cf.* N. Dak. Agric. Exp't Station, Bull. 9, 1893, p. 32.

"POTATO-ROT." [*Phytophthora infestans*, (Mont.) DeBary.]

This fungus which does so much damage to potatoes frequently attacks tomatoes also. Its general effect is the same in both cases, and it may be controlled by the same means.

DISEASES OF CELERY.

"LEAF-SPOT." (*Cercospora Apii*, Fres.)

This disease attacks the leaves of celery, forming upon them discolored spots and blotches. Sometimes almost the whole leaf becomes involved, the blotches presenting a more or less pale and watery appearance.

Treatment.

The ammoniacal solution of copper carbonate has been used with some success against this disease, but from our own experience we would recommend the use of sulphur. A warm, sunny day should be chosen, and the sulphur dusted upon the plants, at the rate of about 2 lbs. to 1200 plants for each application. The application should be made four times, at intervals of ten days or two weeks.

NOTE.—The treatment should be begun as soon as the disease makes its appearance. Great care should be exercised in selecting seedlings. Seedlings already affected with the disease are frequently offered for sale by retail dealers. Buy only from reliable, first-class seedsmen.

THE PREPARATION OF FUNGICIDES.

BORDEAUX MIXTURE.

Formula 1.

Sulphate of copper ("blue vitriol," "blue-stone")	2¼ lbs. or 6 lbs.
Quick lime	2 lbs. or 4 lbs.
Water	22 galls. or 45 galls.

Formula 2.

Sulphate of copper	1 lb.
Quick lime	1 lb.
Water	22 galls.

Pulverize the sulphate of copper and dissolve in 2 galls. of water heated to hasten the solution.* Dilute this solution with 14 galls. of water. Slake the lime (which should be fresh, i. e. not partly air-slaked) with 6 galls. of water, adding the latter slowly and stirring to a smooth cream. Allow this mixture to stand a short time, then stir it and pour it slowly into the copper sulphate solution, stirring rapidly during the operation. *Never pour in any of the coarser sediment which settles readily to the bottom.*

This mixture should be made fresh for each application in order to secure the best results.

Formula 2 is, of course, cheaper than Formula 1, and is quite as effective against "black-rot," and "mildew" of the grape, and "leaf-blight" of the tomato.

AMMONIACAL CARBONATE OF COPPER.

Carbonate of copper	5 oz.
Aqua ammonia (strong)	3 pts.
Water	45 galls.

Mix the carbonate of copper to a thick paste with water. Dissolve this paste with 3 pts. of ammonia, or if that is insufficient to dissolve all the carbonate, add a little more. Dilute with water to 45 galls.

The strong, undiluted solution may be made and kept in stock, to be diluted and used as needed.

The carbonate of copper can be made more cheaply than it can be bought by dissolving in one barrel 3½ lbs. of carbonate of soda (sal soda) in one gallon of hot water, and in another barrel 3 lbs. of sulphate of copper in two gallons of hot water. When the solutions are complete, and *cool*, pour the sal soda solution slowly into the copper solution, stirring continuously. A heavy green precipitate will result, consisting of carbonate of copper. Now fill the barrel up with water, let the carbonate settle at the bottom, and then siphon off the clear water. Repeat the operation once. Finally, strain out and dry the carbonate of copper, of which there will be found to be 1½ lbs.

Prepared in this way the copper carbonate will cost about 18 cents per pound.

* In case the larger proportions in formula 1, are used, double the amount of water must be used in each step of the preparation.

MODIFIED EAU CÉLESTE.

Sulphate of copper ("blue-stone")	4 lbs.
Carbonate of soda	5 lbs.
Aqua ammonia (strong)	3 pts.
Water	50 galls.

Dissolve the sulphate of copper and the carbonate of soda in warm water in separate vessels. When completely dissolved and cool, mix the two, stirring continuously. Add the ammonia until a clear solution is obtained, and dilute with water to 25 gallons.

The solution can be made more adhesive and therefore more effective by the addition of 3 lbs. of soap dissolved in hot water, or 5 lbs. of molasses to every 25 galls. of the solution.

COST OF MATERIALS.

The following are the approximate wholesale prices of the chemicals most commonly used as fungicides.

Lime	per bbl. (300 lbs.)	$ 1.65
Sulphate of copper (granulated)*	" (450 lbs.)	18.00
Sulphate of iron	per lb.	.01
Carbonate of copper	"	.42
Carbonate of soda	"	.02
Sulphur (flowers of sulphur)	"	.02
Sulphide of potassium (liver of sulphur)	"	about .12
Aqua ammonia (26°)	"	.08

SPRAYING APPARATUS.

PUMPS.

For spraying on a large scale where a large portable receptacle is needed, a strong force-pump which can be mounted on a barrel and drawn from place to place, is a great saving of time and labor. A pump well adapted to this purpose is "Gould's double-acting spraying pump" fitted with couplings on both sides which allows of the simultaneous use of two sets of hose, and the spraying of two orchard rows at the same time. This pump, which is powerful, simple, and compact, is made by the Gould M'f'g. Co., of Seneca Falls, N. Y. An equally good pump for use under the same conditions is manufactured by W. & B. Douglas, of Middle-

* The Nichols Chemical Company, 45–49 Cedar St., New York City.

town, Conn. The mixture may be kept stirred by means of a disk of wood screwed to the end of a broom-handle and inserted through a hole in the top of the barrel.

For spraying on a smaller scale, or where a mounted barrel cannot be driven, some form of "knapsack" sprayer is convenient if not essential. Many forms are advertised, all made on the principle of combining with a small force-pump, a tank or receptacle to be carried on the back. A very perfect machine of the kind is known as the "Galloway Knapsack Sprayer." The Messrs. Douglas, of Middletown, are prepared to furnish this sprayer, or one very similar to it.

If the area to be sprayed requires but six or eight gallons of the liquid, as e. g. in greenhouse work, or when only a few plants or vines are to be treated, a most serviceable pump for attaching to a pail is the Johnson pump, sold for $4.50 by Cordley & Hayes, 173–175 Duane St., New York City. If the nozzle sent with this pump is removed and replaced by a piece of ⅜-in. hose, 6 or 8 ft. long, provided with a Vermorel nozzle, a most effective and convenient means of spraying on a small scale is procured.

Nozzles.

It is hardly necessary to say, after so much has been written and said on the subject, that for the proper application of fungicides a rose nozzle or an ordinary sprinkler is not sufficient. Several spraying nozzles have been devised of which only two need be mentioned here, the Nixon and the Vermorel.

In the Nixon nozzle the liquid is driven through a fine gauze cap and issues in a copious, smoky spray. For use with clear liquids it is unsurpassed. With mixtures however, like the Bordeaux mixture which contains lime in suspension, this nozzle is liable to clog and is not readily cleaned.*

The Vermorel nozzle works equally well with clear solutions and with liquids having substances in suspension, it delivers a fine and abundant spray, and is on the whole the most serviceable nozzle for general work with which we are acquainted.

A very useful adaptation of the Vermorel nozzle, called an "Undersprayer," is manufactured and sold by Messrs. Wm. Boekel & Co., 518 Vine St., Philadelphia, Pa. The nozzle is attached to a brass pipe, 3 ft. long, by a union-joint, which allows of its being turned and the spray applied directly upwards or in any required direction. It is of special use in spraying grapevines for "mildew." The advertised price of the "Undersprayer" is $1.75.

* This nozzle may be procured of the Nixon Nozzle and Machine Co. of Dayton, Ohio, at $1.00 each.

Hose.

It is often necessary in directing a spray at some distance from the ground, to use a greater length of hose than would ordinarily suffice. The best kind for the purpose, as for any light discharge pipe, is what is known as ¼-in. or ½-in. "linen insertion tubing." The hose should be attached to a light pole of sufficient length to reach above the foliage to be sprayed, so that the spray may be directed downwards upon it. A simple means of accomplishing this is to tie the nozzle and the end of the hose carrying it, to a stick a foot or so long which is riveted or screwed to the end of the pole in such a way as to turn parallel to the plane of the pole. Thus the nozzle can be directed either downwards or upwards as desired.

The following quotations for spraying pumps and accessories are furnished by Messrs. W. & B. Douglas of Middletown, Conn. The quotations are on goods ordered directly from their factories at Middletown, and the prices are *net:*

Double-acting Spraying Pump (similar to Gould's) with all brass piston and brass outer cylinder*	$9.50
—— Double-acting Spraying Pump (similar to Gould's) with all brass piston and iron outer cylinder, fitted with leather valves	5.00
—— The same, fitted with metallic valves	6.50
Three feet suction hose for same with couplings and brass strainer	2.25
Single couplings for ¼-inch hose	.25
Y-coupling " "	1.00
Vermorel Nozzle (2 caps with coupling for ¼-inch hose or with large standard coupling as desired)	1.25
The Messrs. Douglas will also be prepared to furnish Prof. Galloway's Knapsack Spraying Pump with planished copper tank and copper cover, for about	11.00

Quotations for tubing given by the Goodyear Rubber Store, F. C. Tuttle, prop., 866 Chapel St., New Haven.

* For use with the copper compounds it is advisable to have all the parts of the pump, including the outer cylinder, made of brass, as these compounds corrode iron.

½-inch linen insertion tubing (lots of 100 feet or more) per foot	.08
" " " " (lots of 50 feet or more) per foot	.10
" " " " (lots of less than 50 feet) per foot	.12
⅝-inch heavy rubber tubing, per foot	.18

A PROVISIONAL SPRAYING CALENDAR.

The following provisional calendar is given here at the request of several fruit-growers. It is manifestly impossible to give with any degree of accuracy the exact dates upon which fungicides should be applied. The fact that we sprayed last year on certain dates, by no means presupposes that those dates will be suitable the coming season.

Seasonal variations between two successive years, and the varying conditions of rain-fall from one season to another, are often so great that the exact date of any farm operation cannot be known beforehand. The following table is therefore merely approximate, to be modified by the exercise of common-sense.

January and February.

But little can be done during these mid-winter months in the way of spraying, though a great deal by way of preparation. If it has not been already done at the proper time, cut out and burn the "black knot" of plum and cherry now, and destroy all neighboring wild cherries which are knotty.

In the latter part of February do all necessary trimming of vines and fruit trees, unless this has been done in the autumn, as is often the case. Where "anthracnose" has previously attacked grape-vines, raspberries, or blackberries, prune severely, cut out every trace of diseased wood or cane and burn it. The increased vigor obtained by the free access of light, air, and ventilation will compensate for the severe pruning.

In open winters, February is none too early to go over the orchard carefully and collect and burn all leaves and fruit from diseased trees, such as mummified cherries, plums and peaches, scabby or rotted pears and quinces, and all blighted leaves. Remember that on the first warm day the air will be full of the germs of plant disease from these fruits and leaves, if they are not destroyed. Do not use them for bedding or mulch, and do not throw them into the pig-pen.

March.

The middle or end of this month will see everything ready for winter treatment (copper sulphate, 1 lb. to 25 galls. of water). Select a warm day, or if possible, several days of warm, melting weather. In some seasons winter treatment can hardly be made before April. This treatment is especially good for diseases of apple, pear and quince, for "anthracnose," and for the "black-rot" of grapes. Where the latter has occurred the previous year, ploughing between the rows in order to cover up diseased berries will be found of great advantage. If plums and cherries suffer in summer from lice, spray the trees now with kerosene emulsion to destroy the eggs.

April.

Put all spraying apparatus in thorough order. Clean and rinse pumps, oil all bearings, see that the valves work well, and test the tubing for leaks.

If the winter treatment has been deferred until this month, see that it is finished before the middle of the month.

May.

This is usually the flowering month for vines and fruit trees, and the first application of Bordeaux mixture or other fungicide should immediately precede the opening of the flowers. Use your own judgment. Apples and pears are generally in bloom by the second week in May; quinces and grapes usually not until somewhat later. The importance of these early treatments can hardly be overestimated. Watch to see when the petals begin to fall, and make a second application within a few days after that date.

During the last part of May examine carefully the plum and cherry trees. The young "black-knots," now of a greenish color, will be found bursting through the bark. Cut them out and burn them, and paint the wound over at once. A day spent on the "black-knot" in May and June is worth ten days' work later.

June.

The first part of June usually marks the fall of the flowers of most fruit trees. Never spray while trees and vines are in full bloom. Make the second application as soon as the petals have fallen. This will be late in May or early in June for apples, a week or ten days later for other fruit-trees and grapes. Make the June treatment thorough. In spraying for apple-scab, add Paris green to the fungicide for this second application, and also for the third; this will act against the codling-moth. June is a critical month for all fruits and vegetables, especially for grapes. They are most susceptible to "black-rot" between June 20th and July 10th; treat thoroughly and frequently.

The spraying of potatoes should be begun this month; early in the month if the "mould" has been prevalent in former years, later if the "rot" alone is to be feared.

A good general rule to follow after the second spraying, is to let each additional treatment be made from ten days to three weeks after the preceding one; the shorter interval if there are heavy, washing rains, the longer if the weather is comparatively dry.

It must also be remembered that the more adhesive a fungicide is (e. g. the Bordeaux mixture), the less frequently will the applications be needed.

July.

This month will close the treatment for most diseases. To avoid the spotting of grapes by the Bordeaux mixture, the two applications during the latter part of this month should consist of the ammoniacal solution of copper carbonate. Early in the month spray for the "black-rot" of quinces, and continue treatment every two weeks until the last of August.

Continue the treatment of potatoes throughout this month and the following.

August.

The spraying season closes this month. For "leaf-blight" of strawberries, mow the leaves late in July or early in August, and after allowing them to dry where they lie, set fire to them and burn the bed over.

Thoroughly clean and oil all spraying apparatus, and see that it is carefully stored.

September, October, and November.

The months of harvest. When picking fruit, let one or two boys follow and clean the trees of all diseased and mummified

fruit, collecting it in baskets to burn. At the same time gather and burn, as far as possible, all diseased fruit which has fallen.

In November clean the orchard thoroughly of fallen leaves, especially if disease has been prevalent, and burn them. Better to destroy them now than in the spring, when the fungous fruit will have come to maturity in and on the leaves.

December.

The "black-knot" fungus matures during December and January; attack it early in the former month. Use the pruning-knife unsparingly, cutting out two or three inches above and below each "knot." Burn every "knot," and paint the wound over at once.

EXPERIMENTS IN GROWING TOBACCO WITH DIFFERENT FERTILIZERS. SEASON OF 1892.

FINAL REPORT ON THE FERMENTED CROPS OF 1892-3.

On pages one to twenty-four of the report for 1892, is given an account of the organization of the Connecticut Tobacco Experiment Company, of a general plan of experiments to test the effect of fertilizers on tobacco, to be carried out by this Station and the Tobacco Experiment Company jointly, of the raising, sorting and casing of the first experimental crop, and of the judgment of the experts on its appearance at the time when it was put in cases for fermentation. The cases lay in the public warehouse of Mr. B. L. Haas of Hartford, and were undisturbed till September 2d, 1893, when examination of the other crops there in store showed that fermentation was satisfactorily finished.

On the 2d of September, 1893, the cases of experiment tobacco were opened in the presence of a Station officer, samples were drawn from each lot of the wrappers by Mr. James McCormick, and these were immediately sealed in the usual manner, marked and left in charge of Mr. Haas. Duplicate samples, four "hands" in each, were taken for the Station.

Following are the weights of the cases as noted by the Station officer:

The letters designating the lots correspond with those in the published report of last year which has been already referred to. The weights, gross, tare and net, are in pounds avoirdupois.

Lots.	Case.	Gross.	Tare.	Net.
H. D. G.	No. 1	333	75	258
Q. C. F.	" 2	341	85	256
J. K. L.	" 3	347	85	262
X. S. O. P.	" 4	338	84	254
W. N. M. R.	" 5	342	85	257
V. U. E. A.	" 6	350	84	266
I. T. B.	" 7	357	82	275

SHRINKAGE OF THE TOBACCO DURING FERMENTATION.

A comparison of the figures given above, with those on page 11 of the last Station report, shows that the cases lost from 12.4 to 15 per cent. of their weight during fermentation, and that the average loss was 13.8 per cent.

QUALITY OF THE CROPS.

Messrs. William Westphal, Jr., David Rothschild, and Benjamin L. Haas, all of Hartford, Conn., served as judges of the Tobacco. These experts are engaged in the Connecticut leaf-tobacco trade, with the demands of which they are fully acquainted and two of them are practical cigar makers. They were not informed which plots were represented by the different lots of tobacco under examination, and the marks had been so changed as to make it impossible for them to determine this. They were requested to make a strict judgment, noting every defect in the quality, however slight. Hence the casual reader might gather from their report a more unfavorable opinion of the whole crop than it deserves. They devoted an entire day to the work, each making his own independent judgment which was then modified when necessary, by conference. How thorough the examination was will be seen by their report which follows.

It is believed that in this way there has been secured a perfectly unbiased and intelligent judgment on the quality of the crops, by dealers who are in touch with the present requirements of the Connecticut wrapper leaf trade.

The following schedule, prepared by Mr. B. L. Haas, was used by the judges as a guide in examining the leaves. It shows the special points which should be regarded in examining critically a crop of tobacco.

DISEASES AND FAULTS.

Is it flea-bitten?
worm-eaten?
hail-cut?
torn?
musty?

Has it pole-burn?
white vein?
white mould?

CHARACTER OF VEIN.

Is it prominent?
fine?
woody?
green?
white?
curly?

RIPENESS.

Is it ripe?
over-ripe?
under-ripe?

SIZE OF LEAF.

Is it very desirable?
desirable?
medium?
large?
vein-cutter?

COLOR OF LEAF.

Is it cinnamon?
dark yellow?
light yellow?
dark brown?
black?
green?
spotted?

STEM.

Is it light?
medium?
heavy?

TASTE.

Is it strong?
mild?
bitter?

TEXTURE OF LEAF.

Is it extra-fine?
fine?
silky?
pimply?
mottled?
gummy?
brittle?
harsh?
dead?

BURN OF THE LEAF.

Is it slow?	Quality of the ash—Is it firm?
free?	flaky?
Does it hold fire long?	Color of the Ash—Is it clear white?
fairly?	blue white?
short time?	muddy?
not at all?	gray?
Does it coal not at all?	black?
somewhat?	black and white?
badly?	mixed?

Number of Leaves in one pound ....

In order to facilitate comparison, there is prefixed to the judges' report on the quality of each lot of tobacco, the name of the plot, the fertilizers applied per acre and their cost, together with the quantities of nitrogen, phosphoric acid and potash which each supplied, and the yield of pole-cured long and short wrappers per acre.

REPORT OF THE JUDGES.

LOT A.

Fertilizers: 1500 lbs. cotton seed meal, 1500 lbs. cotton hull ash per acre, containing 105 lbs. nitrogen, 150 lbs. phosphoric acid, 341 lbs. potash. Cost $50.25.

Yield: 770 lbs. long wrappers per acre.
350 " short " "

Total 1120 "

Quality:—*Burn*, good, holds fire very well. *Ash*, light gray. *Vein*, thin and good. *Texture*, good. *Size*, good and desirable. *Ripeness*, ripe. *Colors*, dark red and mottled. *Yield*,* very good. *Soundness*, very sound. *Taste*, good. *Stem*, medium. *Remarks*, desirable.

LOT B.

Fertilizers: 2000 lbs. cotton seed meal and 1500 lbs. cotton hull ash per acre, containing 140 lbs. nitrogen, 165 lbs. phosphoric acid, 350 lbs. potash. Costing $57.25.

Yield: 715 lbs. long wrappers per acre.
415 " short " "

Total 1130 "

* "Yield" here means not the number, size, or weight of leaves but the number of *cut wrappers* the crop can furnish.

Quality:—*Burn*, somewhat slow, coals. *Ash*, mixed gray, flakes slightly. *Vein*, small and perfect. *Texture*, medium glassy and close grain. *Size*, medium and desirable. *Ripeness*, ripe. *Color*, light to medium, clear and glassy. *Yield*, profitable. *Defects*, slightly worm-eaten. *Taste*, good. *Stem*, medium. *Remarks*, fair style.

LOT C.

Fertilizers: 2500 lbs. cotton seed meal and 1500 lbs. cotton hull ash per acre, containing 175 lbs. nitrogen, 180 lbs. phosphoric acid, 359 lbs. potash. Cost $63.75.

Yield: 855 lbs. long wrappers per acre.
340 " short " "

Total 1195 "

Quality:—*Burn*, free, inclined to coal slightly. *Ash*, clear gray, hard. *Vein*, small and very fine. *Texture*, open grain. *Size*, very desirable. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, immense. *Soundness*, sound. *Taste*, good. *Stem*, small and fine. *Remarks*, very desirable.

LOT D.

Fertilizers: 3000 lbs. cotton seed meal and 1500 lbs. cotton hull ash per acre, containing 210 lbs. nitrogen, 195 lbs. phosphoric acid, 368 lbs. potash. Cost $70.50.

Yield: 1085 lbs. long wrappers per acre.
300 " short " "

Total 1385 "

Quality:—*Burn*, free, holds fire, slightly inclined to coal. *Ash*, very hard and white. *Vein*, very small and fine. *Texture*, open grain. *Size*, very desirable. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, very good. *Soundness*, sound. *Taste*, good. *Stem*, small. *Remarks*, very desirable.

LOT E.

Fertilizers: 1980 lbs. castor pomace and 1500 lbs. cotton hull ash per acre, containing 105 lbs. nitrogen, 139 lbs. phosphoric acid, 334 lbs. potash. Cost $50.79.

Yield: 735 lbs. long wrappers per acre.
375 " short " "

Total 1110 "

Quality:—*Burn*, fair, holds fire fairly well. *Ash*, light gray, flakes some. *Vein*, heavy, curly. *Texture*, medium. *Size*, medium. *Ripeness*, ripe. *Color*, medium to dark. *Yield*, medium. *Soundness*, very sound. *Taste*, good. *Stem*, heavy. *Remarks*, undesirable.

LOT F.

Fertilizers: 2640 lbs. castor pomace and 1500 lbs. cotton hull ash per acre, containing 140 lbs. nitrogen, 150 lbs. phosphoric acid, 340 lbs. potash. Cost $57.72.

Yield: 760 lbs. long wrappers per acre.
420 " short " "

Total 1180 "

Quality:—*Burn*, good, coals slighty, burns free. *Ash*, white and hard. *Vein*, small and fine, but little curl. *Texture*, open grain. *Size*, medium size. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, only fair. *Soundness*, fairly sound. *Taste*, good. *Stem*, small and fine. *Remarks*, fairly desirable.

LOT G.

Fertilizers: 3300 lbs. castor pomace and 1500 lbs. cotton hull ash per acre, containing 175 lbs. nitrogen, 161 lbs. phosphoric acid, 347 lbs. potash. Cost $64.65.

Yield: 895 lbs. long wrappers per acre.
275 " short " "

Total 1170 "

Quality:—*Burn*, coals slightly, fairly free. *Ash*, mixed gray but hard. *Vein*, small and fine. *Texture*, open grain, very thin. *Size*, little above the medium. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, very good. *Soundness*, very sound. *Taste*, good. *Stem*, small and fine. *Remarks*, desirable.

LOT H.

Fertilizers: 4000 lbs. castor pomace and 1500 lbs. cotton hull ash per acre, containing 212 lbs. nitrogen, 173 lbs. phosphoric acid, 354 lbs. potash. Cost $72.00.

Yield: 1110 lbs. long wrappers per acre.
330 " short " "

Total 1440 "

Quality:—*Burn*, very free, but inclined to coal, holds fire well. *Ash*, clear gray and hard. *Vein*, small and medium. *Texture*, open grain. *Size*, fair, but inclined to be large. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, fair to good. *Soundness*, sound. *Taste*, good. *Stem*, small and fine. *Remarks*, desirable.

LOT. I.

Fertilizers: 2640 lbs. castor pomace, 1500 lbs. cotton hull ashes and 440 lbs. nitrate of soda per acre,* containing 210 lbs. nitrogen, 150 lbs. phosphoric acid, 340 lbs. potash.

Yield: 1060 lbs. long wrappers per acre.
390 " short " "

Total 1450 "

Quality:—*Burn*, good and holds fire. *Ash*, clear, grayish. *Vein*, coarse, prominent. *Texture*, coarse, but good grain. *Size*, too large. *Ripeness*, ripe. *Colors*, mottled and reddish. *Yield*, poor. *Soundness*, sound. *Taste*, good. *Stem*, coarse. *Remarks*, undesirable.

LOT J.

Fertilizers: 2640 lbs. castor pomace, 1500 lbs. cotton hull ashes and 440 lbs. nitrate of soda † per acre, containing 210 lbs. nitrogen, 150 lbs. phosphoric acid, 340 lbs. potash. Cost $68.72.

Yield: 1280 lbs. long wrappers per acre.
340 " short " "

Total 1620 "

Quality:—*Burn*, good and holds fire well. *Ash*, white and does not flake. *Vein*, coarse, prominent, curly. *Texture*, coarse. *Size*, medium and undesirable. *Ripeness*, ripe. *Color*, uneven, mottled and medium. *Yield*, poor. *Soundness*, fairly sound. *Taste*, very good. *Stem*, coarse. *Remarks*, undesirable.

LOT K.

Fertilizers: 1500 lbs. cotton seed meal, 1220 lbs. double sulphate of potash and magnesia and 360 lbs. Cooper's bone per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 341 lbs. potash. Cost $43.95.

Yield: 955 lbs. long wrappers per acre.
415 " short " "

Total 1370 "

Quality:—*Burn*, slow, inclined to coal, holds fire fairly. *Ash*, clear gray and hard. *Vein*, very small and fine. *Texture*, A

* 220 lbs. applied at time of first cultivation and 220 lbs. at second cultivation.
† Applied between rows at time of first cultivation.

No. 1. *Size*, very desirable. *Ripeness*, ripe. *Colors*, medium to light. *Yield*, very good. *Soundness*, very sound. *Taste*, good. *Stem*, light. *Remarks*, very desirable except burn.

LOT L.

Fertilizers: 1500 lbs. cotton seed meal, 1220 lbs. double sulphate of potash and magnesia, 360 lbs. Cooper's bone and 300 lbs. lime per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 341 lbs. potash. Cost $44.70.

Yield: 965 lbs. long wrappers per acre.
455 " short " "
Total 1420 "

Quality:—*Burn*, very free. *Ash*, clear white, does not flake. *Vein*, inclined to curl. *Texture*, open grain. *Size*, good. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, very fair. *Soundness*, very sound. *Taste*, good. *Stem*, small and fine. *Remarks*, fairly desirable.

LOT M.

Fertilizers: 1500 lbs. cotton seed meal, 620 lbs. high grade sulphate of potash and 360 lbs. Cooper's bone per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 341 lbs. potash. Cost $42.70.

Yield: 835 lbs. long wrappers per acre.
355 " short " "
Total 1190 "

Quality:—*Burn*, poor and coals, does not hold fire. *Ash*, dirty gray. *Vein*, good. *Texture*, close grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium to dark mottled. *Yield*, good. *Soundness*, very sound. *Taste*, bitter. *Stem*, small and fine. *Remarks*, undesirable.

LOT N.

Fertilizers: 1500 lbs. cotton seed meal, 620 lbs. high grade sulphate of potash, 360 lbs. Cooper's bone and 300 lbs. of lime per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 341 lbs. potash. Cost $43.45.

Yield: 745 lbs. long wrappers per acre.
305 " short " "
Total 1050 "

Quality:—*Burn*, coals, does not hold fire. *Ash*, white. *Vein*, very good. *Texture*, good. *Size*, good and desirable. *Colors*, light, but somewhat mottled. *Yield*, very good indeed. *Soundness*, very sound. *Taste*, good. *Stem*, small and fine. *Remarks*, very desirable, except fire-holding quality.

LOT O.

Fertilizers: 1500 lbs. cotton seed meal, 580 lbs. carbonate of potash and 360 lbs. Cooper's bone per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 341 lbs. potash. Cost $74.95.*

Yield: 625 lbs. long wrappers per acre.
245 " short " "
Total 870 "

Quality:—*Burn*, very free, inclined to coal, but holds fire well. *Ash*, clear gray, hard. *Vein*, very small and fine. *Texture*, A No. 1. *Size*, perfect, small. *Ripeness*, ripe. *Colors*, very light and desirable. *Yield*, immense. *Soundness*, great. *Taste*, good. *Stem*, very fine. *Remarks*, very desirable except burn.

LOT P.

Fertilizers: 760 lbs. nitrate of potash, 500 lbs. Cooper's bone per acre, containing 110 lbs. nitrogen, 146 lbs. phosphoric acid, 341 lbs. potash. Cost $66.47.†

Yield: 315 lbs. long wrappers per acre.
140 " short " "
Total 455 "

Quality:—*Burn*, slow, inclined to coal, holds fire well. *Ash*, clear gray, hard, does not flake. *Vein*, very small and fine. *Texture*, papery. *Size*, very desirable. *Ripeness*, ripe. *Colors*, light and desirable. *Yield*, immense. *Soundness*, very sound. *Taste*, good. *Stem*, very small and fine. *Remarks*, not very desirable.

LOT Q.

Fertilizers: 2020 lbs. Baker's AA superphosphate and 3920 lbs. Baker's Tobacco Manure per acre, containing 230 lbs. nitrogen, 466 lbs. phosphoric acid, 510 lbs. potash.

Yield: 1275 lbs. long wrappers per acre.
450 " short " "
Total 1725 "

* If carbonate of potash, not chemically pure, were bought in ton lots, the cost would be much less.

† Nitrate of potash, not chemically pure, bought in ton lots, would make the cost considerably less.

Quality:—*Burn*, slow burn, *coals* slightly, does not hold fire long. *Ash*, clear white, flakes slightly. *Vein*, prominent and curly. *Texture*, open grain. *Size*, too large. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, not profitable. *Soundness*, perfectly sound. *Taste*, good. *Stem*, heavy. *Remarks*, not desirable.

LOT R.

Fertilizers: 2000 lbs. Stockbridge Tobacco Manure per acre, containing 99 lbs. nitrogen, 207 lbs. phosphoric acid, 126 lbs. potash.

Yield: 725 lbs. long wrappers per acre.
375 " short " "
Total 1100 "

Quality:—*Burn*, inclined to coal. *Ash*, clear gray. *Vein*, fine and small. *Texture*, good, open grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium and mottled. *Yield*, very good. *Soundness*, very sound. *Taste*, good. *Stem*, small and fine. *Remarks*, fairly desirable.

LOT S.

Fertilizers: 4000 lbs. Stockbridge Tobacco Manure per acre, containing 219 lbs. nitrogen, 278 lbs. phosphoric acid, 391 lbs. potash.

Yield: 1120 lbs. long wrappers per acre.
415 " short " "
Total 1535 "

Quality:—*Burn*, slow burn, inclined to coal, does not hold fire long. *Ash*, clear gray. *Vein*, fine and small. *Texture*, good open grain. *Size*, medium to large. *Ripeness*, ripe. *Colors*, medium to dark. *Yield*, profitable. *Soundness*, very sound. *Stem*, medium. *Remarks*, desirable with exception of burn.

LOT T.

Fertilizers: 900 lbs. Ellsworth's Starter and 2700 lbs. Ellsworth's Foundation per acre, containing 215 lbs. nitrogen, 238 lbs. phosphoric acid, 168 lbs. potash.

Yield: 1170 lbs. long wrappers per acre.
335 " short " "
Total 1505 "

Quality:—*Burn*, good and holds fire well. *Ash*, white and does not flake. *Vein*, good. *Texture*, coarse and fleshy. *Size*,

medium. *Ripeness*, not quite ripe. *Color*, red and mottled. *Yield*, good. *Soundness*, perfectly sound. *Taste*, good. *Stem*, prominent. *Remarks*, undesirable.

LOT U.

Fertilizers: 501 lbs. lime, 501 lbs. Mapes Starter, 2601 lbs. Mapes Tobacco Manure W. B. per acre, containing 173 lbs. nitrogen, 230 lbs. phosphoric acid, 312 lbs. potash.

Yield: 1290 lbs. long wrappers per acre.
390 " short " "
Total 1680 "

Quality:—*Burn*, does not hold fire. *Ash*, white, flakes slightly. *Vein*, curly and heavy. *Texture*, medium grain. *Size*, too large. *Ripeness*, ripe. *Color*, medium to dark. *Yield*, unprofitable. *Soundness*, very sound. *Taste*, good. *Stem*, very heavy. *Remarks*, not desirable.

LOT V.

Fertilizers: 501 lbs. lime, 501 lbs. Mapes Starter, 2601 lbs. Mapes Tobacco Manure, special, per acre, containing 170 lbs. nitrogen, 205 lbs. phosphoric acid, 418 lbs. potash.

Yield: 890 lbs. long wrappers per acre.
285 " short " "
Total 1175 "

Quality:—*Burn*, slow, holds fire fairly well. *Ash*, white. *Vein*, curly. *Texture*, thick and oily, medium grain. *Size*, too large. *Ripeness*, ripe. *Color*, medium to dark. *Yield*, unprofitable. *Soundness*, very sound. *Taste*, fair. *Stem*, coarse. *Remarks*, not desirable.

LOT W.

Fertilizers: 501 lbs. lime, 501 lbs. Mapes Starter, 2601 lbs. Mapes Tobacco Manure, special, per acre, containing 176 lbs. nitrogen, 227 lbs. phosphoric acid, 364 lbs. potash.

Yield: 875 lbs. long wrappers per acre.
285 " short " "
Total 1160 "

Quality:—*Burn*, slow, holds fire fairly well. *Ash*, clear gray and solid. *Vein*, somewhat prominent. *Texture*, medium, close grain. *Size*, medium. *Ripeness*, inclined to be unripe. *Color*, greenish cast, running to mottled and medium colors. *Yield*, profitable. *Soundness*, sound. *Taste*, bitter. *Stem*, medium. *Remarks*, not desirable.

LOT X.

Fertilizers: 6080 lbs. of L. Sanderson's Formula B per acre, containing 345 lbs. nitrogen, 581 lbs. phosphoric acid, 643 lbs. potash.

Yield: 970 lbs. long wrappers per acre.
325 " short " "
Total 1295 "

Quality:—*Burn*, slow burning, does not hold fire well, coals. *Ash*, a very dirty gray. *Vein*, small, perfect. *Texture*, medium, open grain. *Size*, medium and desirable. *Ripeness*, ripe. *Color*, medium and mottled. *Yield*, profitable. *Soundness*, sound. *Taste*, somewhat bitter. *Stem*, medium. *Remarks*, undesirable lot.

The lots in order of their value as wrappers, taking all points into consideration, were arranged by the judges as follows, the most valuable coming first, in the table, and the least valuable last.

O (best),	C,	D,	G,	H,	K,	N,	F,
1st	2d	3d	4th	5th	6th	7th	8th
L,	A,	S,	B,	R,	P,	Q,	E,
9th	10th	11th	12th	13th	14th	15th	16th
T,	W,	I,	U,	X,	J,	M,	V (poorest).
17th	18th	19th	20th	21st	22d	23d	24th

DISCUSSION OF THE QUALITY OF THE CROPS.

It is designed to repeat the experiments with fertilizers here referred to, and fully described in the Report of last year, for a period of at least five years. By this means the effects of differences of season may be noted, the cumulative effect of the different fertilizers may be studied, and misapprehensions corrected which might arise in the deductions from the results obtained in any single year. It is well therefore to use caution in interpreting these first results which may be considerably modified by subsequent experiments in years less favorable to the growth of the crop.

It will be noticed that there are only four or five lots of tobacco which are perfectly satisfactory as regards their burning quality. The defect in some cases is very slight, and not enough to seriously lower the market values. It is also noted by the judges that all the tobacco has a very slight abnormal feeling in the hand, best described perhaps, as a rawness, or want of finish. The defect in burning quality, or slight tendency to coal, common to nearly all the lots, as well as the rawness, are attributed to the fact that the crop was raised on new ground which had not been planted to tobacco for many years, nor even been under good cultivation for a long time. It may be expected that in subsequent crops these defects will disappear.

COMPARISON OF THE CROPS, BEFORE AND AFTER FERMENTATION.

In our report on the unfermented crops, it was said: "It must be distinctly understood that this judgment is given on the appearance of the unfermented leaves, and it is expressly stated by the experts to be in no sense a final judgment on the quality of the crop.

The relative value of the tobacco from the several plots is liable to very great changes during the fermentation which no one can appreciate or estimate from an examination of the tobacco before it has been cased and fermented."

The comparison of the judgments of the quality of the different lots before and after fermentation, will illustrate the truth of this statement.

Of the seven lots of unfermented leaves named as best before fermentation, five are among the seven best after fermentation, but lot A, which ranked first before fermentation, ranks tenth now, and lot I, that stood second then, is now classed as nineteenth, among the poorest.

Lot V, judged the poorest before fermentation, is judged the same after fermentation, but the other five lots which were judged poorest then, are not among the five poorest now. Lot B, which ranked twenty-third before, now ranks as twelfth.

These illustrations make clear the wisdom of the plan adopted to carry the tobacco through the fermentation and not to give a final judgment on its quality till it came out of the case.

Comparative Fire-Holding Capacity.

The experts tested each sample with reference to fire-holding capacity in ways usual in the trade. A more elaborate test was afterwards made at the Station, using 10 leaves (5 short wrappers and 5 long wrappers), and testing each leaf at 6 different places, 3 on each side of the midrib, at the base, near the center, and near the tip. The average of these 60 tests is taken to represent the fire-holding capacity of the lot. The details of the operation are given in the Report for 1892, page 17, and need not here be repeated.

The lot which held fire for the shortest time is marked 100, and the other lots are marked so as to represent numerically their comparative capacity for holding fire; for example, of the long wrappers, lot Q held fire for a shorter time than any other; lot A held fire between 4 and 5 times as long, lot P more than 8 times as long.

Comparative Fire-Holding Capacity.

	Long Wrappers.	Short Wrappers.	Calculated from the mean of both.	Average number of seconds during which leaf holds fire. Unfermented.	Fermented.
A	485	222	310	9	26
B	464	675	552	10	47
C	398	331	336	13	29
D	309	296	282	11	24
E	357	227	263	8	23
F	383	1086	746	18	64
G	309	219	240	11	21
H	482	226	311	10	27
I	234	222	213	10	18
J	252	261	241	11	21
K	325	208	240	9	21
L	320	352	317	10	27
M	270	315	278	7	24
N	225	215	205	8	18
O	285	319	286	11	25
P	822	509	599	16	52
Q	100	112	100	6	9
R	257	213	217	10	19
S	185	161	160	9	14
T	187	154	157	7	14
U	165	109	124	7	11
V	451	100	230	8	20
W	263	133	163	5	15
X	178	196	176	6	15

The fire-holding capacity is an important element in the value of the leaf, but is not in itself a decisive quality. Inspection of the table shows that of the 12 lots which had the average, or more than the average fire-holding capacity, 10 were judged by the experts to be of average, or above average quality and value as wrappers.

The table also shows the average number of seconds during which the leaves held fire both before and after fermentation. It appears that all the lots without exception were improved in their fire-holding capacity by fermentation, though by no means in the same degree; thus lot U, before fermentation held fire 7 seconds; after fermentation 11 seconds, a gain of about one-half, while lot M, before fermentation held fire the same length of time, 7 seconds, but after fermentation, 24 seconds, or more than 3 times as long. The average fire-holding capacity of all the lots before fermentation was 9.6 seconds, after fermentation 24.4 seconds.

Effect of Larger Quantities of Nitrogen than are Commonly used and Comparison of Cotton Seed Meal and Castor Pomace as Fertilizers.

These two subjects are conveniently examined together. There is little difference in the yield of crops raised with help of the two fertilizers when applied in corresponding quantities. Lots A, B, C, D, raised with cotton seed meal and cotton hull ashes, yielded at the rate of 1207 pounds of wrappers per acre. Lots E, F, G, H, raised on castor pomace in equivalent quantity, and cotton hull ashes, yielded 1225 pounds of wrappers.

Nor is there any important difference in the *quality* of the four crops raised on these two fertilizers. The lots raised on cotton seed meal, ranked 2nd, 3rd, 10th and 12th, while those on castor pomace, ranked 4th, 5th, 8th and 16th.

There is, however, a difference in each case in both quality and quantity when crops raised by use of large *quantities* of meal or pomace are compared to crops produced with small applications. The total yield of crop increased with the increase of either fertilizer, being very decidedly the largest, when 3000 pounds of cotton seed meal, or its equivalent, 4000 pounds of pomace were used. The yields of wrapper leaves were as follows:

A (1500 Cotton Seed Meal), 1120 lbs. wrappers.
B (2000 " "), 1130 " "
C (2500 " "), 1195 " "
D (3000 " "), 1385 " "
E (1980 Castor Pomace), 1110 lbs. wrappers.
F (2640 "), 1180 " "
G (3300 "), 1170 " "
H (4000 "), 1440 " "

This increase has not been attended by loss of quality in the leaf; on the contrary, the wrappers raised with the two larger applications of meal or pomace, are judged by the experts to have a distinctly better quality, than those grown with the smaller applications. The lots which received the heavier applications, rank 2nd, 3rd, 4th and 5th, those that had lighter applications rank 8th, 10th, 12th and 16th.

In what respects the increased quantity of these fertilizers has improved the quality of the crops is seen by an inspection of the expert's report. There is no perceptible difference in the burn, the ash is perhaps a little firmer, the texture is better, the colors are lighter, and the stems smaller.

The soil on which the tobacco was raised was at the outset in low condition. It is quite possible that after the land has been brought into good heart, applications of these maximum quantities of cotton seed meal or of castor pomace continued year after year may have no distinctly favorable effect on either quality or quantity of crop, or may even prove injurious.

Effect of Applications of Nitrate of Soda, at the First and Second Cultivation.

The point of this experiment, plots H, I, J, is to ascertain the effect on the crop of supplying one-third of the nitrogen of a heavy application (210 pounds), as a top dressing in the form of nitrate of soda in one application at the time of the first cultivation (Plot I) or in two applications at the time of the first and second cultivation (Plot J). This year the effect has been decidedly injurious. The burn was not impaired, but the veins were coarse and curly, stem coarse, and colors uneven and mottled. The wrappers raised on 4000 pounds of castor pomace with cotton hull ashes (H) rank 5th. The wrappers raised on 2640 pounds of castor pomace, and 440 pounds of nitrate, ranked 19th and 22nd, that is among the very poorest, though in one case, lot J, they weighed more than those of lot H by 180 pounds.

There was no striking difference in the effect of nitrate of soda whether used in a single application at the time of first cultivation (J) or in two applications at the first and second cultivation, I.

The Effects of Potash from Various Sources.

The results of these tests are difficult to understand, and it is unwise to try to draw any definite conclusions from them till corroborated by those of following years.

For example, the wrappers of M, raised on high grade Sulphate, which is regarded as a particularly safe form of potash for tobacco, were among the very poorest of the whole lot, having a bad burn, dirty gray ash, medium to dark colors, close grain and bitter taste. Yet the same application of high grade Sulphate, with the addition of 300 pounds of lime (lot N) gave a somewhat smaller crop of wrappers, of good quality, ranking 7th in the list. Their burn was defective, and the colors somewhat mottled, but otherwise the wrappers were unobjectionable.

The double manure salt by itself (K), and also with added lime (L) gave a considerably larger crop than any other form of potash, and also an excellent quality of wrappers, somewhat better indeed than the same quantity of cotton hull ashes. The leaves from K and L ranked 6th and 9th in quality. In this case the added lime had no marked effect on the quality of the crop.

Carbonate of potash, Lot O, yielded only a very small crop, 870 pounds of wrappers per acre. The yield was possibly depressed by the caustic action of the carbonate, but the quality was pronounced by the judges to be the very best of all.

Nitrate of potash, Lot P, yielded an extremely small crop, only 450 pounds of wrappers, and the quality was below the average. It should be said, however, that a tremendous rain just after planting may have carried a large part of the nitrogen of this plot, which was entirely in the form of nitrate, down out of the reach of the crop, so that the small yield and inferior quality may be due to deficiency of nitrogen, and not to any unfavorable action of the nitrate. This seems to be a reasonable explanation.

Comment on the lots raised with fertilizers supplied by the different fertilizer manufacturers, is reserved to await further results. This year the wrappers raised with these fertilizers, while above the average yield of the other plots have been as a rule below the average quality. It should be remembered that these tests are in no sense a competitive trial of various brands, but are in the nature of experiments by the manufacturers to test the value of certain mixtures.

EXPERIMENTS IN GROWING TOBACCO WITH DIFFERENT FERTILIZERS. SEASON OF 1893.

The following experiments are in continuation of those begun last year by this Station, in coöperation with the Connecticut Tobacco Experiment Co., of Poquonock, and described in the Report of this Station for 1892, pages one to twenty-four.

Plan of the Experiments.

Four points regarding the effect of fertilizers on tobacco, were contemplated in the work of last year. They were the following:

1. What is the effect on quantity and quality of leaf of larger applications of cotton seed meal than are commonly used as a fertilizer? (Plots A, C, D.)

2. What is the comparative effect on quantity and quality of leaf, of applications of castor pomace containing the same amounts of nitrogen as the cotton seed meal used in the experiments under 1? (Plots E, G, H, compared with A, C, D.)

3. If a heavy application of nitrogen in the form of castor pomace proves injurious to the leaf, can the injury be lessened or prevented if half of this quantity of nitrogen is supplied by castor pomace and the other half by nitrate of soda? (Plots I, J, compared with A, E.)

4. What are the comparative effects on quantity and quality of leaf, of applications of equal quantities of potash (K_2O) in the following forms: Cotton hull ashes, high grade sulphate of potash, the same with lime, double sulphate of potash and magnesia, the same with lime, pure carbonate of potash, and pure nitrate of potash? (Plots K, L, M, N, O,* compared with A.)

Early in 1893 the Tobacco Experiment Co. purchased additional land and extended the scope of the experiments to cover the following points:

5. What is the effect on quantity and quality of leaf, of applications of linseed meal containing the same quantity of nitrogen as the cotton seed meal and castor pomace used in the other experiments? (Plot B, compared with Plots A and E. Notice also F and CC.)

* The comparison of nitrate of potash was discontinued this year on account of the very small yield and small per cent. of wrappers obtained last year.

6. What is the effect on quantity and quality of leaf, of using less than half the quantity of cotton hull ashes or about 150 pounds of actual potash to the acre, instead of 340 pounds as in the other experiments? (Compare F and B.)

7. What is the effect on quantity and quality of leaf, of using fish as a source of nitrogen in place of cotton seed meal or castor pomace? (Compare Z and K; also notice T. The mixture on plot T was put in at the last moment to fill a vacancy made by the withdrawal from the experiment, of a manufacturer.)

8. What is the effect on quantity and quality of leaf, of using stable manure as a fertilizer by itself, or with "Swift-sure superphosphate" as a starter?* (Plot AA.)

9. What is the effect on quantity and quality of leaf, of using tobacco stems with castor pomace, both together and also with some superphosphate added as a starter? (Plot BB.)

Also under 4, unleached Canada ashes (Plot Y), and a new potash salt, the double carbonate of potash and magnesia (Plot P), which was described in the Report for 1892, page 34, are compared with the other forms of potash (Plots K, L, M, N, O and A).

On much smaller plots, containing about $\frac{1}{160}$ of an acre, tobacco was grown with the three fertilizing ingredients, nitrogen, phosphoric acid, and potash, each by itself and in the different combinations possible with these ingredients. (Plot DD.)

The Experiment Field.

The experiments of last year were repeated in every case on the same plots as before.

The new plots, of precisely the same shape and size, ($\frac{1}{20}$ acre), as those used in 1892, were in the same field, and by the side of the others, and were marked Y, Z, AA, BB, CC, DD. These new plots are on ground believed to be like the rest of the field in texture and quality, with the exception that the new land had not been cultivated for six years, and was covered with a neglected growth of poverty grass and blackberry vines. It was in the same condition as the tobacco field of last year before it was taken up for the experiments of 1892.

* A "starter" is a soluble and quickly acting fertilizer which is put in the row where the plants are to be set, intended to meet the immediate wants of the young plants before the broadcast fertilizer becomes available.

Fertilizers.

The stalks of last year's tobacco crops were put back on the plots from which they came, and were ploughed under very early in the spring. The fertilizers applied (1893) with the exception of the nitrate of soda, cotton seed meal, high grade sulphate of potash and double manure salt, were all sampled and analyzed by the Station. The raw materials contain the following percentages of nitrogen, phosphoric acid and potash:

Composition and Cost of Fertilizers Used.

	Cost per ton.	Nitrogen.	Phosphoric Acid.	Potash.
Nitrate of Soda	$52.50	16.00	----	----
Cotton Seed Meal	32.00	7.00	3.00	1.80
Castor Pomace	25.00	4.64	1.45	1.09
Linseed Meal	27.00*	5.98	1.90	1.40
Tobacco Stems	14.00	1.92	.60	8.10
Cooper's Bone	27.00	1.60	29.20	----
Cotton Hull Ashes	44.00	----	6.33	19.04
Wood Ashes	12.00	----	1.00	5.60
High Grade Sulphate	55.00	----	----	50.60
Carbonate of Potash	170.00†	----	----	54.10
Double Carbonate Potash and Magnesia	39.00‡			18.10
Double Manure Salt	30 00			26.00
Fish	45.00	8.06	6.70	----

The mixed fertilizers supplied by certain manufacturers were also weighed, sampled and analyzed by the Station with the following results: The samples of Baker's Tobacco Manure and AA. Phosphate were lost by an accident, after the fertilizers had been sown. They were claimed to have the average composition of these brands and therefore the analyses of these goods as found in the Connecticut market the last season are inserted in the table.

* Given to the Station by the Cleveland Linseed Oil Co. for the experiment.

† By the single pound. Ton rates for an article not chemically pure, would be very much lower.

‡ Total cost of importing a one ton lot from Stassfurt. The quantity used in the experiments was given to the Station by the Stassfurt Potash Syndicate.

Analyses of Mixed Fertilizers Used in the Experiment.

	Baker's Tobacco Manure.	Baker's AA. Phosphate.	Stockbridge's Tobacco Manure.	Mapes' Tobacco Manure, Wrapper Brand.	Mapes' Tobacco Starter.	Sanderson's Formula for Tobacco.	Pinney's Formula for Tobacco.	Shoemaker's Swift Sure Superphosphate.
Station No.	3951	3889	4021	4020	4024	4022	4023	3837
Plots	Q.	Q.	R. & S.	U.V.W.	U.V.W.	X.	C.C.	AA.BB.
Nitrogen as nitrates		.23	3.23	1.26	.51	trace	----	.66
" as ammonia	3.92	2.01	----	2.46	.45	3.08	----	----
" organic	.47	.61	2.87	2.22	1.83	2.09	4.63	2.23
Total nitrogen	4.40	2.85	6.10	5.94	2.79	5.17	4.63	2.89
Total phosphoric acid	5.28	12.22	9.80	5.97	12.51	14.07	7.01	14.39
Total potash	11.70	3.21	12.08	10.85	3.33	5.27	7.47	4.72
Chlorine	.79	3.23	1.55	.57	.45	.26	.23	----

The quantities of chemicals for each plot were accurately weighed by the Station representative, mixed thoroughly under his supervision, and bagged and labeled by him.

The bags were carried to the several plots by Mr. DuBon and their contents were sowed on the plots by him or under his constant supervision.

All the fertilizers were very carefully and evenly sown when no wind was blowing. The plots were immediately harrowed by Mr. DuBon, each by itself, to avoid carrying fertilizer from one plot to the next. The "starters" were applied later, in the usual way. The whole piece was then "rowed out," the rows running east and west.

The following statement shows what fertilizers were put on each plot, their cost and the quantities of nitrogen, phosphoric acid and potash contained in them, expressed in pounds per acre:

Fertilizers Applied, 1893.

Most of the plots which were under experiment in 1892 received the same fertilizers in 1893 as in the previous year. Where a change was made however, in 1893, it is indicated by italics.

Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains pounds.		
			Nitrogen.	Phosphoric Acid.	Potash.
A	1500 Cotton Seed Meal 1660 Cotton Hull Ashes	$60.35	105	150	342
B	1760 *Linseed Meal* 1660 *Cotton Hull Ashes*	57.79	105	138	340
C	2500 Cotton Seed Meal 1540 Cotton Hull Ashes	73.88	175	172	342
D	3000 Cotton Seed Meal 1500 Cotton Hull Ashes	81.00	210	184	342
E	2260 Castor Pomace 1660 Cotton Hull Ashes	64.60	105	139	340
F	1760 *Linseed Meal* 660 *Cotton Hull Ashes* 260 *Cooper's Bone*	41.79	105	150	150
G	3760 Castor Pomace 1560 Cotton Hull Ashes	81.32	175	154	342
H	4520 Castor Pomace 1520 Cotton Hull Ashes	89.94	210	164	342
I	2260 Castor Pomace 1660 Cotton Hull Ashes 328 Nitrate Soda* 328 " " †	81.96	210	139	340
J	2260 Castor Pomace 1660 Cotton Hull Ashes 656 Nitrate Soda*	81.96	210	139	340
K	1500 Cotton Seed Meal 1220 Double Manure Salt 360 Cooper's Bone	47.12	110	150	342
L	1500 Cotton Seed Meal 1220 Double Manure Salt 360 Cooper's Bone and 300 Lime	47.94	110	150	342
M	1500 Cotton Seed Meal 620 High Grade Sulphate of Potash 360 Cooper's Bone	45.87	110	150	340

* Applied between rows at time of first cultivation.
† Applied between rows at time of second cultivation.

Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains pounds.		
			Nitrogen.	Phosphoric Acid.	Potash.
N	1500 Cotton Seed Meal 620 High Grade Sulphate of Potash 360 Cooper's Bone and 300 Lime	46.69	110	150	340
O	1500 Cotton Seed Meal 580 Carbonate of Potash 360 Cooper's Bone	78.12*	110	150	342
P	1500 *Cotton Seed Meal* 1740 *Double Carbonate Potash and Magnesia* 360 *Cooper's Bone*	62.75*	110	150	342
Q	2000 Baker's A. A. Superphosphate 4000 " Tobacco Manure	----	233	456	533
R	2000 *Stockbridge Tobacco Manure* 500 " " " †	----	153	245	302
S	3000 *Stockbridge Tobacco Manure* 500 *Stockbridge Tobacco Manure*†	----	214	343	403
T	880 *Dry Fish* 440 *Nitrate of Soda* 720 *Cooper's Bone* 300 *Lime*	42.05	153	268	none.
U‡	600 *Mapes' Starter* 2200 " *Tobacco Manure W. B.*	----	147	206	259
V‡	800 *Mapes' Starter* 2000 " *Tobacco Manure W. B.*	----	141	220	244
W‡	1000 *Mapes' Starter* 1800 " *Tobacco Manure W. B.*	----	135	232	229
X	2000 *Sanderson's Formula*	----	103	281	105

* If bought in ton lots, not chemically pure the cost would be considerably less.
† Applied as a starter.
‡ These plots have an area of $\frac{1}{30}$ acre each.

The following plots were planted for the first time in 1893:

Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains pounds.		
			Nitrogen.	Phosphoric Acid.	Potash.
Y	1500 Cotton Seed Meal 5620 Unleached Wood Ashes 160 Cooper's Bone	$59.74	105	153	342
Z	1300 Dry Fish 1220 Double Manure Salt 200 Cooper's Bone	52.12	105	147	342
AA	Stable Manure 10–12 cords* On half the plot Swift Sure Superphosphate at rate of 500 per acre	----	126	143	172
BB	6000 Tobacco Stems and 2640 Castor Pomace On half the plot Swift Sure Superphosphate at rate of 500 per acre	84.80	252	146	538
CC	Pinney's Formula†	----	139	210	224
DD 1	No fertilizer of any kind	----	----	----	----
DD 2	1520 Castor Pomace	----	71	22	17
DD 3	1440 Cooper's Bone	----	23	420	----
DD 4	1760 Double Carbonate Potash and Magnesia	----	----	----	319
DD 5	1520 Castor Pomace 1760 Double Carbonate Potash and Magnesia	----	71	22	336
DD 6	1440 Cooper's Bone 1760 Double Carbonate Potash and Magnesia	----	23	420	319
DD 7	1520 Castor Pomace 1440 Cooper's Bone 1760 Double Carbonate Potash and Magnesia	----	94	442	336
DD 8	No fertilizer of any kind	----	----	----	----

*Estimated to contain 111 lbs. nitrogen, 71 lbs. phosphoric acid and 149 lbs. potash.

†The nitrogen of this formula is chiefly in the form of linseed meal.

The Plants and the Planting.

The plants were of the so-called "Havana seed" from seed grown by Mr. DuBon. The rows were 3½ feet apart, eight rows in a plot, and the plants were accurately set 17 inches apart, making about 8,700 to the acre. The plants were set out by Mr. DuBon and his men on June 8th.

Notes during the Growing Season.

Following is Mr. DuBon's record, kept during the time that the crop was growing.

June 8th: Planted the whole piece to-day.

June 25th: Up to this date about 4,000 plants had to be reset on account of injury from cut-worms.

July 3d: H and D have a very uneven stand, on account of the ravages of worms and the dry weather. The plants on R and S are also very uneven, R more so than S. The season has thus far been very dry. The stand on U, V, and W is very uneven; U is the best of the three. V and W are the poorest plots in appearance on the whole field on account of the attacks of worms, and the dry weather. Plots AA, BB, CC and Z have the most even stand, these plots having been treated with Paris green the day after planting. It was feared that these new plots would be more subject to the attacks of worms than the others because they were on new ground; so Paris green was applied to the new plots and not to the others. All the other plots on the field look about equal.

On this day, 32 pounds of nitrate of soda were applied to plot J, and half that quantity to plot I.

July 10th: The effect of the nitrate of soda was favorable to the strong plants, but a few of the re-set plants, that were small, were checked in their growth and some of them died. I believe it is best to use nitrate of soda after the plants are a foot high to get the best results. Plots A, E, I, J, T, O, CC, Q, Y, AA and BB are the most uniform and most forward. Plots R, S, U, V and W are the most uneven. The rest of the field looks about alike. The plants on the half of the plots AA and BB, where swift-sure superphosphate was applied are about one-third larger than on the other half.

July 19th: W, very uneven, poorest of all, V next, U up to the average of the field. B looks sick and poor, G up to the average of the field, much better than B. Plots O, P, Q and Z above the average on the old part of the field. H and D are quite alike, and uneven. G, C, F and B are good, CC good and the stand very even. BB good, very even and best on the half where swift-sure starter was applied. AA good and very even and the half where swift-sure starter was applied is the best of all the field. Plots I and J, improved only a very little by the application of nitrate of soda. DD1 is of a pale green color, and the smallest of all. The other seven are about alike, and nearly as large as the rest of the field, but a paler green.

July 26th: 16 pounds of nitrate of soda, applied to plot I. Plots A, E, I, J, T, very good, although the weather is very dry; also N, M, K, L, O, P, Q, Z; very little difference in these plots. H, D, C and G look somewhat better. CC, Z and T, are above the average for evenness. Commenced topping to-day. BB and AA are nearly all topped on the half where swift-sure starter was applied, being ahead of all the rest of the field. U, V, and W are behind all the rest.

August 16th: Finished topping. Of the plots U, V and W, U is the best and W the poorest.

August 19th and 20th: A very light rain has come at last and continued until the 20th in the afternoon and has wet the ground three inches down. This is more rain than we have had at any one time since the 8th of June when the plants were set. The tobacco has been pinched through all the growing season until now.

August 24th: A driving storm has broken the tobacco somewhat, but the heavy rain has improved it very much. Plot AA was affected most by the dry weather, and plot CC, next. All the rest of the field has stood the drought well.

August 28th: Plants on T, U and X are the largest at this date, and on the rest of the field are quite even in size. The larger part of the tobacco is ripe now but must stand another week, on account of the re-set plants which are growing. There is a marked difference between T and Z in favor of T, as it looks in the field. T is fresh and growing, while Z is about ripe and not so large.

August 30th: Commenced harvesting to-day.

September 1st: Finished the harvesting. The weather has been clear, or slightly overcast, and the crop was secured in good shape.

Notes on Temperature and Rainfall, Season of 1893.

1893 was the coldest year since 1888, though June, August and September were not colder than usual.

For the tobacco-growing months the average, maximum and minimum temperatures were as follows:

	Average.	Maximum.	Minimum.
June	67.5	92	48
July	69.8	89	49
August	69.7	88	45

The normal rainfall in Windsor is 45.60 inches. In 1893 it was only 41.42 inches or 4.18 inches below normal. All the summer months were much drier than usual.

The rainfall was 1.75 inches in June, 1.68 in July and 2.74 in August, the larger part of the August fall being in the latter part of the month, when there were two very violent wind and rain storms within a single week. This rain was a great help to the crop, but the leaves were very badly torn and beaten down by the wind in some places.

The average temperature and the total rainfall is given by weeks in the following statement. The figures are kindly furnished by Mr. Harry Moore of Windsor.

Fractions of a degree have been omitted in the statement of temperature.

	1892. Average Temperature.	1892. Total Rainfall.	1893. Average Temperature.	1893. Total Rainfall.
Week ending June 8	71	.05	69	.53
" " 15	67	3.94	68	.15
" " 22	73	1.07	70	.01
" " 29	71	.64	64	1.06
" " July 5	68	1.68	67	.14
" " " 12	69	.45	68	.81
" " " 19	70	.51	71	.38
" " " 26	75	.96	69	.04
" " Aug. 2	74	1.38	69	.33
" " " 9	73	2.76	70	.13
" " " 16	71	1.15	70	.20
" " " 23	70	.09	66	.78
" " " 30	64	1.33	73	1.61

Harvesting, Curing, Stripping and Sorting.

On the 30th of August and 1st of September all the tobacco was harvested. Each lath on which stalks were strung was marked with the letter denoting the plot and the whole number of laths for each plot was counted.

The laths were so hung in the barn that an equal portion of the tobacco from each plot was hung in the purline bent and in each of the other lower bents.

The crop cured without any appearance of pole-burn and hung in the barn till December 25th, when it was taken down and carted to Mr. DuBon's barn where it lay in the basement till January 2d, 1894. On the second and third of January it was taken from the laths and stripped from the stalks, bundled and weighed.

Each lath was examined to prevent possible mixture of crops from different plots and the laths from each plot were in every case counted. The numbers agreed exactly with those of the counting at harvest time.

Sorting was begun by Mr. DuBon on the 5th of January and finished on the 12th. All the weighings during the sorting were made by the Station representative.

As the crop was sorted samples were carefully drawn from each lot of long and short wrappers. Each sample contained twelve "hands," (15 to 20 leaves in each "hand"). Four "hands" were tied together by the butts and a tag was attached bearing a number which designated the plot.

These samples, each consisting of three bunches, four hands in each bunch, were taken to the warehouse of Mr. L. B. Haas, of Hartford, where they were cased for fermentation, the case being lined with top leaves and seconds from the same crop.

The remainder of the crop was sold.

No attempt was made to judge of the quality of the wrappers before they were fermented as the experience of last year showed that such a judgment was likely to be reversed by an examination of the crops after fermentation.

The results of the sorting and of some preliminary examinations of the quality of the tobacco are here given together, followed by discussion of the results.

The following table gives the results of the sorting. The weights are in pounds. For those unfamiliar with the details of sorting leaf-tobacco, it may be said that the "seconds" are the lower leaves on the stalk, smaller than those of either of the other grades, over-ripe and unfit for wrappers. The "long wrappers" and "short wrappers" are the most valuable part of the crop, the latter being smaller and lighter, and often cutting to greater advantage than "long wrappers." The "top leaves" are often as large as the long wrappers, but heavier, darker in color and unripe.

Weights of the Barn-Cured Leaves from $\frac{1}{20}$ Acre.

Crop of 1893.

Plot.	Gross Weight of Leaves.	Long Wrappers.	Short Wrappers.	Top Leaves.	Seconds.	Waste and Shrinkage.	Net Weight of Sorted Tobacco.
A	80	26¼	8	21¼	15½	9	71
B	78	29¼	9½	20¼	14½	4½	73½
C	80½	23¾	8½	25½	18	4¾	75¾
D	83	26¾	9¼	24½	19¾	2¾	80¼
E	85½	30¼	9¼	26¼	15¼	4½	81
F	84½	36¼	9¼	19¾	14¼	5	79½
G	80	21¼	11	29½	16¼	2	78
H	87½	34½	10½	17½	21½	3½	84
I	86	33½	9¼	22½	15¼	5¼	80½
J	91½	40¼	13	20½	13¾	4	87½
K	92½	37½	9½	21	19¼	5¼	87¼
L	80½	25¾	9¼	23¼	19¼	3	77½
M	85	22¾	9¾	27¼	20¾	4½	80½
N	87½	29½	12	27	17	2	85½
O	78	21¾	10	29½	13¼	3½	74½
P	72½	24	11¾	22	11½	3¼	69¼
Q	100½	42½	10	23½	19½	5	95½
R	78½	22¾	8¼	25¾	18½	3¼	75¼
S	89½	30¾	10¾	25¾	17¾	4½	85
T	95	36¾	9	28¾	18¼	2¼	92¾
U*	103½	48¾	12½	20¼	20	2	101½
V*	84	34½	9	17¾	15½	7¼	76¾
W*	77¼	30¾	8¼	17	18¾	2½	74¾
X	78½	26¼	10	24¼	15½	2½	76
Y	79½	18	6½	24½	25¾	4¾	74¾
Z	73½	15¾	7½	24	17¾	8½	65
AA	69½	13½	12¾	21½	18¾	3	66½
BB	74	15	9	27½	16½	6	68
CC	69½	8¾	7¾	25½	15¼	12¼	57¼
DD	51						

* Reckoned to $\frac{1}{20}$ acre.

PER CENT. OF THE FOUR DIFFERENT GRADES.

POLE-CURED CROP OF 1893.

Plot.	Long Wrappers.	Short Wrappers.	Total Per cent. of Wrappers.	Tops.	Seconds.
A	37	11.3	48.3	29.9	21.8
B	39.9	12.9	52.8	27.5	19.7
C	31.3	11.2	42.5	33.7	23.8
D	33.4	11.5	44.9	30.5	24.6
E	37.3	11.4	48.7	32.4	18.9
F	45.7	11.6	57.3	24.8	17.9
G	27.3	14.1	41.4	37.8	20.8
H	41.1	12.5	53.6	20.8	25.6
I	41.6	11.5	53.1	27.9	19.0
J	46.0	14.9	60.9	23.4	15.7
K	42.9	10.9	53.8	24.1	22.1
L	33.2	11.9	45.1	30.0	24.9
M	28.2	12.1	40.3	33.9	25.8
N	34.5	14.0	48.5	31.6	19.9
O	29.1	13.5	42.6	39.6	17.8
P	34.6	17.1	51.7	31.7	16.6
Q	44.5	10.5	55.0	24.6	20.4
R	30.2	10.9	41.1	34.3	24.6
S	36.2	12.7	48.9	30.2	20.9
T	39.6	9.7	49.3	30.9	19.8
U	48.1	12.2	60.3	20.0	19.7
V	45.1	11.8	56 9	23.0	20.1
W	41.2	11.1	52.3	22.6	25.1
X	34.5	13.2	47.7	31.9	20.4
Y	24.1	8.8	32.9	32.6	34.5
Z	24.2	11.5	35.7	37.0	27.3
AA	20.3	19.2	40.5	32.3	28.2
BB	22.1	13.2	35.3	40.4	24.3
CC	15.3	13.6	28.9	44.5	26.6

DD not sorted on account of its inferior value.

COMPARATIVE FIRE-HOLDING CAPACITY.

POLE-CURED CROP OF 1893.

The method of determining fire-holding capacity is fully described in the Report of this Station for 1892, page 17.

The lot which held fire for the shortest time is marked 100 in the table and the others are marked higher and according to their

relative fire-holding capacity. Thus lot Z is marked 100 as it had a lower fire-holding capacity than any other. Lot F, long wrappers, marked 180 held fire 1.8 times as long as Z.

	Long Wrappers.	Short Wrappers.	Calculated from the Mean of both.
A	213	238	227
B	298	273	283
C	230	180	200
D	171	188	181
E	149	189	172
F	180	261	227
G	275	187	224
H	224	190	204
I	169	242	211
J	193	256	229
K	173	147	160
L	139	148	145
M	149	156	152
N	172	143	155
O	166	168	167
P	290	215	247
Q	147	118	130
R	161	165	146
S	173	164	168
T	135	157	147
U	154	172	166
V	159	161	146
W	168	157	162
X	173	161	152
Y	138	200	172
Z	100	100	100
AA	169	193	183
BB	160	160	160
CC	176	136	152

NUMBER OF POLE-CURED LEAVES TO THE POUND.

CROP OF 1893.

	Long Wrappers.	Short Wrappers.
A	68	86
B	66	82
C	59	76
D	68	82
E	59	70
F	62	84
G	60	76
H	65	78
I	62	79

	Long Wrappers.	Short Wrappers.
J	68	80
K	60	81
L	57	75
M	61	73
N	67	76
O	70	82
P	67	91
Q	54	68
R	61	73
S	66	81
T	60	76
U	52	73
V	58	72
W	70	85
X	66	72
Y	67	82
Z	68	71
AA	63	76
BB	71	82
CC	63	79

Discussion of the Results.

Net Weight of the Sorted Crops, 1893.

In 1892 there was harvested from 23 plots, of $\frac{1}{20}$ acre each, 2122 pounds of sorted tobacco, or at the rate of 1845 pounds per acre.

In 1893 there was harvested from 28 plots, 2183 pounds, or at the rate of 1559 pounds per acre. This is 84½ per cent. of the crop of 1892. The crop of 1892 contained 66.7 per cent. of wrappers. The crop of 1893 contains only 48.5 per cent.

The reduced yield in 1893 was caused in small part by the ravages of cut-worms, just after setting, which made the crop uneven, but was mainly due to the severe drought that prevailed through most of the growing season. The tobacco which was planted on plots Y, Z, AA, BB, CC, and DD, that had not been under cultivation for ten years, suffered more severely from drought than the crops on plots which had been under cultivation for a year.

On a single plot, U, the crop weighed at the rate of over 2000 pounds per acre, 2030 pounds, with 1225 pounds of wrappers. On plot Q the yield was 1910 pounds, with 1050 pounds of wrappers. These two plots bore more than any others in both years.

Plot T followed next with 1855 pounds, and plots J, K, N and S all yielded between 1700 and 1750 pounds per acre.

Cotton-Seed Meal and Castor Pomace. The three plots on which cotton seed meal was used with cotton hull ashes alone averaged 1513 pounds of sorted tobacco per acre, those on which corresponding quantities of castor pomace were used with ashes alone, averaged 1620 pounds. In 1892 there was nearly the same difference of yield between these two sets of plots.

In 1892, however, the quantity of wrappers per acre from the plots that received castor pomace was only 17 pounds greater than the quantity from the corresponding plots where cotton-seed meal was used. But in 1893 97 pounds more of wrappers per acre were raised on castor pomace than on cotton seed meal.

Increasing the quantities of cotton seed meal increased the weight of crop. With castor pomace the increase was slight.

Nitrate of Soda with Castor Pomace. Where for an application of 210 pounds of nitrogen in castor pomace as on plot H, was substituted half that quantity of nitrogen in pomace and the other half in nitrate of soda, plots I and J, the yield was 70 pounds less per acre when the nitrate was applied, half at the first and half at the second cultivation, plot I; but the total yield was increased by 70 pounds per acre when the nitrate was all put on at the first cultivation, and the quantity of wrappers was increased by 165 pounds per acre. The relative yields on plot J as compared with H are not very different from those of the previous year.

Potash Salts. Of the various potash salts, the double sulphate of potash and magnesia (plot K), produced the largest total crop, 1745 pounds, and the largest quantity of wrappers, 940 pounds.

The high-grade sulphate of potash used with lime (plot N), came next in total yield, 1710 pounds, 825 pounds of wrappers, and the high-grade sulphate used without lime ranked third, 1610 pounds, though the quantity of wrappers from this plot was smaller than from most of the other plots on which potash salts were tested, 650 pounds. In 1892 plots M and N also produced more total crop and more wrappers than any of the potash-test plots except K, but in that year M yielded more than N.

All of the forms of potash which were compared with cotton-hull ashes this year gave a higher yield than the latter, excepting the new potash salt, the double carbonate of potash and magnesia.

The quantities of wrappers, however, raised with either Canada ashes, Y (new land), carbonate of potash, O, or high grade sulphate of potash, M, were smaller than the weight of wrappers raised on cotton-hull ashes, A.

Linseed Meal. A comparison of the yield of plots B and F, to which linseed meal was applied, with plots A and E which received equivalent quantities of cotton seed meal and castor pomace shows that linseed meal yielded fully as much total crop and wrapper leaves as either cotton seed or castor pomace. Plot CC cannot be compared with the others being on new land which evidently suffered more from drought than that which had been under cultivation longer.

Smaller quantity of Potash. Plot B received, together with linseed meal, 340 pounds of actual potash per acre in form of cotton-hull ashes. Plot F received the same fertilizers in 1892 as B, but in 1893 had only 170 pounds of actual potash in form of cotton-hull ashes. The total crop in 1893 on F exceeded that on B by 120 pounds and the yield of wrappers by 135 pounds.

Very striking also is the result on plot T which received fish, nitrate of soda and bone in 1893, *with no potash at all.* Only two other plots yielded more tobacco than this one and there were only four plots out of the twenty-nine which yielded more wrappers.

Discussion of the crops raised on the new land is omitted because the drought affected them much more severely than the others.

Discussion of the fire-holding capacity and the number of leaves per pound may be deferred till the crop has been fermented.

SOME OBSERVATIONS ON THE WORKING OF THE COOLEY SYSTEM AND THE DE LAVAL SEPARATOR SYSTEM IN COÖPERATIVE CREAMERIES.

The Cooley system of raising and measuring cream is sufficiently well known in this State to need no description. It may be said by way of explanation for the benefit of other readers who are unacquainted with it that the method consists in bringing milk warm from the cows into cans $8\frac{1}{2}$ inches in diameter and 19 inches deep, holding 18 quarts and provided with a cover loosely fitting which allows free circulation of air but prevents any water from coming into the can when it is nearly filled with milk and submerged in water. The filled cans are submerged at once in pure water having a temperature of 45 degrees F. in summer and 40 in winter and remain at about the same temperature from 12 to 24 hours. Every can has a strip of glass set in near the bottom, on which are marked "spaces," each being $\frac{19}{64}$ of an inch in width. To draw off the cream the cans are lifted by hand or by an elevator; the skimmed milk is run off through a stop cock at the bottom till the lower limit of the cream layer corresponds with zero on the space scale. The number of "spaces" are then read off and recorded by the cream-gatherer who represents the creamery, and are credited on its books to the patron, who is paid by the number of "spaces" of cream furnished.

A "space" is the equivalent of a cylinder $8\frac{1}{2}$ inches in diameter and $\frac{19}{64}$ inches high. The cream-gatherer collects daily or in some cases four times in the week the cream from all the patrons and carries it to the creamery to be ripened and churned.

The centrifugal separator system is more generally known. Under this system the warm milk is slowly run into a steel bowl which is made to revolve at high speed and by centrifugal force the heavier part of the milk is driven to the circumference of the bowl while the cream is forced to its center and by proper mechanical contrivance is constantly skimmed off as it accumulates and runs in a small stream into the cream-gathering vessel. In the same way the skim-milk is taken off nearer the circumference of the bowl and in a larger stream runs to the skim-milk tank.

When separator cream is sold to a creamery which runs mainly on the Cooley cream-gathering basis, it is usually paid for by the quart, the price depending on the quantity of butter got from a quart of separator cream in churning-tests made from time to time at the creamery.

Most of the creameries in this State are on the cream-gathering basis and the cream is raised by the Cooley system. A certain number of patrons of creameries as well as other dairymen, however, use and prefer the separator system.

In view of the rapid increase in the use of separators in this State and throughout the country the following questions are of great importance:

Is it possible to ripen and churn mixtures of cream raised by the two systems without greater loss of fat in buttermilk, than when the two are separately ripened and churned, and is the quality of the butter made from such a mixture as good as that of butter made from cream raised by either system, but ripened and churned by itself?

These questions were discussed at length in the meeting of the Dairymen's Association at Hartford in 1892, and while there was the widest difference of opinion, no one could offer a single accurate observation which had been made on the subject.

Later in the winter the Dairymen's Association, through its secretary, Mr. W. I. Bartholomew, of Putnam, asked the Station to make a study of these questions in the interest of dairymen and promised the coöperation of the Association.

The Station agreed to undertake this work and has up to the present time made the tests hereinafter described.

The analytical work was done at the Station laboratory in New Haven by Messrs. A. L. Winton and A. W. Ogden.

The tests were made at the Woodstock Creamery which was put at our disposal for the purpose by the Board of Directors.

Special acknowledgment is due to Mr. Abel Child, and to the superintendent, Mr. Hopkins, the butter maker at Woodstock Creamery for their cordial coöperation in the plan and for their skill and helpfulness which did much to make the experiments a success.

1. COMPARISON OF THE CHURNING OF COOLEY CREAM, SEPARATOR CREAM AND A MIXTURE OF COOLEY AND SEPERATOR CREAM.

The plan first proposed was to weigh a batch of Cooley cream at the creamery as it was put into the churn, weigh the water and salt added in the butter making and also the buttermilk, washings and butter, and from the analyses of all these products determine just where each ingredient of the cream had gone. The same course was to be followed with a batch of Separator cream, and also with a batch of mixed Cooley and Separator cream.

The Creamery built for business purposes wholly, necessarily offers imperfect facilities for experiments of this kind, and makes the work of collecting and weighing the cream, the buttermilk and washings, extremely arduous while the chances of mechanical loss are large.

In later experiments the work was therefore limited to determining the total quantity of butter-fat which was in the cream and the quantity which was lost in buttermilk and washings.

COOLEY CREAM.

On March 6th the observations were begun with a lot of Cooley cream, which was received at the Creamery at 3.45 P. M. Its weight as received was 729⅛ pounds. Some of the cream was frozen, and after mixing in the ripening vat, the temperature of the whole was 40° F. It was immediately warmed so that at 5 P. M. the temperature was 70°. During the night it sunk to 66°, but was brought to 70° in the morning of March 7th, and held there till 10.30 when it was cooled for churning. At 1.30 P. M. the temperature was 63°, but rose one degree during the weighing as it was transferred to the churn. The weight of the cream as put into the churn was 730½ pounds, to which was added for rinsing the vat, 8⅝ pounds of water. After a few oscillations of the churn to mix thoroughly, the churn was stopped and one pound and one ounce was removed for laboratory sample, making the net weight of the cream churned, $738\frac{1}{16}$ pounds.

The churning required 56 minutes and the butter came in fine granular condition. A small, weighed quantity of water was used to rinse down the sides and cover of the churn towards the end of the churning and this of course went in with the buttermilk. After the buttermilk was drained off, weighed and sampled, the butter in the churn was washed with a weighed quantity of water. This was then drawn off and in the following tabular statement is called "first washings." A smaller weighed quantity of water was next poured in to float the butter so that it could be conveniently removed from the churn. After the butter had all been taken out, this water was run off, weighed and sampled and is called for convenience the "second washings." On the weights of the butter and other milk products and their analyses the following calculations are based. The analyses are first given and next the calculations made from them.

ANALYSES OF THE COOLEY CREAM AND BY-PRODUCTS.

	Cooley Cream.†	Buttermilk.	First Washings.	Second Washings.
Mineral matter,	.77	1.14	.15	.68
Curd,*	3.00	3.25	.50	.25
Sugar, by difference,	4.07	5.23	.61	.25
Fat,	16.28	.16	.08	.04
Water,	75.88	90.22	98.66	98.78
	100.00	100.00	100.00	100.00

* Throughout this paper "curd" denotes all the nitrogenous matter of the milk products, and its per cent. is the product of the per cent. of nitrogen multiplied by 6.25.

† The mixture of 730¼ pounds of cream and 8⅝ pounds of water.

		Fat.	Curd.	Sugar.	Mineral Matter.	Water.
There went into the churn, in pounds—						
Cream	738 1/16 pounds, containing	120.16	22.14	30.04	5.68	560.04
Water, for rinsing, washing and floating the butter	756 3/16 "	.....	.....	.....	.....	756.18
There was added during the working, salt	8 9/16 "	.....	.....	.....	8.56	.....
Total	1502 13/16	120.16	22.14	30.04	14.24	1316.22
There was taken out of the churn, in pounds:—						
Buttermilk	534 6/16 pounds, containing	.85	17.37	27.95	6.09	482.11
First Washings	534 15/16 "	.43	2.67	3.26	.80	527.77
Second Washings and draining from butter	239 2/16 "	.09	.60	.60	1.63	236.20
Butter, worked only once (by difference)	196 3/16 "	118.79	1.50		5.72	70.14
Total	1504 10/16‡	120.16	22.14	31.81‡	14.24	1316.22

‡ Excess due to errors of sampling and analysis.

In this case 1.37 pounds or 1.14 per cent. of the total butter-fat was lost in the buttermilk and washings; otherwise expressed, for every 100 pounds of finished butter made, one pound and two and one-quarter ounces of butter were lost in the buttermilk and washings.* This is a very much larger percentage of loss than was found in any of our subsequent experiments. There is little doubt that it is due to the fact that a portion of the cream had been frozen. From such cream good churning results are not to be expected. The results are introduced here, because they are instructive in showing what heavy losses may arise from this cause. At this point the Station representative was obliged to leave the work on account of serious illness.

On the 2d of May the observations were taken up again. The plan followed was the same as before except that the cream was weighed but once and at the time when it was received from the cream gatherer. Samples of the cream, butter, and other products were sent to the Station, preserved when necessary by corrosive sublimate or potassium bichromate, and were analyzed in duplicate by gravimetric methods.

Cooley Cream.

There was received at the Creamery at 9.10 A. M., 411½ pounds of Cooley cream, having a temperature of 48 degrees. At 11 A. M. the temperature was raised to 70°. From time to time the degree of acidity of the cream was determined and is expressed in the following table in per cent. of lactic acid:

Time.		Temperature of Milk.	Per cent. of Lactic Acid.
May 2d,	9.10 A. M.	48° F.	.25
"	11.00 "	"	--
"	12.00 "	72° F.	--
"	2.00 P. M.	70½° F.	.31
"	3.00 "	70° F.	.35
"	4.00 "	69° F.	.37
"	5.00 "	"	.38
May 3d,	5.30 A. M.	64° F.	.71

The cream was cooled to 62° F., and churned in the Davis Swing Churn May 3d, at 9.50 A. M. The time occupied in churning was 55 minutes. The details of the test are here presented in tabular form.

* Reckoning that the finished butter contains 82 per cent. of butter fat.

Analyses of the Cooley Cream, Butter and By-Products.

	Cooley Cream.	Butter-milk.	First Washings.	Second Washings.	Butter.
Mineral matter	.57	.60	.14	.17	3.07
Curd	2.78	2.69	.66	.16	1.03
Sugar, by difference	3.98	3.79	1.02	.27	----
Fat	16.08	.08	.02	.00	82.80
Water	76.59	92.84	98.16	99.40	13.10
	100.00	100.00	100.00	100.00	100.00

			Fat.	Curd.	Sugar.	Mineral matter.	Water.
There went into the churn, in pounds—							
Cream	$411\frac{8}{16}$	containing	66.17	11.44	16.38	2.35	315.16
Water for rinsing, washing and floating the butter	612	"	....	....	....	....	612.00
There was added during the working, salt	$4\frac{1}{16}$	"	....	....	....	4.06	....
Total	$1027\frac{9}{16}$	"	66.17	11.44	16.38	6.41	927.16
There was taken out of the churn, in pounds:—							
Buttermilk	$317\frac{14}{16}$	containing	.25	8.55	12.05	1.91	295.12
First washings	$372\frac{10}{16}$	"	.08	2.46	3.80	.52	365.76
Second washings and draining from the butter	$239\frac{4}{16}$	"	....	.38	.65	.41	237.81
Butter, worked twice and ready to print	$79\frac{12}{16}$	"	66.03	.82	....	2.45	10.45
Total	$1009\frac{8}{16}$	"	66.36	12.21	16.50	5.29	909.14

It appears from this balance sheet that in the 26 weighings involved in the experiment there is an apparent error of 18.06 pounds, or 1.7 per cent. of the whole weight.

There is an apparent loss of water and salt amounting to 19.14 pounds which is due to unavoidable mechanical loss in handling these large quantities of water and washings, and to losses on the butter worker which on account of its construction, it was impossible to avoid. The quantity of sugar in the products from the churning is practically the same as the quantity found in the cream. There appears a small excess of both butter-fat and of curd in the products of the churning, amounting in the former to about three ounces and in the latter to 12 ounces. This discrepancy is chiefly due to imperfect sampling of the butter. It is extremely difficult to draw a sample of butter which shall accurately represent the lot from which it is drawn. The water in the butter is not evenly diffused through it but is in drops which yield to the slightest pressure and run off so that one is likely to get in the sample a less proportion than the whole mass contains. These discrepancies, however, do not affect the value of the observations for the present purpose. It appears that of the 66.17 pounds of butter-fat which went into the churn, .33 pounds or 5.3 ounces were lost in buttermilk and washings. This amounts to .5 per cent. of the total fat. Otherwise expressed, for every 100 pounds of butter made, 6.4 ounces of butter-fat or 8 ounces of butter were lost in the buttermilk and washings.*

Separator Cream.

A batch of cream separated by the DeLaval machine, representing the milk from three patrons, was also received at the creamery on May 2d. Its weight was 284.4 pounds and its temperature when received was 56°, or 8° warmer than the Cooley cream. It was also apparent that it had not been properly cared for by the producers, because it was quite sour when received as the following table shows. It was weighed and brought into the ripening vat at 11.30 A. M. The temperature and course of ripening is shown in the table:

* Whenever in this paper it has been desirable to calculate the butter represented by small quantities of butter-fat, it has been done by multiplying the weight of butter-fat by 1.22, thus assuming that average butter contains 82 per cent. of fat.

	Time.	Temperature.	Per cent. of Lactic Acid.
May 2d,	9.30 A. M.	56° F.	.56
"	11.30 "	58°	.56
"	12.10 P. M.	58°	.56
"	2.00 "	62°	.56
"	3.00 "	62°	.57
"	4.00 "	63°	.58
"	5.00 "	63°	.61
May 3d,	5.30 A. M.	61°	.70

The acidity of the cream when churned was precisely the same as that of the Cooley cream already spoken of. The cream after adding water to thin it, was churned at a temperature of 60°. The churning required 30 minutes. The further conduct of the experiment may be learned from the following table:

ANALYSES OF THE SEPARATOR CREAM, BUTTER AND BY-PRODUCTS.

	Cream.	Buttermilk.	First Washings.	Second Washings.	Butter.
Mineral matter	.76	.50	.11	.32	4.35
Curd	2.38	2.31	.50	.22	.82
Sugar	3.79	3.72	.69	.16	----
Fat	26.08	.21	.01	--	82.56
Water	66.99	93.26	98.69	99.30	12.27
	100.00	100.00	100.00	100.00	100.00

There went into the churn, in pounds:—		Fat.	Curd.	Sugar.	Mineral Matter.	Water.
Cream	$284\frac{6}{16}$ pounds, containing	74.17	6.77	10.78	2.16	190.52
Water for rinsing, washing and floating the butter	$575\frac{1}{16}$ " "	----	----	----	----	575.07
There was added during the working, salt	$5\frac{15}{16}$ " "	----	----	----	5.94	----
Total	$865\frac{6}{16}$	74.17	6.77	10.78	8.10	765.59

There was taken out of the churn, in pounds:—		Fat.	Curd.	Sugar.	Mineral Matter.	Water.
Buttermilk	$227\frac{14}{16}$ pounds, containing	.48	5.26	8.48	1.14	212.52
First Washings	$352\frac{12}{16}$ " "	.04	1.76	2.43	.39	348.13
Second Washings and draining from the butter	$191\frac{6}{16}$ " "	----	.42	.31	.61	190.04
Butter, worked twice and ready to print	$88\frac{2}{16}$ " "	72.76	.72	----	3.83	10.82
Total	$860\frac{2}{16}$	73.28	8.16	11.22	5.97	761.51

There is here an apparent loss of about 6 pounds of water and salt, to be explained as in the former case. The sugar in the churn products tallies very nearly with that of the cream which was put in. There is an apparent gain of 1.4 pounds of curd, due to imperfect sampling of the butter, and a loss of .9 pounds of fat. The actual loss of fat in the buttermilk and washings amounts to .52 pounds; that is, of the 74.17 pounds of butter-fat which went into the churn, .52 pound or 8.3 ounces were lost in buttermilk and washings. This amounts to .7 per cent. of the total butter-fat. Or expressed otherwise, for every 100 pounds of butter made, 11½ ounces of butter are lost in buttermilk and washings.

Mixed Cooley and Separator Cream.

On May 3d there was weighed into the ripening vat as it was received from the cream gatherer, 129.5 pounds of Separator cream, and 225.9 pounds of Cooley cream; total 355.4 pounds. This was received at noon and warmed at once to 70° F. The following observations were made on the temperature and acidity.

Time.	Temperature.	Per cent. of Lactic Acid.
May 3d, 12.00 M.	70° F.	--
" 2.00 P. M.	70°	.35
" 3.00 "	70°	.40
" 4.00 "	70°	.46
May 4th, 5.30 A. M.	63°	.65

At 7.00 A. M., May 4th, this mixed cream was churned at a temperature of 61°. The churning required one hour and 15 minutes. The further details of the experiment will appear in the following statement:

Analyses of the Mixed Cream, Butter and By-Products.

	Mixed Cream.	Buttermilk.	First Washings.	Second Washings.	Butter.
Mineral Matter	.59	.54	.11	.16	4.78
Curd	2.78	2.28	.66	.09	1.07
Sugar	4.17	3.66	.86	.45	----
Fat	18.95	.11	.02	.00	83.53
Water	73.51	93.41	98.35	99.30	10.62
	100.00	100.00	100.00	100.00	100.00

		Fat.	Curd.	Sugar.	Mineral Matter.	Water.
There went into the churn —						
Cream	355 6/16 pounds, containing	67.35	9.88	14.82	2.10	261.22
Water for rinsing, washing and floating the butter	608 10/16 " "	----	----	----	----	608.63
There was added during the working, salt	5 1/16 " "	----	----	----	5.94	----
Total	969 1/16	67.35	9.88	14.82	8.04	869.85
There was taken out of the churn:						
Buttermilk	318 8/16 pounds, containing	.35	7.26	11.66	1.72	297.51
First Washings	359 8/16 " "	.07	2.37	3.09	.40	353.57
Second Washings and draining from the butter	189 " "	----	.17	.85	.30	187.68
Butter worked twice and ready to print	78 12/16 " "	65.78	.84	----	3.77	8.36
Total	945 12/16	66.20	10.64	15.60	6.19	847.12

The larger deficit of water in this observation was due to the accidental loss of a part of the second washings, which, however, involved no loss of fat. An apparent gain of curd and loss of mineral matter (salt), due to errors and losses of experiment, is noted here as in the previous cases. There is also a deficiency of 1.15 pounds of butter-fat due to errors in sampling the butter. The analyses of the buttermilk and washings show that they contained .42 pounds of butter-fat, which of course was lost to the creamery. This is .62 per cent. of the total butter-fat. Otherwise expressed, in making 100 pounds of butter, there has been lost $10\frac{2}{5}$ ounces of butter.

Omitting the first test which was made with damaged cream and was not carried to its full conclusion, the results of the three tests may be summarized as follows:

Losses in Buttermilk from Churning Mixed Cream of Creamery Patrons.

For every 100 pounds of butter made, there is lost in the buttermilk and washings:

	Ounces of butter.	Money equivalent.*
Cream raised by the Cooley system	8	16 cents.
Cream raised by the Separator system	11 1-2	23 "
Mixture of cream raised by the two systems	10 2-5	21 "

The foregoing tests were made with large quantities of cream ripened and churned in precisely the same way as all the rest of the cream which is taken to the creamery and show the losses of butter in the buttermilk and washings which occurred in every day practice at this creamery with Cooley cream, Separator cream and mixtures of the two, at the time these experiments were undertaken. They show that there was a money loss in the buttermilk and washings from Separator cream greater by seven cents per 100 pounds of butter made, than in the buttermilk and washings from the Cooley cream. The losses in buttermilk and washings from a mixture of Separator and Cooley cream were a little less than in those from Separator cream alone. It should be remarked that the Separator cream whenever it came under observation of the Station chemist, was already quite sour when it reached the creamery, being considerably warmer than the Cooley cream. This ought not to be and it is a fault not of the system but of the patron, due to carelessness. There is no necessity for sour cream in May. Separator cream should be cooled below 50° as soon as separated and kept in a cold, clean place till taken by the cream gatherer. The place to ripen cream is the creamery, not the pantry or milk room of the patron, and to insure the best quality of butter, the *whole* of the cream must come sweet to the creamery. It has been fully demonstrated that the best butter cannot be made from a mixture of portions of cream of different degrees of ripeness, and in this comparison the Separator cream suffers because of this souring previous to its coming to the creamery.

* Butter at 32 cents per pound.

The above tests are made with cream from different herds. The Cooley cream came from a considerable number of herds and was mixed by the cream gatherer. The Separator cream came from three or four *other* herds. It is quite possible that the one lot of cream, represented on the whole, cows better kept and better fed, and cream better protected from contamination before being turned into the creamery, than the other. It may also be claimed that neither the Separator nor the Cooley system was in in all cases properly used by the patrons; so that the results do not show what the two systems can do *at their best.*

These considerations made it desirable to carry out still another trial which we were able to do by the courtesy of Mr. Gardiner Sumner, of Woodstock, who placed the milk of his herd at our disposal for the week beginning November 6th.

This herd consists of five grade Guernseys, three thoroughbred and five grade Jerseys, and one grade Short-horn.

Their feed was two quarts of bran, one of corn-meal and one of gluten feed per day and head, with hay in the morning and a feed of pumpkins at night. The herd was turned to pasture during the day.

The milking was begun punctually at six o'clock morning and evening. The milk was always brought to the milk-room as soon as two pails were filled, was strained at once into Cooley cans which were then promptly submerged in water of from 40° to 44° F., containing ice to keep the temperature down.

The milk stood ten hours during the day and eleven hours during the night, before skimming.

The DeLaval Separator was furnished for these tests by the DeLaval Separator Co., of New York, and it was operated by their agent, Mr. F. J. Parker.

The cream was weighed always by the Station representative on scales sensitive to one-quarter of an ounce, and when poured from one vessel to another the emptied vessel was carefully rinsed with a very little water which was added to the cream.

The general plan followed was to set by the Cooley system, the milk of one night and of the following morning. The night's milk was skimmed at 5 A. M., the morning's milk at 4.00 to 4.30 P. M.

The cream from these two settings was immediately mixed and taken to the creamery.

From the milk of the following night and morning the cream was taken by the DeLaval Separator, mixed and immediately carried to the creamery.

Each lot of cream, as soon as it was received there, was put into deep cans, standing in a tank of water, and kept as nearly as possible at 70° F. till it was ripe and ready for churning.

The churning was done by hand in a barrel churn of the so-called "Surprise" pattern.

All weights were made by the Station representative. The care of the cream and the churning, however, was entirely under the management of the butter maker, Mr. Hopkins. The butter-milk was carefully weighed and analyzed to ascertain directly the loss of fat in it.

The weather during the whole experiment was quite alike from day to day, being uniformly fair with sharp frost at night. The details of the experiment follow. The general result is given on pages 162 and 163.

Cooley Cream.

The Cooley cream from night's milk of November 8th, and morning's milk of November 9th weighed 58.75 pounds, and its temperature was 53° F. when taken to the creamery. It contained 10.08 pounds of butter-fat. It was brought to 70° immediately and kept there till into the evening. During the night it cooled to 64° but at 6 A. M. on the 10th it was brought to 70° and kept there through the day, with occasional stirring. At night it fell again to 60° and was again brought on the morning of the 11th to 70° and held there till 4.30 P. M., when it was ripe enough to churn.

It required nearly forty-six hours to ripen this lot.

It was cooled to 56° and churned at that temperature. The churning took 27 minutes and the butter came in fine-granular condition.

The buttermilk weighed 61.37 pounds and contained .035 per cent. or $\frac{34}{100}$ ounces of butter-fat.

From the churning there was made 12 pounds of butter. Hence for every 100 pounds of butter made there was lost in the buttermilk 3.5 ounces, the equivalent of 7.0 cents.

Separator Cream.

The Separator cream from the night's milk of November 9th and morning's milk of November 10th weighed 34.23 pounds, contained 10.23 pounds of butter-fat and had a temperature of 63° when received at the creamery. It was kept at 70° from 9.30 A. M. of the 10th till 2.30 of the 11th, 29 hours in all, except that during the night the temperature sank to 60°. It was churned at a temperature of 50° F. in the barrel churn. Twenty-two minutes were required for the churning and the butter came in excellent condition, fine-granular and firm.

The buttermilk weighed 37 pounds and contained .085 per cent. or $\frac{50}{100}$ ounce of butter-fat.

From the churning was made 12.56 pounds of butter.

Hence for every 100 pounds of butter made there was lost in the buttermilk 4.9 ounces of butter; the equivalent of 9.8 cents.

Mixed Cooley and Separator Cream.

The Cooley cream from the night's milk of November 10th and the morning of November 11th was mixed with the Separator cream from the night's milk of November 11th and the morning's milk of November 12th and the mixture was brought to the creamery.

The total weight of cream was 101.65 pounds and contained 21.02 pounds of butter-fat.

It was received at the creamery at 10 A. M. of the 12th and was brought at once to 70° and held at that temperature, except as it fell during the night time, till 7.30 A. M. on the 14th when the cream was ripe for churning. Time of ripening, 45½ hours. The cream was cooled to 53°–54° F. and churned in the barrel churn. The quantity of cream, double that used in the other two tests, was a little more than could be conveniently handled in this churn. It would have been better to make two churnings of it. The butter came in 16½ minutes, but did not seem as fine as the previous lots nor was it as distinctly granular.

The buttermilk weighed 87.19 pounds and contained .095 per cent. or $1\frac{32}{100}$ ounces of butter-fat.

From the churning were made 25¼ pounds of butter.

Hence for every 100 pounds of butter made there was lost in the buttermilk 6.3 ounces of butter, the equivalent of 12.6 cents.

The two sets of observations may now be summarized. The first set shows what losses of butter-fat in the buttermilk and washings are to be expected in general creamery practice when Cooley cream and Separator cream are ripened and churned, each by itself, and when the two kinds of cream are mixed before ripening and are churned together. The Separator cream in these experiments was quite sour when it reached the creamery, showing that it had not been properly cared for by the patrons.

The second set of observations shows the losses of butter-fat in buttermilk and washings when cream properly raised and handled from one and the same herd, is used for the comparison of the Cooley and Separator systems and for the churning of a mixture of the two.

Losses of Fat in Buttermilk.

For every 100 pounds of butter made there is lost in the buttermilk and washings:

	Ounces of butter.	Money equivalent.
Cooley system, mixed cream of different herds	8	16 cents.
Cooley system, cream of single herd properly handled	3 1-2	7.0 "
Separator system, mixed cream of different herds	11 1-2	23 "
Separator system, cream of single herd properly handled	4 9-10	9.8 "
Mixed Cooley and Separator system, cream of different herds	10.4	21 "
Mixed Cooley and Separator system, cream of one herd	6 3-10	12.6 "

The general results are as follows:

First: There was in every case, a larger loss of butter in the buttermilk from Separator cream than from Cooley cream.

Second: In one case this increased loss by the Separator system amounted to 7 cents for every 100 pounds of butter made; in the other case to 3 cents, less than half as much.

Third: It is fair to suppose that the losses in buttermilk could be reduced one-half, at least, if the milk and cream were properly handled by the patrons.

Fourth: The loss of butter in the buttermilk, from a churning of mixed Cooley and Separator cream, is not very different from the loss in a churning of Separator cream by itself.

The quality of the butter made by the two systems will be spoken of further on.

The losses of fat in the buttermilk are not by any means the only ones in the creamery, nor are they always the largest losses. Experiment has shown that there is often a considerable mechanical loss due partly to carelessness in draining the cream-carriers as well as to the sticking of cream and butter to the utensils during ripening, churning and butter-working.

To reduce the mechanical loss of cream as much as possible, the Separator should be set to deliver the cream as thin as the cream from deep-setting systems.

2. COMPARISON OF THE RELATIVE EFFICIENCY OF THE DeLAVAL SEPARATOR AND THE COOLEY SYSTEM FOR SEPARATING CREAM.

In connection with the work above described, the opportunity was taken to test the efficiency of these two systems side by side on milk of the same herd and of nearly the same composition.

The details of the tests will be given first for the benefit of any who wish to make a critical examination of them and the final results will be concisely stated in conclusion for the general reader.

The first tests were made during the week beginning Monday, May 22, on the farm of Mr. Sumner, already referred to. Fourteen of the cows were the same described on page 159. They were all old in milk, most of them having calved in September and October, 1892. Eighteen cows were being milked. They were at pasture but were fed corn meal and shorts. The cows are kept with very exceptional neatness. The stables are very clean and the cows, bags and teats are washed off every morning before milking. The same neatness and care characterize the handling of the milk and cream. The milk in all the following experiments and in accordance with Mr. Sumner's usual practice is brought as soon as two pails are ready from the stable to the milk room which is near by, strained into Cooley cans which are immediately submerged in the tank, in water having a temperature of from 40° to 44°. The times of milking and of skimming given in the last experiments were here observed, and the cream was cared for in the same way.

EXPERIMENTS OF MAY 22D TO MAY 26TH.

May 22d, evening. Cooley system. Temperature of water in which the milk was submerged, 42°; temperature at skimming time, 48°.

May 23d, morning. Cooley system. Temperature of water, 45°. Ice was immediately added to reduce temperature to 42°. Temperature at skimming time, 47°.

May 23d, evening. DeLaval separator (Baby, No. 2), operated by Mr. Lindermann. It was run with about 48 revolutions of the crank per minute. After the milk was run through, a quart or two of skim milk was used to free the bowl of the Separator from cream.

May 24th, morning. DeLaval separator.

May 24th, evening. Cooley system. Temperature of water, 43°. Temperature at skimming time, 45°.

May 25th, morning. Cooley system. Temperature of water, 45°.

May 25th, evening, and May 26th, morning. DeLaval separator.

The weighings and analytical results for economy of space are all given together in the following table:

COMPARISON OF EFFICIENCY OF SKIMMING BY COOLEY SYSTEM AND DELAVAL SEPARATOR.

Observations of May 22d to May 26th, 1893.

	MILK.				CREAM.			SKIM-MILK.			
	Weight.	Per cent. of Fat.	Weight of Butter-Fat.	Spaces.	Weight.	Per cent. of Fat.	Weight of Butter-Fat.	Weight.	Per cent. of Fat.	Weight of Butter-Fat.	In 1000 lbs. of milk having 4.9 per cent. of fat there is lost of Butter-Fat.
	Pounds.		Pounds.		Pounds.		Pounds.	Pounds.		Pounds.	Pounds.
Cooley System, Monday P. M.	168.75	4.71	7.948	57	43.25	17.68	7.647	125.500	.242	.304	1.85
" Tuesday A. M.	123.50	5.24	6.471	49	35.875	17.37	6.231	88.125	.275	.242	
Total	292.25		14.419	106	79.125		13.878	213.625		.546	
Cooley System, Wednesday P. M.	145.875	4.53	6.608	48	36.875	17.26	6.365	109.000	.23	.251	1.77
" Thursday A. M.	131.375	5.29	6.949	51	38.750	17.34	6.719	92.625	.26	.241	
Total	277.250		13.557	99	75.625		13.084	201.625		.492	
DeLaval Separator, Tuesday P. M.	140.875	4.48	6.311	"	19.875	30.60	6.082	121.000	.195	.236	1.65
" Wednesday A. M.	124.500	5.36	6.673	"	20.375	31.78	6.475	104.125	.195	.203	
Total	265.375		12.984	"	40.250		12.557	225.125		.439	
DeLaval Separator, Thursday P. M.	149.375	4.56	6.811	"	27.375	24.07	6.589	122.000	.18	.220	1.23
" Friday A. M.	117.000	5.09	5.955	"	21.875	26.72	5.845	95.125	.105	.100	
Total	266.375		12.766	"	49.250		12.434	217.125		.320	

The table shows that something over 500 pounds of milk was creamed in four different lots, by each method.

The milk was from the same herd and contained, practically, the same per cent. of fat; the milk creamed by the Cooley system containing 4.94 per cent. of fat, that by the DeLaval, 4.87.

The average per cent. of fat in the Cooley skim milk was .25; in Separator skim milk, .17 per cent.

In 1000 pounds of milk creamed .37 of a pound of butter-fat was lost in the Cooley skim milk, which was saved by the DeLaval separator.

The losses of butter-fat in handling and churning the Separator cream, were, however, larger than in handling Cooley cream, so that in this test notwithstanding the somewhat closer skimming by the Separator system, it required to make one pound of butter, 16.4 pounds of milk creamed by the Separator and 15.9 pounds of milk creamed by the Cooley system.

Sample prints of the butter from Cooley cream, marked B, and of the butter from Separator cream marked A were immediately submitted to Mr. O. Douglass, of Boston, to be scored, no information being given him regarding the origin of the samples. Following is his report:

	Perfect.	Sample A, Separator Butter.	Sample B, Cooley Butter.
Flavor	50	50	50
Texture and grain	30	28	30
Color	10	10	10
Salt	10	10	10
	100	98	100

The quantity of fat left in the skim milk by the Separator was so much more than has been found in other observations as to create the suspicion that either the Separator itself was not in order or that it was not run at the proper speed.

It was accordingly thought best to make still another comparison, which was done early in November.

Experiments of November 6th to November 12th.

The weather during this test was fair, no rain or snow falling for the week. The days were warm, "Indian Summer," the nights frosty, making a thin sheet of ice on shallow pools.

The cows were fed a mixture of two quarts of bran, one quart corn meal and one quart gluten feed per day and head with a ration of hay in the morning and pumpkins at night. They pastured during the day. The milk and cream were handled as in the experiments on Mr. Sumner's farm, already described. The DeLaval Separator was furnished by the DeLaval Separator Co., and was operated by their agent, Mr. F. J. Parker. After the whole of the milking was run through the Separator a weighed quantity of warm water was run through the machine to clear out all cream from the bowl. This water went into the skim milk.

November 6th, evening. Cooley system. Temperature of water, 43°.

November 7th, morning. Cooley system. Temperature of water, 40°.

November 7th, evening and November 8th, morning. DeLaval Separator.

November 8th, evening. Cooley system. Temperature of water, 43°.

November 9th, morning. Cooley system. Temperature of water, 44°.

November 9th, evening and November 10th, morning. DeLaval Separator.

November 10th, evening. Cooley system. Temperature of water, 42°.

November 11th, morning. Cooley system. Temperature of water not recorded.

November 11th, evening and November 12th, morning. DeLaval Separator.

It appears that in this test, for every 1000 pounds of milk creamed, 2.06 pounds of butter-fat were lost by the Cooley system which were saved by the Separator.

The results of churning tests show that to make one pound of butter there were required on the average, 17 pounds of milk creamed by the Separator system and 17.9 pounds of the same milk creamed by the Cooley system.

From the butter made from the Cooley cream of November 6th, evening, and November 7th, morning, a sample pound package was made, marked G.

A sample from the butter made from Separator cream of November 7th, evening, and November 8th, morning, was marked B.

COMPARISON OF EFFICIENCY OF SKIMMING BY COOLEY SYSTEM AND DELAVAL SEPARATOR.

Observations of November 6th to November 12th, 1893.

	MILK.				CREAM.			SKIM-MILK.			
	Weight.	Per cent. of Fat.	Weight of Butter-Fat.	Spaces.	Weight.	Per cent. of Fat.	Weight of Butter-Fat.	Weight.	Per cent. of Fat.	Weight of Butter-Fat.	In 1000 lbs. of milk having 4.9 per cent. of fat, is lost of Butter-Fat.
	Pounds.		Pounds.		Pounds.		Pounds.	Pounds.		Pounds.	Pounds.
Cooley System, Nov. 6, P. M.	119.130	4.24	5.051	41	31.44	15.56	4.892	87.69	.19	.167	
" " 7, A. M.	102.375	4.95	5.068	35	27.13	17.44	4.732	75.245	.45	.339	
Total	221.505		10.119	76	58.57		9.624	162.935		.506	2.45
Cooley System, Nov. 8, P. M.	108.750	4.70	5.111	38½	30.03	16.43	4.934	78.72	.23	.181	
" " 9, A. M.	114.685	5.19	5.952	40	30.825	17.85	5.502	83.86	.53	.444	
Total	223.435		11.063	78½	60.855		10.436	162.58		.625	2.77
Cooley System, Nov. 10, P. M.	128.855	4.52	5.824	45	34.28	16.17	5.543	94.575	.29	.274	
" " 11, A. M.	118.090	5.12	6.046	40	31.59	17.46	5.516	86.50	.62	.536	
Total	246.945		11.870	85	65.87		11.059	181.075		.810	3.35
Separator System, Nov. 7, P. M.	110.560	4.67	5.163	--	14.20	35.83	5.088	101.81	.08	.081	
" " 8, A. M.	93.990	5.32	5.000	--	14.47	34.12	4.937	86.50	.07	.061	
Total	204.550		10.163	--	28.67		10.025	188.31*		.142	.68
Separator System, Nov. 9, P. M.	119.370	4.66	5.563	--	18.31	29.99	5.491	104.53	.07	.073	
" " 10, A. M.	102.740	5.12	5.260	--	17.44	29.78	5.194	90.28	.08	.072	
Total	222.110		10.823	--	35.75		10.685	194.81†		.145	.65
Separator System, Nov. 11, P. M.	119.385	3.83	4.572	--	16.265	27.24	4.431	103.12	.14	.144	
" " 12, A. M.	138.860	4.39	6.096	--	22.060	27.22	6.005	118.25	.07	.083	
Total	258.245		10.668	--	38.325		10.436	221.37‡		.227	1.03

* Including 12.43 pounds of water to clear the bowl of cream.
† Including 8.45 pounds of water to clear the bowl of cream.
‡ Including 1.45 pounds of water to clear the bowl of cream.

The sample from Cooley cream of November 8th, evening, and November 9th, morning, was marked A.

The sample from Separator cream of November 9th, evening, and November 10th, morning, was marked H.

The Cooley cream of November 10th, evening, and November 11th, morning, was mixed with Separator cream of November 11th, evening, and November 12th, morning, and the two lots were ripened and churned together.

This lot was too large to be conveniently churned in the barrel churn at one time and should have been churned in two lots. The sample package was marked F.

These five samples were immediately taken to Mr. Fales, of the firm of Fales & Lehy, dealers in butter, cheese and eggs, 30 and 32 Commercial street, Boston, Mass. Mr. Fales has acted as judge of butter at the State Dairymen's Association in this State and is considered as competent a judge of butter as can be found. After examination, in which he pronounced A the best as regards flavor, and F the poorest in texture, it was decided to leave the samples in his care in cold storage for a few days as the butter was then too fresh to judge closely of its texture and grain. No information regarding the origin of the samples was given to Mr. Fales and no one excepting the representative of the Station knew the significance of the letters by which the samples were marked. The judgment of Mr. Fales is as follows:

	Flavor.	Texture and grain.	Color.	Salt.	Total.
Perfect quality requires	50.0	30	10	10	100
Sample A, Cooley	48.0	30	10	10	98
" G, Cooley	42.0	30	10	10	92
" B, Separator	47.0	30	10	8	95
" H, Separator	46.0	30	10	10	96
" F, mixed Cooley and Separator	47.0	27	10	10	94

Mr. Fales also wrote, "Sample F would have been a fine piece of butter if there had been any body to it. It was either worked too much or there was some trouble with the cream."

The batch of cream from which this lot of butter was made was twice as large as any of the others, and should have been divided and churned in two portions. It is believed that its texture suffered because this was not done. If so, its low score should be charged to errors of manipulation rather than to the character of the cream.

One ounce of salt was added to each pound of butter at the first working. All of the samples are graded perfect in salt except B, Separator, which is scored off two points but whether because of deficiency or excess of salt is not known.

CONCLUSIONS.

The relative merits of the two systems of creaming are not to be established by any single experiment or series of experiments. The object of these tests was in part to meet certain extravagant claims and charges made by interested persons regarding the two methods.

The observations show that in these tests which were made with all possible care:

1. There was no significant difference in the quality of the butter made from cream raised by the Cooley system and by the Separator system.

2. In each trial the Separator got more butter-fat from 1000 pounds of milk than the Cooley system of creaming.

The Cooley system left from 1.77 to 3.35 pounds of butter-fat in skim milk from 1000 pounds of whole milk while the Separator in milk of the same composition left from .65 to 1.65 pounds.

3. The losses of fat in the buttermilk and butter washings were in both tests larger when Separator cream was churned than when Cooley cream was churned.

The loss in Separator cream over and above that in Cooley cream was equal to from 1 1-2 to 3 1-2 ounces of butter in every 100 pounds of butter made.

4. When Cooley cream and Separator cream were ripened and churned together the loss of fat in the butter milk and washings was about the same as when Separator cream was ripened and churned by itself.

5. In one test it required 15.9 pounds of milk creamed by the Cooley system to make a pound of butter and 16.4 pounds of same milk creamed by the Separator to make a pound of butter.

In the second test it required 17 pounds of milk creamed by the Separator to make a pound of butter and 17.9 pounds of the same milk, creamed by the Cooley system.

ON THE GUNNING-KJELDAHL METHOD AND A MODIFICATION APPLICABLE IN THE PRESENCE OF NITRATES.*

BY A. L. WINTON.

The Gunning-Kjeldahl Method (*in absence of nitrates.*)

The modification of the Kjeldahl method, proposed by Gunning in 1889, has since been indorsed by a number of well-known chemists.

The Gunning method is very simple, the only reagents used previous to the distillation with caustic soda being sulphuric acid and potassium sulphate, the latter taking the place of the three reagents—mercury (oxide or metallic), potassium permanganate and potassium sulphide—ordinarily used.

The mixture of sulphuric acid and potassium sulphate boils at a high temperature, and, as a rule, oxidizes the organic substance more rapidly than the ordinary mixture of sulphuric acid and oxide of mercury.*

The results obtained by Gunning,† Atterberg,‡ Van Slyke§ and others, including the writer, on fodders, dairy products, fertilizers free from nitrates, and various organic substances, show that this method is fully as accurate as the ordinary Kjeldahl method, and, in some cases, gives better results. It is a well known fact that the nitrogen of many alkaloids, azo-compounds and various bodies of the aromatic series cannot be determined by the usual Kjeldahl method, but Gunning and Atterberg have obtained good results on morphine, quinine, indigo and aniline oxalate by the Gunning modification.

The chief disadvantage of the method is the frothing which occurs during the first part of the heating. This frothing, however, causes but little trouble if a flask of at least 500 c.c. capacity (which can afterwards be used for the distillation), is employed and care be taken in adjusting the heat.

*Published as Bulletin No. 112, in June 1892, but by an oversight not included in the Annual Report for that year. It is here reprinted without essential change except that 12 additional test-analyses are appended to the 25 originally given at the conclusion, p. 148.

† Fres. Zeit., **28**, 188.

‡ Chem. Zeitung, **14**, 509.

§ U. S. Dept. Agr. Div. Chem. Bull., **31**, 142.

The Gunning mixture is, at ordinary temperatures, half-solid, and must be heated before it can be measured for use. It is therefore best to add 18 grams of potassium sulphate and 20 c.c. of sulphuric acid, separately and in the order named, to the flask containing the substance, shaking a few times before heating. The coarsely powdered sulphate may be conveniently measured out in a cartridge-shell adjusted to hold 18 grams and provided with a wire handle. The acid may be added from a graduated cylinder or a burette of wide calibre connected by a siphon with the acid reservoir.*

After the digestion is completed water should be added before the mixture becomes too cold, otherwise it is difficult to obtain a solution of the solid mass.

The writer has found that the fertilizer-chemical known in the trade as "High Grade Sulphate of Potash," and costing but a few cents a pound, answers every purpose, and is, in fact, better than the white sulphate of the apothecary, being usually free from moisture and chlorides, the presence of which tends to increase the frothing.

Following is a comparison of results, obtained by the methods named, on those forms of organic nitrogenous matter which are most commonly used in mixed fertilizers, and on four commercial fertilizers free from nitrates.

	Kjeldahl Method.	Gunning-Kjeldahl Method.
Cotton Seed Meal	7.06	7.11
" " "	7.10	7.13
" " "	7.10	7.15
" " "	6.95	6.97
Castor Pomace	5.56	5.59
Tankage	5.03	5.07
"	5.72	5.82
Bone	4.03	4.02
"	3.92	3.90
Dry Ground Fish	8.69	8.77
" "	8.14	8.06
Peruvian Guano	2.88	2.95
Mixed Fertilizer †	3.45	3.45
" " ‡	3.00	3.00
" " §	3.80	3.76
" "	1.82	1.81

* Report Conn Agr. Expt. Station, 1889, 192.

† Contains 1.89 per cent. Nitrogen in Ammonia salts.

‡ " 1.76 " " " "

§ " 1.77 " " " "

The Modified Method applicable in the presence of Nitrates.*

In laboratories where fertilizer analyses are being made, the adoption of the Gunning method would tend to complicate rather than to simplify matters so long as in the presence of nitrates nitrogen is determined by another method.

It is impracticable to add salicylic acid to Gunning's reagent as such a mixture could only be used while hot and it is important that the temperature be kept as low as possible during the early stages of the digestion. It occurred to the writer, however, that Scovell's mixture of sulphuric and salicylic acids might be used in the ordinary way, potassium sulphate being added later in the process in place of mercury. After a number of unsuccessful trials—unsuccessful because too much potassium sulphate was used and the boiling point of the liquid became so high that oxides of nitrogen were driven off—the following plan was settled upon.

The material, .5 to 1.0 gram, is digested with 30 c. c. of Scovell's salicylic acid mixture (30 c. c. of sulphuric acid and 2 gms. salicylic acid) in a flask of 600 c. c. capacity, for two hours with frequent shaking. Two grams of zinc dust are then slowly added, with continual shaking, and the flask heated, at first gently, until after a few minutes boiling, dense fumes are no longer given off. Thus far the process is the same as in the Scovell-Kjeldahl method (the official method of the Association of Official Agricultural Chemists) except, that the digestion is continued for two hours, which, in some cases, the writer has found absolutely necessary in order to secure complete solution of the nitrate. Ten to twelve grams of potassium sulphate are next added and the boiling continued for a little time after the solution is colorless or, if iron is present, has a light straw color which remains unchanged. On cooling, as the mixture begins to solidify, water is added, at first slowly with shaking, and the distillation with caustic soda is carried on in the usual manner.

The trials thus far made with this method on nitrates and fertilizers containing nitrates, have proved entirely satisfactory.

In the following table are given the results obtained by the official method and the method here described, together with the percentage of nitrogen in nitrates as determined by the Schulze-Tiemann method.

* This excellent method was worked out by Mr. Winton at my suggestion, and I take the liberty of designating it the WINTON-GUNNING-KJELDAHL method.—S. W. Johnson.

The average of the 37 determinations by the Scovell-Jodlbauer method is 4.65 per cent., by the proposed method 4.66. The greatest discrepancy in any instance is one-tenth per cent., the average discrepancy five one-hundredths per cent. In 13 cases the proposed method gave the lower result, in 21 cases the higher result and in 3 instances both gave the same result.

	Nitrogen in Nitrates by Schulze-Tiemann.	Total Nitrogen by Scovell-Jodlbauer.	Total Nitrogen by new Method.*
Pure Potassium Nitrate	....	13.73	13.71
Commercial Nitrate of Soda	....	15.86	15.90
Tobacco Dust	....	1.76	1.71
Mixture of Ground Bone, Muriate of Potash and Nitrate of Soda	3.61	5.74	5.66
Mixture of Bone, Tankage, Dis. Bone Black, Mur. Potash and Nitrate of Soda	1.46	3.81	3.85
Mixture of Bone, Tankage, Dis. Bone Black, Sulph. and Mur. Potash, Sulph. Am. and Nitrate Soda	.63	4.15	4.07
Mixture of Bone, Tankage, Dis. Bone Black, Sulph. and Mur. Potash and Nitrate of Soda	.43	4.03	4.10
Mixture of Tankage, Dis. Bone Black, Mur. Potash and Nitrate of Soda	2.23	4.41	4.51
Mixture of Tankage, Dis. Bone Black, Wood ashes and Nitrate of Soda	1.63	3.85	3.85
Mixed Fertilizer	.56	3.82	3.86
" "	2.39	6.89	6.99
" "	.69	4.84	4.89
" "	1.55	3.45	3.47
" "	.36	3.05	3.10
" "	.86	2.70	2.65
" "	1.54	3.56	3.63
" "	.21	2.84	2.79
" "	.83	3.69	3.76
" "	.12	2.83	2.77
" "	.95	4.84	4.91
" "	.70	2.48	2.44
" "	.68	2.56	2.56
" "	.38	3.56	3.55
" "	.91	2.54	2.58
" "	2.91	5.02	4.96
" "	1.42	5.97	5.95
" "	1.65	4.86	4.96
" "	2.72	5.43	5.47
" "	.28	2.93	2.93
" "	1.28	5.68	5.66
" "	2.19	6.15	6.21
" "	.17	3.17	3.24
" "	.31	2.85	2.78
" "	.37	3.77	3.80
" "	.24	3.61	3.65
" "	.58	3.13	3.16
" "	7.38	8.44	8.49

* Winton-Gunning-Kjeldahl method.—S. W. J.

PROTEIDS OF THE WHEAT KERNEL.

BY THOMAS B. OSBORNE AND CLARK L. VOORHEES.

In the Annual Report of this Station for 1892, pp. 143–146, was printed a brief statement giving some results of our investigation of the wheat proteids. The full account of this work has since been published in the American Chemical Journal, Vol. 15, pp. 392–471.

The importance of wheat as a breadstuff, and the fact that its superiority over all other cereals for bread-making mainly depends on the properties of the proteids composing the gluten which wheat dough yields when cautiously washed with water, justify giving here in some detail an account of the present state of knowledge regarding the proteids of wheat.

The wheat used in our work was of two kinds. One of these, Scotch Fife, a hard spring wheat, raised in Minnesota, was obtained through the kindness of Dr. D. N. Harper, late Chemist of the Minnesota Experiment Station. It was carefully selected, free from all other varieties, and was milled under the supervision of Dr. Harper, who supplied us with samples of the various mill products, together with some of the unground wheat. Two grades of flour were used, namely, "patent flour," made from the finest and purest middlings, and "straight flour," from the coarser and less pure middlings. The "shorts," chiefly composed of the outer coating of the seeds together with adhering portions of the endosperm, was also examined. Samples of whole wheat flour were prepared as required from the wheat by grinding small quantities in the laboratory mill. The other wheat used was a variety of winter wheat known as "Fultz." This was procured from Mr. F. S. Platt, seedsman, of New Haven, and was carefully selected and freshly harvested.

When wheat flour or meal is made into a stiff dough with water and then carefully kneaded or squeezed in a gentle stream of water, the starch which makes up 60–68 per cent. of the flour or meal is gradually washed away for the most part, and there remains a tough elastic sticky mass.

The first published description of this body was made by Beccari in 1745 who gave it the name it still bears, viz: *Gluten.*

In 1805 Einhof observed that hot alcohol extracts from wheat flour a substance resembling gluten. In 1820 Taddei showed that gluten contains two substances, one soluble the other insoluble in boiling alcohol.

Since 1820 many chemists have undertaken to investigate gluten but their conclusions as regard the number, properties and composition of the proteids it contains are extremely discordant. Einhof, Boussingault, Bouchardat, Denis, Weyl and Bischoff and Martin have considered gluten to consist essentially of a single proteid. Berzelius, DeSaussure, Liebig, Dumas & Cahours, and Von Bibra, believed it to contain three, while Ritthausen and Bechamp regard it as composed of four proteids.

We have separated from the wheat kernel five distinct proteids, viz: Gliadin, Glutenin, a Globulin, an Albumin and a Proteose. A proteose-like body, apparently distinct, was also obtained, but in too small quantity for satisfactory examination.

The mode of isolating these substances in a state of comparative purity and establishing their individuality, is fully stated in our paper, to which reference must be made for details.

Of these proteids only the first two properly belong to gluten.

I. *Gliadin* is the proteid which is readily dissolved from wheat flour and from gluten by hot dilute alcohol. It also exists in the rye-kernel.

This substance, when dehydrated by absolute alcohol and thoroughly dried over sulphuric acid, forms a snow-white, friable mass which is easily reduced to a powder. If dried after being moistened with dilute alcohol or water it resembles, in appearance, pure gelatin. Dried thus, in thin sheets it is perfectly clear and transparent but is rather more brittle than gelatin. When treated in the cold with distilled water it becomes sticky and slightly dissolves. If the water is warmed, more dissolves and on boiling much goes into solution. Solutions in warm water on cooling deposit a part of the substance. The solution in pure water is instantly precipitated by adding a very minute amount of sodium chloride.

In absolute alcohol gliadin is entirely insoluble, but dissolves on adding water, the solubility increasing with the addition of water up to a certain point, and then diminishing. The exact degree of solubility for various strengths of alcohol has not been determined, but mixtures of about 70 per cent. of alcohol and 30 per cent. of water dissolve the proteid in almost indefinite amount. From solutions in strong alcohol as well as from those in very weak alcohol the proteid is precipitated by adding a few drops of solution of sodium chloride, the completeness of the precipitation depending on the strength of the alcohol and the amount of salt added. The more the alcohol varies in strength from 70–80 per cent. the more completely is the substance precipitated.

In extremely dilute acids and alkalies this proteid is readily soluble, and is precipitated from such solutions on neutralization apparently unchanged either in properties or composition.

Gliadin gives with Millon's reagent, with nitric acid and with the biuret-test, the usual proteid reactions. Dissolved in concentrated hydrochloric acid, a beautiful violet color develops slowly. With warm 50-per cent. sulphuric acid a similar color appears which is greatly increased in intensity on boiling.

On boiling its aqueous solutions, gliadin coagulates and becomes insoluble both in alcohol and in $\frac{2}{10}$ per cent. potash-solution, but is not thus converted into glutenin, the latter being soluble in weak alkali.

Gliadin was so called by Taddei because of its resemblance to glue. It has also been called plant-gelatin by Liebig and glutin by Dumas. The plant-casein of Dumas, the mucin of De Saussure and Berzelius, the gluten-fibrin and wheat-mucedin of Ritthausen are impure gliadin.

Gliadin is entirely distinct in composition from the alcohol-soluble proteids of barley, maize and oats. We found in Fife wheat, 4.33 and in Fultz, 4.25 per cent. of gliadin.

Our analyses of these gluten-proteids are as follows:

	Gliadin of wheat, average of 25 analyses.	*Gliadin* of rye, average of 13 analyses.	*Glutenin* of wheat, average of 8 analyses.
Carbon	52.72	52.75	52.34
Hydrogen	6.86	6.84	6.83
Nitrogen	17.66	17.72	17.49
Sulphur	1.14	1.21	1.08
Oxygen	21.62	21.48	22.26
	100.00	100.00	100.00

II. *Glutenin.* Characteristic reactions of a proteid body which can be dissolved only in dilute acids or alkalies are necessarily very few in number. Our preparations of glutenin after drying over sulphuric acid, were found to yield to distilled water, especially when warm, a little proteid substance. Diluted alcohol also dissolved a minute amount of proteid matter in the cold, and when heated to boiling, a much greater quantity. It is questionable whether the substance dissolved by water and by alcohol was not a trace of gliadin which had failed to be completely extracted in the process of preparing the glutenin. The fact that the solution in hot alcohol began to precipitate at once on cooling and that especial care had been taken in every case to remove the gliadin, makes it probable that glutenin is slightly soluble in water and in alcohol, especially if these are warmed.

In very dilute alkalies, as $\frac{1}{10}$-per cent. potash solution, and in very dilute acids, as $\frac{2}{10}$-per cent. hydrochloric acid, glutenin, after dehydration with absolute alcohol and drying over sulphuric acid, is slowly soluble, with the exception of a greater or less amount of coagulated residue, depending on the circumstances of its preparation. When freshly precipitated and in the hydrated condition it is extremely soluble in the slightest excess of caustic alkali, and in a somewhat greater but still very slight excess of acid. In this condition it is also soluble in the slightest excess of sodium carbonate solution or ammonia. After drying over sulphuric acid it dissolves partly in $\frac{5}{10}$-per cent. sodium carbonate solution.

Dissolved in concentrated hydrochloric acid it gives a solution slightly yellowish at first, but becoming a deep violet color on standing. In sulphuric acid diluted with an equal volume of water the solution is brownish in color after boiling, and remains clear when diluted. The undiluted solution, on standing, retains its brown color.

A comparison of the analyses of glutenin with those of gliadin shows a very close agreement of the two in composition. As it is well known that many proteids readily lose their solubility, without change of composition detectable by analysis, it might seem proper to consider this body as an altered and insoluble gliadin.

There is, however, no evidence that gliadin is actually transformed into glutenin, and since very recent investigation shows that rye-grain contains gliadin but probably not glutenin, it would appear that the two are to be regarded as distinct.

This proteid, in an impure state, has been termed by various investigators zymom, plant-fibrin, gluten-casein and gluten-fibrin. As all these names are associated with confused and erroneous notions as to its composition, origin and properties, they are all properly discarded in favor of the new designation glutenin.

In Fife wheat we found 3.96 and in Fultz 3.91 per cent. of glutenin. The other proteids in the wheat kernel are :—

III. *Edestin*,* a *globulin* belonging to the vegetable vitellins, soluble in saline solutions, precipitated therefrom by dilution and also by saturation with magnesium sulphate or ammonium sulphate, but not by saturation with sodium chloride. Partly precipitated by boiling, but not coagulated at temperatures below 100°. The wheat kernel contains between 0.6 and 0.7 per cent. of this globulin. When dried at 110° its composition was found to be as below stated.

IV. *Leucosin*,† an *albumin*, coagulating at 52°, unlike animal albumin in being precipitated on saturating its solutions with sodium chloride or magnesium sulphate. It is not precipitated on completely removing salts by dialysis in *distilled* water. It was found to form between 0.3 and 0.4 per cent. of the wheat kernel, and to have the following composition when separated from solution in the coagulated form by heating to 60° C. :

	Edestin.	*Leucosin,* coagulated.	*Coagulum* from Proteose.
Carbon	51.03	53.02	51.86
Hydrogen	6.85	6.84	6.82
Nitrogen	18.39	16.80	17.32
Sulphur	0.69	1.28	24.00
Oxygen	23.04	22.06	
	100.00	100.00	100.00

V. A *proteose*, precipitated (after removing the globulin by dialysis, and the albumin by coagulation) by saturating the solution with sodium chloride, or by adding 20 per cent. of sodium chloride and acidifying with acetic acid. This body was not analyzed in its unaltered form. On concentrating its solutions by boiling, a *coagulum* was gradually developed which formed about 0.3 per cent. of the wheat kernel and had the composition given above.

VI. The solution filtered from the substance just described (V.), still contained a *proteose-like body* which was not obtainable in a pure state. Its amount could only be roughly estimated by precipitating the concentrated filtrate from the preceding substance with alcohol, and multiplying the nitrogen contained in the precipitate by 6.25. The amount of this proteose was from 0.2 to 0.4 per cent. of the seed. Both this proteose and the above coagulum are unquestionably derivatives of some other proteid in the seed, presumably the proteose first mentioned.

* Εδεστὸς, edible. † Λευκὸς, white.

The Formation of Gluten.

Wheat, so far as is known, is the only plant whose seeds contain proteid matter separable in a coherent form from the other constituents by washing with water. When ground fine and mixed with a suitable quantity of water it yields a dough from which a light, porous bread can be made. The importance of this fact in bread-making is so great that considerable attention has been paid to gluten by the chemists who have studied wheat proteids.

The investigations of Günsberg and of Martin, as well as our own, disprove the existence of gluten-fibrin and mucedin, which are currently stated to exist in gluten, and demonstrate that, as Taddei maintained, gluten consists of two proteids only.

Weyl and Bischoff have asserted* that the proteid matter of the wheat kernel is *chiefly a globulin substance*, and that in contact with water it undergoes a change, presumably through the influence of a ferment, by which gluten is first produced.

The statements of these investigators are not sustained by any sufficient evidence. They say: "On investigating the proteids of wheat meal, one of us found principally a globulin substance, which he designated, in consequence of its similarity to myosin of the muscle, *vegetable myosin*. This vegetable myosin must be the mother-substance of the gluten, since in the wheat meal, together with it, other proteids, if at all, exist only in very small amount." What the reasons were for concluding that the "myosin" constitutes nearly if not all the proteid of the wheat kernel does not appear. In view of our results this statement is certainly erroneous. Direct treatment of the meal with alcohol yields extracts containing gliadin in exactly the same amount as obtained from the gluten made from an equal quantity of flour, and extraction of either flour or gluten with alcohol, after complete exhaustion with sodium chloride solution, also gives the same proportion of gliadin. This substance must therefore exist in the seed, having the same composition and properties as in the gluten, and as it forms one-half of the gluten, it leaves the other half only as possibly derived from a globulin body through the influence of a ferment. If Weyl and Bischoff's view were correct, treatment of the flour with 10-per cent. salt solution ought to alter the character and quantity of the gluten obtained, if not

* Ber. d. deutsch. Chem. Gesell., 1880, 367.

altogether to prevent its formation. This is not so, for the usual amount of gluten can readily be obtained from flour made into dough with 10-per cent. sodium-chloride solution and then washed with the same until starch is removed.

Weyl and Bischoff next state that, "with the aid of a 15-per cent. rock-salt solution the flour was extracted until no proteid could be detected in the extract; the residue of the meal kneaded with water then gave no gluten. *If the globulin substance be extracted no formation of gluten takes place.*" We have found that this is true if the flour is stirred up with a large quantity of salt solution, extracted repeatedly with fresh quantities of the same solution until no more proteid is dissolved, and the excess of solution removed by allowing the residue to drain on a filter as completely as possible. If, however, wheat flour is mixed at first with just sufficient salt solution to make a firm dough, this dough may then be washed indefinitely with salt solution, and will yield gluten as well and as much, as if washed with water alone. This difference is due to the fact, that when large quantities of salt solution are applied at once, the flour fails to unite to a coherent mass and cannot afterwards be brought together, as is possible when treated with smaller quantities of solution.

Weyl and Bischoff compare the formation of gluten to that of blood-fibrin from fibrinogen under the influence of a ferment. They say that the formation of gluten is affected by all the conditions which interfere with the activity of ferments in general. "Large amounts of salt hinder the formation of gluten. Sulphates of magnesium and sodium behave like common salt." These statements are explained by what has been said above.

They tried unsuccessfully to obtain the supposed ferment in the following manner:

"We allowed meal with an equal weight of 90-per cent. alcohol to stand in closed vessels different lengths of time (in one case four months, then several times 3 to 4 weeks, frequently only 8 to 10 days). The vessels were repeatedly shaken and the yellow-colored alcoholic extract was poured off. The residue was freed from alcohol by pressing and evaporating at the ordinary temperature. After it was stirred up with water, little or no gluten was obtained. Evidently the globulin substance had been coagulated for the most part by the alcohol." It is clear that if the flour were thus treated, the greater part of the gliadin would be removed. We have found that if flour be extracted with dilute alcohol until the gliadin is removed, and the residue freed from alcohol by exposure to the air, the latter will then yield no gluten when treated with water.

More recently Sidney Martin has advanced a somewhat similar theory of the formation of gluten from the proteids contained in the seed. He states* that alcohol extracts from gluten but one proteid substance; that this is soluble in hot water but not in cold, and he therefore calls it an *insoluble phytalbumose.*

The residue of the gluten not dissolved by alcohol is uncoagulated proteid, if the alcohol has not been allowed to act too long. This substance he names *gluten-fibrin.* Martin further says that gluten dissolves almost completely in $\frac{2}{10}$-per cent. hydrochloric acid, or $\frac{2}{10}$-per cent. potash solution, leaving a small residue of fat. The solution gives a copious precipitate when neutralized, but the supernatant liquid still contains a quantity of proteid which is the dissolved insoluble albumose. The whole of the gluten-fibrin is reprecipitated by neutralization, that is, it is wholly converted into an "albuminate."

Martin then asks: "Does flour contain gluten-fibrin? Does it contain insoluble phytalbumose?" The first question he says cannot be answered directly. "The second is answered by extracting flour with 76–80 per cent. alcohol. This ought to contain the insoluble albumose if it were present as such in the flour, *but it does not contain it;* it extracts only fat." This statement is contrary to our experience, for we have never failed, in many experiments, thus to extract this substance (gliadin) from the flour, and that too in the same amount and of the same properties and composition as from the gluten.

Martin concludes that insoluble albumose is not present as such in the flour. He then says: "Before proceeding to mention its precursor, it will be well to state that 10-per cent. sodium-chloride solution extracts from flour a large quantity of globulin and of albumose. This globulin is of the myosin type, coagulating between 55° and 60° C., and precipitated by saturation with sodium chloride and ammonium sulphate. Both the globulin and albumose are present in a much smaller quantity in the watery extract of the flour." From this it is evident that Martin has fallen into the same error as Weyl and Bischoff, mistaking the albumin for a myosin-like globulin, and being greatly misled as to its amount.

* British Med. Jour., 2, p. 104 (1886).

Continuing, Martin says: "The direction of the evidence is to show that the insoluble albumose is formed from the soluble. Moreover, I think that the globulin is transformed into the gluten-fibrin, for I have been able to obtain from the globulin in solution a body having the same reactions as the gluten-fibrin." What this evidence is, which, by its direction, shows that the insoluble albumose is derived from the soluble, is not clear, and Martin makes no further statements on this point. That a body should be obtained from the solution containing the globulin which had the same reactions as the "gluten-fibrin" is not surprising, for the so-called "albuminates" derived from nearly all globulins have no characteristic reactions, being merely soluble in dilute acids and alkalies, and precipitated by neutralization in the same way as "gluten-fibrin." Martin then states his theory of the formation of gluten in the following scheme:

$$\text{Gluten} = \begin{cases} \text{Gluten-fibrin} & \text{—precursor, globulin.} \\ \text{Insoluble albumose—} & \text{" soluble albumose.} \end{cases}$$

This cannot be a correct representation of the formation of gluten, for it has been shown to be founded on two erroneous observations: first, that alcohol does not extract proteid matter from the flour when applied directly, and second, that at least one-half the proteid matter of the seed is a myosin-like globulin.

The results obtained by us and described at length in our paper* lead to the conclusion that no ferment-action is involved in the formation of gluten; that but two proteid substances are contained in the gluten, gliadin and glutenin, and that these exist in the wheat kernel in the same form as in the gluten, except that in the latter they are combined with water in an amount equal to about twice the weight of the water-free proteids. The reasons for this opinion are, first, that alcohol extracts the same gliadin in the same amount, whether applied directly to the flour, to the gluten, or to the flour previously extracted with 10-per cent. sodium-chloride solution; second, that $\frac{2}{10}$-per cent. potash extracts glutenin of uniform composition and properties from flour which has been extracted with alcohol or with 10-per cent. sodium-chloride brine and then with alcohol, as well as from gluten which has been exhausted with alcohol.

Both glutenin and gliadin are necessary for the formation of gluten, as shown by the three following experiments.

* Am. Chem. Jour., **15**, 392–471.

1. A portion of flour was washed completely free from gliadin by means of alcohol of 0.90 sp. gr., next with stronger alcohol, finally with absolute alcohol, and air-dried. The residue was then rubbed up fine until all lumps were removed, and water carefully added and a dough made of the mass. A tolerably coherent dough was thus obtained, but much less elastic and tough than that produced from the untreated flour. This dough was then washed with water on a sieve, using every precaution to obtain a gluten, but none was formed.

2. Again, 7.5 grams of very finely ground air-dried gliadin were mixed intimately with 70 grams of fine corn-starch and distilled water added. A plastic dough was thus produced, but it had no toughness. On adding a little 10-per cent. sodium-chloride solution, the dough became at once tough and elastic. This was then washed with great care on a sieve with cold water, a little 10-per cent. salt solution being added from time to time, but in spite of every precaution no gluten was obtained.

3. The following experiment shows that the gliadin used was capable of forming gluten when glutenin was present, and also that salts have a marked influence on the toughness of wheaten dough.

Two portions of flour, weighing 100 grams each, were taken, and after adding 5 grams of gliadin to one, both were made into dough with the same quantity of water. The two doughs presented marked differences; that to which the gliadin had been added was much tougher and more yellow than the other. They were then washed with water as long as starch separated. The gluten was dried superficially by wiping with a cloth and weighed in the moist state. That from 100 grams of flour to which 5 grams of gliadin had been added weighed 44.55 grams; that from 100 grams of flour alone weighed 27.65 grams. The moist glutens were dried at 110° to constant weight, and both yielded the same proportion of dry gluten, viz., 34.6 per cent. The yield of dry gluten was accordingly, in the first case 15.41 grams, and in the second 9.56 grams. The difference, 5.85 grams, shows that the added gliadin was fully recovered in the gluten.

The above figures show that these proteids combine with about twice their weight of water in forming gluten. The fact that the added gliadin entered so readily and completely into the formation of gluten indicates that it exists in the seed as such and undergoes no chemical change during extraction and drying.

The properties observed in testing the separated gliadin show how it acts in forming gluten, and explain many of the points observed by others and attributed to a ferment-action.

When treated with distilled water in small amount the fine ground air-dry gliadin at once forms a sticky mass which, on adding more distilled water, dissolves to a turbid solution. If, however, a very little sodium chloride is added to distilled water and this applied to gliadin that has been first moistened with pure water, a very coherent, viscid mass results which adheres to everything it touches and can be drawn out into long threads. If the gliadin is moistened with 10-per cent. sodium-chloride solution and then treated with a larger quantity of this solution, the substance unites to a plastic mass which can be drawn out into sheets and strings, but is not adhesive. From this it is evident why Ritthausen, in washing flours which gave a fluid gluten obtainable only in small quantity and with great difficulty, found that the addition of calcium sulphate to the wash-water rendered the gluten much more coherent and easily obtainable. The gliadin is thus proved to be the binding material which causes the particles of flour to adhere to one another, in forming a dough.

But the gliadin alone is not sufficient to form gluten, for it yields a soft and fluid mass which breaks up entirely on washing with water. The insoluble glutenin is probably essential by affording a nucleus to which the gliadin adheres and from which it is not mechanically carried away by the wash-water.

It might be supposed that this insoluble glutenin which so nearly resembles gliadin in composition results from an alteration of the latter brought about by the action of the mineral or other constituents of the seed or of the water. This is not probable, for the same amount of gliadin is extracted from flour directly by treating it with alcohol of 0.90 sp. gr. as is obtained from the gluten itself, and also the same amount is obtained after extracting the flour completely with 10-per cent. sodium-chloride solution and then with alcohol.

The behavior of the gliadin towards 10-per cent. sodium-chloride solution shows why no gluten was obtained by Weyl and Bischoff from flour extracted with this solvent. The gliadin had under these conditions no adhesive qualities and therefore was unable to bind the flour into a coherent mass. If, however, the salt solution is added in small quantities and the flour kneaded and pressed, the particles are brought together and then adhere tenaciously.

THE PROTEIDS OF THE KIDNEY BEAN,

(*Phaseolus Vulgaris*,)

BY

THOMAS B. OSBORNE.

The only work on the proteids of the kidney bean having importance at the present time, is that of Ritthausen. This investigator in 1883, stated* that the extract of the white bean which has a weak alkaline reaction, and is extremely difficult to filter, when made clear by subsidence, yields on adding acetic acid, a voluminous precipitate, amounting to about 11 per cent. of the seed, having the following composition:—

Carbon	51.48
Hydrogen	7.04
Nitrogen	14.40
Sulphur	0.42
Oxygen	26 66
	100.00

In 1884, Ritthausen† published the results of further study of this seed. He then stated that the proteid, obtained in his earlier experiments, was wholly insoluble in 5 per cent. sodium chloride solution, but partially dissolved in 2 per cent. brine, and by diluting was precipitated in a form entirely like the original substance. By treating the bean meal with alcohol he found that clarification of the extracts was greatly facilitated and he therefore used meal so treated in his subsequent experiments.

By extraction with 2 per cent. sodium chloride solution, and clearing the extract by subsidence, he obtained, in two cases, precipitates of proteid, amounting respectively to 13.2 and 11.45 per cent. of the meal. Another preparation, equal to 8.67 per cent., he obtained from an aqueous extract of the meal precipitated with hydrochloric acid, the precipitate being redissolved in potash-water and the solution neutralized after filtering clear. By extracting the bean meal with dilute hydrochloric acid, he obtained 10.07 per cent. of proteid. Preparations made by precipitating aqueous solutions with hydrochloric acid and sodium chloride extracts by dilution and submitting the precipitates to

* Jour. f. prakt. Chem., **103**, 204.

† Jour. f. prakt. Chem. n. folge, **29**, 452.

analysis without re-solution and consequent purification, had a composition similar to that found for the earlier preparations.

The precipitate obtained from hydrochloric acid solutions, had a different composition, agreeing with that of the proteid extracted by dilute salt solution both from the older preparations and from the freshly formed precipitate produced by acids in the aqueous extract, as well as with that of the insoluble portion remaining after this extraction, and also with that of the precipitate produced by hydrochloric acid in the aqueous extract, redissolved in dilute potash-water and precipitated by neutralization. An average of five quite closely agreeing analyses of the proteid thus obtained, is shown by the following figures :—

Carbon	52.55
Hydrogen	7.09
Nitrogen	16.18
Sulphur	0.43
Oxygen	23.75
	100.00

This proteid, Ritthausen remarked, "is so similar in composition to albumin, that one might be led to regard it as an albumin, low, indeed, in sulphur." In most respects the experiments of the writer now to be detailed, confirm these observations of Ritthausen, but in two particulars his statements have not been corroborated. The reaction of the aqueous extract, I have found in all cases, to be distinctly acid, even when the beans were tested within two minutes after crushing. Ritthausen's statement that his earlier preparations were wholly insoluble in 5 per cent. solution of sodium chloride, while a very considerable quantity was dissolved by 2 per cent. brine, is difficult to understand, unless as implied, though not directly so expressed, the presence of the proteid was detected by largely diluting the salt-water extracts. The writer has found that strong saline solutions, unless containing a large proportion of this proteid, are not precipitated by dilution, the salt being present in sufficient quantity to serve as a solvent for the diminishing percentage of the dissolved proteid.

I have been able to identify and obtain in a state of comparative purity, two distinct proteids, one, the most abundant, having quite the properties of a globulin, which I shall designate *phaseolin* and another, not so definite in character, that may be distinguished as *phaselin*.

Preparation of Phaseolin.

An extract was prepared by treating 500 grams of freshly ground bean meal,* which had been previously exhausted with ether, with one liter of 2 per cent. sodium chloride solution. The residue was strained out on coarse linen, squeezed dry in a screw press, and again treated with a liter of the 2 per cent. salt solution. The resulting extract filtered very slowly and not wholly clear; about nine-tenths of it was finally obtained as a turbid filtrate. This was saturated with ammonium sulphate and the precipitate produced, collected on a filter and separated as completely as possible from the solution. This precipitate was removed from the filter and treated with water. Much of the substance went into solution, but a considerable part remained undissolved. After 24 hours filtration, a very nearly clear liquid was obtained, amounting to about two-thirds of the solution. This was then dialyzed in a stream of river water for six days. When thus freed from chlorides, the contents of the dialyzer were transferred to a filter, but only a part of the separated proteid remained on the paper, the filtrate being milky. The precipitate collected was washed with water, alcohol and ether, and when dried over sulphuric acid, weighed 16 grams. This preparation had the following composition :—**1.**

Phaseolin, *Preparation* **1.**

	I.	II.	Average.	Ash-free.
Carbon	51.73	----	51.73	52.23
Hydrogen	6.89	----	6.89	6.95
Nitrogen	16.28	16.14	16.21	16.37
Sulphur	0.68	0.54	0.61	0.62
Oxygen				23.83
Ash	0.96		0.96	----
				100.00

As this preparation separated from a not perfectly clear solution, and therefore, presumably, was impure, a part of it was dissolved in 1 per cent. sodium chloride brine and precipitated by dilution. After standing a few hours to settle, the precipitate was filtered off and washed with distilled water, with alcohol and with ether. Its composition is as follows :—**2.**

* The "White Medium Field Bean," the seeds being about ⅜ inch or 1cm in length, was used for this investigation.

Phaseolin, *Preparation* **2.**

		Ash-free.
Carbon	52.35	52.60
Hydrogen	6.63	6.69
Nitrogen	16.42	16.56
Sulphur	0.63	0.63
Oxygen	----	23.52
Ash	0.82	----
		100.00

Another preparation was made by treating the fine ground beans, previously extracted both with ether and alcohol, with 10 per cent. sodium chloride solution, as long as any proteid was removed. The extract was allowed to stand over night and the very nearly clear, greenish-yellow liquid was decanted from the sediment and saturated with ammonium sulphate. The precipitated proteid was collected on a filter and dissolved in dilute salt solution. This liquid was filtered as clear as possible and then dialyzed. When freed from chlorides, the globulin which had separated was filtered off, and washed and dried in the usual manner. This preparation, **3,** had the following composition :—

Phaseolin, *Preparation* **3.**

	I.	II.	Average.	Ash-free.
Carbon	52.19	----	52.19	52.60
Hydrogen	6.67	----	6.67	6.72
Nitrogen	16.01	16.06	16.04	16.17
Sulphur	0.63	----	0.63	0.63
Oxygen	----	----	----	23.88
Ash	0.79	----	0.79	----
				100.00

As this preparation, **3,** separated from a solution which could not be filtered perfectly clear, it is undoubtedly impure. In order to determine whether the preparations thus far obtained were mixtures of two or more globulins, the following were made by fractionally precipitating the extracts. The extraction was also carried out in such a way as to afford an approximate determination of the amount of phaseolin contained in the extracts.

100 grams of bean meal were treated with 500cc of 1 per cent. sodium chloride solution, strained through cloth, and allowed to stand so as to deposit most of the suspended matter. The solution was then decanted and 350cc of nearly clear extract obtained, being therefore approximately seven-tenths of the whole. This solution was then diluted with 1050cc of distilled water and allowed to stand until the precipitate so produced had settled.

The latter was collected on a filter, washed with alcohol and ether, and when air dried was found to weigh 4.76 grams; preparation **4.** The filtrate from **4** was diluted with about an equal bulk of water and carbon dioxide was passed through it. After standing some time, a precipitate settled out, leaving the liquid nearly clear. This was decanted and the precipitate collected on a filter and treated like **4.** This gave preparation **5,** which weighed 3.76 grams. The filtrate from **5** was further diluted with a considerable quantity of water and carbon dioxide again passed through the solution. This gave preparation **6,** weighing, air dry, 1.12 grams. The filtrate from **6** was treated with acetic acid, and a further small precipitate, **7,** obtained, weighing 0.7 gram. The four preparations together weighed 10.34 grams, and as they were obtained from seven-tenths of the total extract, were approximately equivalent to the proteid derived from 70 grams of air dry bean meal or to 14.77 per cent. of the meal. It is evident that in preparing the globulin by dialysis in the manner just described, only a part was obtained. As preparation **4** was separated from an unfiltered extract, it was necessary to dissolve and reprecipitate it before submitting it to analysis. It was accordingly treated with 1 per cent. sodium chloride solution, but had become largely insoluble in brine. The insoluble matter was filtered off, the clear filtrate diluted, and carbon dioxide passed through it as long as globulin was precipitated.

The precipitate was filtered off, washed thoroughly with water, alcohol and ether and dried over sulphuric acid. Only 1 gram of proteid, preparation **4,** was recovered.

PHASEOLIN, *Preparation* **4.**

	I.	II.	Average.	Ash-free.
Nitrogen	16.05	15.89	15.97	16.12
Ash	0.93	----	0.93	----

Analyses of the other preparations gave the following results:—

PHASEOLIN, *Preparation* **5.**

	I.	II.	Average.	Ash-free.
Carbon	52.14	----	52.14	52.54
Hydrogen	6.78	----	6.78	6.83
Nitrogen	16.35	----	16.35	16.48
Sulphur	0.62	0.53	0.58	0.58
Oxygen	----	----	----	23.57
Ash	0.77	----	0.77	----
				100.00

PHASEOLIN, *Preparation* **6.**

		Ash-free.
Nitrogen	15.82	16.23
Ash	2.51	----

PHASEOLIN, *Preparation* **7.**

		Ash-free.
Nitrogen	16.70	16.87
Ash	1.04	----

A larger quantity of meal was next extracted, and the extract fractionally precipitated in the following manner:

500 grams of meal were treated with 1500^{cc} of 1 per cent. sodium chloride solution, and the extract filtered once through good filter paper. About two-thirds of the extract were thus obtained as a turbid solution. Three volumes of distilled water were added, and the large precipitate formed was designated A. Through the filtrate from A, a current of carbonic acid gas was passed, and the resulting precipitate filtered off and marked B. Precipitate A was treated with about 50^{cc} of 10 per cent. sodium chloride brine and filtered as well as possible. A considerable part of A had become insoluble, and the filtration was exceedingly slow. After two and one-half days, most of the solution had filtered very nearly clear. This was then diluted with about ten times its volume of water, and the precipitate thereby produced, filtered off, washed with alcohol and ether, and dried over sulphuric acid; preparation **8.** The filtrate from **8** was again diluted with a large quantity of water and a second precipitate obtained in a like manner; preparation **9.**

The filtrate from **9** gave a very small additional precipitate with carbon dioxide, weighing when dry, only 0.2 gram. A portion of precipitate B was dried and marked preparation **10.** Five grams of precipitate B were dissolved in ½ per cent. sodium chloride solution, previously heated to 70°, filtered hot from the considerable insoluble matter, an equal volume of water heated to 70° was added to the filtrate, and the solution very slowly cooled. The proteid separated in well-developed spheroids. When this precipitate was filtered off and washed with water, the substance began to dissolve, as the salts were washed out, in the same way as the globulins of the oat kernel, castor bean and hemp-seed dissolve, when they are washed with water, after separating from warm salt solutions on cooling. Alcohol was then added to the contents of the funnel, and the substance washed with alcohol and ether, and dried. This preparation **11,** weighed 2 grams.

The insoluble proteid filtered from the solution which yielded **11**, was dissolved in $\frac{2}{10}$ per cent. potash-water and after filtering, the solution was exactly neutralized with $\frac{2}{10}$ per cent. hydrochloric acid. The precipitate, which was very readily soluble in dilute sodium chloride solution, after washing with water, alcohol and ether, and drying, weighed 0.65 gram; preparation **12.**

Another portion of precipitate B weighing 3.35 grams, was treated with $\frac{1}{2}$ per cent. sodium chloride brine, and heated to 70°. The insoluble matter was filtered off, washed with hot dilute salt solution, with water, alcohol and ether, and when dried formed preparation **13,** weighing 1.16 gram. The dissolved proteid separated from the filtrate and washings of **13** on gradually cooling, and after washing with dilute alcohol, absolute alcohol and ether, gave 1.54 grams of preparation **14.** All were then dried at 110°, and analyzed with the following results:—

PHASEOLIN, *Preparation* **8.**

	I.	II.	Average.	Ash-free.
Carbon	52.31	----	52.31	52.72
Hydrogen	7.18		7.18	7.24
Nitrogen	16.32	16.32	16.32	16.45
Sulphur	0.67	0.66	0.67	0.67
Oxygen	---	---	----	22.92
Ash	0.80	----	0.80	----
				100.00

PHASEOLIN, *Preparation* **9.**

		Ash-free.
Carbon	51.89	52.35
Hydrogen	6.83	6.89
Nitrogen	16.37	16.52
Sulphur } Oxygen }	----	24.24
Ash	0.88	----
		100.00

PHASEOLIN, *Preparation* **10.**

	I.	II.	Average.	Ash-free.
Carbon	51.89	51.98	51.94	52.74
Hydrogen	6.84	6.64	6.74	6.84
Nitrogen	16.40		16.40	16.65
Sulphur	0.63	----	0.63	0.64
Oxygen	----	----	----	23.13
Ash	1.52	----	1.52	----
				100.00

PHASEOLIN, *Preparation* **11.**

		Ash-free.
Carbon	52.34	52.49
Hydrogen	6.78	6.80
Nitrogen	16.80	16.85
Sulphur } Oxygen }	----	23.86
Ash	0.30	----
		100.00

PHASEOLIN, *Preparation* **12.**

		Ash-free.
Nitrogen	16.54	16.67
Ash	0.81	----

PHASEOLIN, *Preparation* **13.**

		Ash-free.
Carbon	52.76	53.06
Hydrogen	6.81	6.85
Nitrogen	16.59	16.68
Sulphur } Oxygen }	----	23.41
Ash	0.57	----
		100.00

PHASEOLIN, *Preparation* **14.**

		Ash-free.
Carbon	52.12	52.49
Hydrogen	6.68	6.73
Nitrogen	16.33	16.45
Sulphur } Oxygen }		24.13
Ash	0.72	----
		100.00

These results show that the greater part of the proteid extracted by sodium chloride solution, consists of a single globulin, amounting at least to 15 per cent. of the seed. The greater part of the proteid remaining in the seed after extraction with salt solution, is presumably the same globulin, possibly inclosed in the tissue of the coarsely ground seed, so that it was not reached by the salt solution, or more likely, an insoluble or "albuminate" form of this globulin, as the following experiment indicates. After complete exhaustion with 10 per cent. sodium chloride brine, of the meal from which preparation **3** was obtained, the residue was extracted with $\frac{2}{10}$ per cent. potash water, the extract allowed to stand over night and then decanted and precipitated with hydrochloric acid, added in very slight excess. The precipitate was washed by decantation, redissolved in potash water and filtered clear. This solution was then precipitated by hydrochloric acid, and as the proteid separated imperfectly, it was treated with alcohol and ether, and filtered off. After washing with dilute alcohol, absolute alcohol and ether, it was dried and analyzed; preparation **15.**

PHASEOLIN, *Preparation* 15.

		Ash-free.
Carbon	51.57	52.47
Hydrogen	6.78	6.90
Nitrogen	15.71	16.00
Sulphur } Oxygen }	----	24.63
Ash	1.72	----
		100.00

Another preparation of the globulin was made by treating 100 grams of bean meal, previously extracted with ether, with 500 cc. of *distilled water*, straining through a cloth, allowing the extract to stand over night to deposit suspended matter and decanting the slightly turbid liquid, of which the 250 cc. thus obtained were diluted to 2000 cc. and treated with a current of carbonic acid gas. On standing, the considerable precipitate settled out so that the solution could be filtered. The precipitate was washed with water, alcohol, and ether, and when dried over sulphuric acid weighed 5.5 grams. As the extract employed measured one-half the volume of the water applied to the meal, the yield of globulin was in this case approximately 11 per cent. of the bean meal. Although precipitated from a somewhat turbid solution, and consequently not quite pure, this preparation was analyzed with the following results:—

PHASEOLIN, *Preparation* 16.

	I.	II.	Average.	Ash-free.
Carbon	52.48	52.49	52.49	53.22
Hydrogen	6.71	6.86	6.79	6.86
Nitrogen	16.32	16.18	16.25	16.48
Sulphur	0.45	0.48	0.47	0.48
Oxygen	----	----	----	22.96
Ash	1.53	1.27	1.40	----
				100.00

It is evident from this analysis that the principal proteid extracted by water, is the same as that extracted by saline solutions, and as this substance is precipitated from the aqueous extract by dilution, it is undoubtedly dissolved by aid of the salts contained in the beans. It is not probable that the acid contained in the seed, causes this solution, for in that case the proteid would not be precipitated by dilution, a considerable excess of acid being necessary to effect its precipitation. The meal after extracting with water, as just described, was treated with 1 per cent. sodium chloride solution, the extract filtered, largely diluted with water, and charged with carbon dioxide. Only a trifling precipitate resulted which, when prepared in the usual manner, weighed 0.52 grams. This preparation, **17**, ash-free, contained 16.29 per cent. of nitrogen. These results show that nearly, if not quite as much of the globulin is extracted by water with help of the salts of the seed, as by use of stronger salt-solutions.

Another portion of the bean-meal was extracted with a considerable quantity of 1 per cent. sodium chloride solution, the extract was filtered as clear as possible, and dialyzed in a large vessel containing alcohol. The globulin readily separated after a short time, in well formed tetrahedral crystals mixed with amorphous matter. This precipitate was filtered off, treated for 48 hours with a 1 per cent. sodium chloride solution, filtered clear and again precipitated by dialysis in alcohol, at first quite dilute, but afterwards of gradually increased strength. The substance now separated in large well formed tetrahedral crystals, the edges of which were slightly curved. This precipitate was filtered off, washed with water, alcohol and ether, dried and analyzed with results as follows:—

PHASEOLIN, *Preparation* 18. CRYSTALS.

	I.	II.	Average.	Ash-free.
Carbon	50.98	----	50.98	52.70
Hydrogen	6.56	----	6.56	6.78
Nitrogen	16.21	16.10	16.16	16.71
Sulphur	0.33	0.29	0.31	0.32
Oxygen	----	----	----	23.49
Ash	3.27	----	3.27	----
				100.00

As dilute acids precipitate proteid substance when added to the sodium chloride extracts of the ground beans, it was thought desirable to make some preparations by this method. Accordingly an extract was prepared by treating the meal with 1 per cent. sodium chloride solution, and after clearing as completely as possible by subsidence and decantation, $\frac{2}{10}$ per cent. hydrochloric acid was added until a considerable precipitate resulted. After standing some hours the precipitate was filtered off, dissolved in very dilute brine, filtered clear and precipitated by dilution. Only a small part of the substance separated. This preparation, **19**, was then washed with water, alcohol and ether, dried and found to contain ash-free, 16.71 per cent. of nitrogen.

The filtrate from **19**, when greatly diluted, gave a further precipitate, which, when filtered off and washed with water, alcohol and ether had the following composition:—

PHASEOLIN, *Preparation* **20**.

		Ash-free.
Carbon	51.85	52.20
Hydrogen	6.91	6.95
Nitrogen	16.15	16.26
Sulphur	0.51	0.51
Oxygen		24.08
Ash	0.68	
		100.00

It is evident that the same globulin was obtained by this method as by those previously followed. Next to be noticed are two preparations of phaseolin, made by diluting the sodium chloride extracts in the manner already described, redissolving the precipitates first obtained in salt solution, and again precipitating by dilution. Preparation **21**, contained ash-free 16.65 per cent. of nitrogen.

PHASEOLIN, *Preparation* **22**.

	I.	II.	Average.	Ash-free.
Carbon	52.24	----	52.24	52.55
Hydrogen	6.86	----	6.86	6.90
Nitrogen	16.03	16.06	16.05	16.14
Sulphur	0.58	----	0.58	0.58
Oxygen	----	----	----	23.83
Ash	0.58	----	0.58	----
				100.00

The filtrate from **22** was then treated with $\frac{2}{10}$ per cent. hydrochloric acid, until a considerable precipitate resulted. This was filtered off, washed with water, alcohol and ether, and analyzed with the following results:—

PHASEOLIN, *Preparation* **23**.

		Ash-free.
Carbon	51.34	52.12
Hydrogen	6.59	6.70
Nitrogen	15.96	16.21
Sulphur	0.58	0.59
Oxygen	----	24.38
Ash	1.48	----
		100.00

One more preparation of this globulin was made with special reference to its purity. For this purpose a considerable quantity of the globulin was precipitated from a 1 per cent. sodium chloride extract of the beans, and after filtering off, was twice dissolved in dilute sodium chloride solution and precipitated by dilution after filtering clear. The final precipitate was thoroughly washed with water, alcohol and ether and analyzed. When dried over sulphuric acid, the preparation was readily soluble in dilute sodium chloride solution, and consisted entirely of the unaltered phaseolin. Its composition is shown by the analysis of preparation **24**.

PHASEOLIN, *Preparation* **24**.

	I.	II.	Average.	Ash-free.
Carbon	52.45	52.52	52.49	52.75
Hydrogen	6.99	6.80	6.90	6.95
Nitrogen	16.52	16.39	16.46	16.57
Sulphur	0.56	0.44	0.50	0.50
Oxygen	----	----		23.23
Ash	0.69	----	0.69	----
				100.00

The properties of phaseolin as shown by careful examination of preparation **24**, dried over sulphuric acid, are as follows:

In cold or warm distilled water it is entirely insoluble.

In sodium chloride solution, and in very dilute acids and alkalies, it is very readily soluble to a clear solution.

Dissolved in 10 per cent. sodium chloride solution, it is not precipitated by acetic, hydrochloric, nitric or sulphuric acids, added in either minute or considerable quantities, although when dilute hydrochloric acid is added to the 1 per cent. sodium chloride extract of the beans, the phaseolin is precipitated.

Dissolved in large proportion in 10 per cent. sodium chloride solution, the proteid is precipitated by adding much pure water.

Solutions of phaseolin in brine are completely precipitated by saturation with ammonium sulphate, but only slightly by saturation with magnesium sulphate or sodium chloride.

Potassium ferrocyanide and acetic acid together, give a precipitate.

With copper sulphate and caustic potash, the usual violet coloration is obtained, and with nitric acid, the xanthoproteic reaction.

Dissolved in 10 per cent. sodium chloride solution and heated very slowly in a double water bath, no turbidity occurs until the temperature is raised to 95°. This turbidity slowly increases as the temperature approaches 100°, and after some time, a flocculent precipitate begins to develop, which even after heating for an hour is but slight.

Like other plant-globulins, phaseolin separates from warm concentrated solutions on cooling, and from salt solutions on dialysis, in the form of spheroids.

The striking resemblance in composition of this proteid to the "myosins" found in the seeds of maize and oats, and also to animal myosin, is shown in the following table:—

	Phaseolin.	Maize-myosin.*	Oat-myosin.†	Animal-myosin.‡
Carbon	52.58	52.68	52.34	52.82
Hydrogen	6.84	7.02	7.21	7.11
Nitrogen	16.48	16.82	16.88	16.77
Sulphur	0.56	1.30	0.88	1.27
Oxygen	23.54	22.18	22.69	21.93
	100.00	100.00	100.00	100.00

The four proteids, although having many properties in common, as well as a similar composition, are yet characterized by differences so considerable, as to leave no doubt of the individuality of each.

The maize-myosin and animal-myosin differ from the other two, by their greater content of sulphur, and also in coagulating, the former at 70° and the latter at 55° C.

* Am. Chem. Journal, **13**, 536.

† Report Conn. Agri. Expt. Station for 1890, pp. 137 and 160; also Am. Chem. Journal, **13**, 389; also Report Conn. Agri. Expt. Station for 1891, p. 135.

‡ Studies from Laboratory of Physiological Chemistry, Yale University, **3**, 133.

Phaseolin presents many points of difference from the oat-myosin. It is not precipitated from solutions in 10 per cent. sodium chloride by acids, and but slightly by saturation with sodium chloride, and is thrown down, both by dilution and by dialysis, with much greater difficulty than the oat myosin.

SUMMARY OF ANALYSES OF PHASEOLIN FROM THE KIDNEY BEAN.

	1	2	3	4	5	6	7	8	9
Carbon	52.23	52.60	52.60	----	52.54	----	----	52.72	52.35
Hydrogen	6.95	6.69	6.72	----	6.83	----	----	7.24*	6.89
Nitrogen	16.37	16.56	16.17	16.12	16.48	16.23	16.87	16.45	16.52
Sulphur	0.62	0.63	0.63	----	0.58	----	----	0.67	24.24
Oxygen	23.83	23.52	23.88	----	23.57	----	----	22.92	
	100.00	100.00	100.00		100.00			100.00	100.00

	10	11	12	13	14	15	16	17	18†
Carbon	52.74	52.49	----	53.06	52.49	52.47	53.22	----	52.70
Hydrogen	6.84	6.80	----	6.85	6.73	6.90	6.86	----	6.78
Nitrogen	16.65	16.85	16.67	16.68	16.45	16.00*	16.48	16.29	16.71
Sulphur	0.64	23.86	----	23.41	24.13	24.63	0.48	----	0.32
Oxygen	23.13						22.96	----	23.49
	100.00	100.00		100.00	100.00	100.00	100.00		100.00

	19	20	21	22	23	24	Average.	Ritthausen.
Carbon	----	52.20	----	52.55	52.12	52.75	52.58	52.55
Hydrogen	----	6.95	----	6.90	6.70	6.95	6.84	7.09
Nitrogen	16.71	16.26	16.65	16.14	16.21	16.57	16.48	16.18
Sulphur	----	0.51	----	0.58	0.59	0.50	0.56	0.43
Oxygen	----	24.08	----	23.83	24.38	23.23	23.54	23.75
		100.00		100.00	100.00	100.00	100.00	100.00

PREPARATION OF PHASELIN.

Proteid remaining in solution after separation of the Globulin just described.

After precipitating phaseolin by the various methods employed in making the foregoing preparations, the extracts contained proteid matter which could be separated by dialysis in distilled water, by adding acids and by prolonged heating.

These methods of precipitation gave products of nearly uniform composition, except in those cases where the phaseolin had

* Omitted in making average. † Tetrahedral crystals.

been incompletely separated. Preparations of phaselin were accordingly made as follows:

When a portion of the dialyzed solution from which preparation **1** had been separated, was heated slowly it became turbid at 40°, flocks appearing at 68° in considerable quantity. When filtered, after heating at 72°, a second turbidity was obtained at 83°, and flocks formed at 87° in greater quantity than at 68°. The remaining solution was dialyzed in alcohol until its volume was reduced by one-half. An equal bulk of strong alcohol was then added to the contents of the dialyzer, and the mixture allowed to stand until the precipitate settled. After three days the solution was decanted and the precipitate washed with absolute alcohol and ether and dried over sulphuric acid. The substance, thus dried weighed 11 grams. It was finely ground, thoroughly extracted with distilled water, and this extract filtered from the large insoluble residue. The clear solution was then found to become turbid when heated to 63° and to yield a flocculent coagulum at 76°. The entire solution was therefore heated for several hours in a water bath at 80°, and the coagulum filtered off, washed thoroughly with water, alcohol and ether and dried over sulphuric acid. The 0.9 gram of substance thus obtained, was dried at 110° and analyzed with the following result. Preparation **25.**

PHASELIN, *Preparation* 25.

		Ash-free.
Carbon	51.67	51.96
Hydrogen	6.67	6.71
Nitrogen	15.55	15.65
Sulphur } Oxygen }	----	25.70
Ash	0.57	----
		100.00

When the filtrate from **25** was again heated to 80°, a further coagulum resulted. The solution was accordingly kept at this temperature as long as any coagulum was produced, filtered, and the coagulum washed with hot water, alcohol and ether, and dried for analysis at 110°. This preparation **26** contained, ash-free, 14.57 per cent. of nitrogen and weighed 0.71 gram.

Two other preparations were made from the filtrate from preparation **3,** in nearly the same way as the two last described, the only difference being that the solution was precipitated with alcohol without first concentrating by dialysis in alcohol.

The first coagulum, preparation **27,** obtained by heating at 80° weighed only 0.17 gram, and when dry contained without correction for ash, 14.90 per cent. of nitrogen. The second weighed 1.0 gram and had the following composition:—

PHASELIN, *Preparation* 28.

		Ash-free.
Carbon	51.19	51.57
Hydrogen	6.87	6.92
Nitrogen	14.36	14.48
Sulphur } Oxygen }	----	27.03
Ash	0.75	----
		100.00

After largely diluting, the filtrate from preparation **16** failed to give any further precipitate on passing carbon dioxide through it for some time. The greater part of this solution was then thrown away, but by chance a little acetic acid was added to the remainder and found to produce a precipitate. This precipitate was filtered off, washed with water, alcohol and ether, and when dried, weighed 0.27 gram and contained without correction for ash, 14.81 per cent. of nitrogen. Preparation **29.**

Another preparation was then made by extracting bean meal with 1 per cent. brine, diluting the extract with a large quantity of water, and filtering off the precipitate. The filtrate was then treated with $\frac{2}{10}$ per cent. hydrochloric acid until a considerable precipitate resulted, which was filtered off and the solution again treated with $\frac{2}{10}$ per cent. hydrochloric acid. This final precipitate was filtered off, washed with alcohol and ether and gave 1.0 gram of preparation **30,** having the following composition:—

PHASELIN, *Preparation* 30.

		Ash-free.
Carbon	50.18	51.38
Hydrogen	6.53	6.71
Nitrogen	14.44	14.84
Sulphur } Oxygen }	----	26.87
Ash	2.74	----
		100.00

Again, the filtrate from preparation **10**, was treated with an equal volume of strong alcohol and allowed to stand over night. The next morning, the precipitate which had separated was filtered off and treated with water. This dissolved some of the substance. The solution, filtered clear, when heated, gave a flocculent coagulum at 80°. With acetic, hydrochloric or nitric acid, it gave a precipitate when the reagents were added in sufficient quantity. These precipitates were soluble in sodium chloride solution, and those produced by hydrochloric and nitric acids, were soluble in an excess of the acid, but that given by acetic acid, was not noticeably soluble in an excess. The precipitate obtained with nitric acid, did not dissolve on warming, as is the case with such precipitates yielded by proteoses. The reaction of the extract was slightly acid, but it was not possible to precipitate anything therefrom, by the most careful neutralization. The whole solution was then treated with $\frac{2}{10}$ per cent. hydrochloric acid; the precipitate thus formed had the following composition:

PHASELIN, *Preparation* **31**.

		Ash-free.
Carbon	49.91	51.98
Hydrogen	6.55	6.82
Nitrogen	13 95	14.53
Sulphur } Oxygen }		26.68
Ash	4.00	----
		100.00

The precipitate from which **31** was derived, after this extraction with water, was but slightly soluble in sodium chloride solution, and was therefore treated with $\frac{2}{10}$ per cent. potash-water. The resulting solution was filtered clear, and hydrochloric acid cautiously added, until a precipitate formed which was collected on a filter and treated in the usual manner. When dry, this preparation, **32**, weighed 3.3 grams.

The filtrate from **32** was further treated with $\frac{2}{10}$ per cent. hydrochloric acid, and a second precipitate obtained which weighed 0.6 gram; preparation **33**.

PHASELIN, *Preparation* **32**.

	I.	II.	Average.	Ash-free.
Carbon	51.74	51.74	51.74	52.65
Hydrogen	7.04	7.00	7.02	7.14
Nitrogen	14.89	----	14.89	15.15
Sulphur } Oxygen }				25.06
Ash	1.78		1.78	----
				100.00

PHASELIN, *Preparation* **33**.

		Ash-free.
Nitrogen	14.24	14.85
Ash	4.12	

Another preparation was made by extracting 100 grams of bean meal, with 100 cc. of 1 per cent. sodium chloride solution, and washing the insoluble residue with 100 cc. of the same solution, applied in successive portions. The entire extract was then filtered nearly clear, and dialyzed into alcohol. The alcohol of the outer vessel was frequently renewed, and the process was continued until practically all the proteid matter had separated. The precipitate was then filtered off and extracted with 1 per cent. sodium chloride solution. Much of the substance remained undissolved. The solution was filtered clear and dialyzed again, in alcohol of 0.85 sp. gr. which was renewed once during the process. The precipitate resulting was filtered off and washed with dilute alcohol, absolute alcohol and ether and dried at 110°. Its composition was as follows:—

PHASELIN, *Preparation* **34**.

		Ash-free.
Carbon	46.49	51.38
Hydrogen	6.25	6.91
Nitrogen	13.27	14.67
Sulphur } Oxygen }	----	27.04
Ash	9.53	----
		100.00

In order to obtain a purer preparation of the proteid by this method, 200 grams of bean meal, first extracted with petroleum-benzine, were treated with 1 liter of 1 per cent. sodium chloride solution and after squeezing out, the residue was mixed with another liter of the same solution and again squeezed. After standing over night, the turbid extract was decanted and dialyzed in alcohol for three days, the alcohol being once renewed. This treatment precipitated nearly all the proteids, which were collected on a filter, and after the solution had run off, the precipitate was suspended in ¼ per cent. sodium chloride solution, filtered off and washed with the same solution. The clear filtrate and washings were then dialyzed into alcohol until a considerable precipitate had formed which was filtered off and washed successively with 50 per cent. alcohol, stronger alcohol, absolute alcohol and ether and dried over sulphuric acid. It was then almost wholly soluble in water, but after drying at 110° it became insoluble, and was washed with water, alcohol and ether and again dried, **35.**

PHASELIN, *Preparation* **35.**

	I.	II.	Average.	Ash-free.
Carbon	49.01		49.01	51.37
Hydrogen	6.77		6.77	7.10
Nitrogen	14.26	13.82	14.04	14.71
Sulphur } Oxygen }				26.82
Ash	4.58		4.58	
				100.00

Another trial was made by treating 400 grams of bean meal, previously exhausted by benzine, with 1 per cent. sodium chloride solution, dialyzing the extract for 24 hours, and filtering off the precipitated phaseolin. The clear filtrate after standing over night, deposited a considerable quantity of proteid, but the solution with this deposit was returned to the dialyzer and left for two days longer, when it was filtered, the precipitate washed with water, alcohol and ether, dried over sulphuric acid, and 6 grams of preparation **36,** obtained.

PHASELIN, *Preparation* **36.**

		Ash-free.
Carbon	50.44	51.41
Hydrogen	7.14	7.28
Nitrogen	14.31	14.59
Sulphur	0.46	0.47
Oxygen		26.25
Ash	1.94	----
		100.00

The filtrate from preparation **36** was then dialyzed into distilled water which was renewed every 24 hours for several days. After a week the solution was filtered and the precipitate washed with water, alcohol and ether and dried over sulphuric acid. It weighed 1.60 grams, **37.**

PHASELIN, *Preparation* **37.**

	I.	II.	Average.	Ash-free.
Carbon	51.38	51.22	51.30	52.19
Hydrogen	7.25	6.99	7.12	7.24
Nitrogen	14.52	----	14.52	14.79
Sulphur } Oxygen }	----	----	----	25.78
Ash	1.83	1.61	1.72	
				100.00

One more preparation, **38,** was made in the same manner as **37,** and had the following composition:—

PHASELIN, *Preparation* **38.**

		Ash-free.
Carbon	50.20	51.27
Hydrogen	7.07	7.22
Nitrogen	14.02	14.32
Sulphur	0.50	0.51
Oxygen		26.68
Ash	2.06	----
		100.00

Further dialysis in distilled water, of the filtrate from preparation **37,** gave no more precipitate. The solution was therefore saturated with ammonium sulphate, and the precipitate so produced filtered off and dissolved in distilled water. This solution which now had a volume of about 400^{cc} was dialyzed for some days, first in river water, and afterwards in distilled water, but only a trace of substance separated. This was filtered off, and the perfectly clear solution gave the following reactions:

Saturation with sodium chloride produced no precipitate until acetic acid was added. Acetic acid in the absence of salt gave no precipitate. Nitric acid gave a turbidity when added in considerable quantity, and the addition of some sodium chloride produced no further precipitation. Sulphate of copper gave no precipitate. This solution when heated became turbid at 57° and particulate at 63°.

The entire solution was therefore heated to 70° in a water bath which did not exceed this temperature, and after 2 hours, filtered from the separated coagulum. This was then washed with distilled water, alcohol, absolute alcohol and ether, and dried over sulphuric acid. It weighed 0.48 gram. Before drying, this coagulum dissolved readily in $\frac{2}{10}$ per cent. hydrochloric acid, and in dilute potash solution, and gave a violet reaction with sulphate of copper and caustic potash. The filtrate from this coagulum gave a further small coagulum when heated at 70°, for some time longer. This was filtered off, and after treating in the same way as the first coagulum, was added to it. The total amount of coagulum, preparation **39,** amounted to 0.63 gram, and after drying at 110° was found to contain, ash-free, 15.23 per cent. of nitrogen.

The filtrate from **39** was then dialyzed into alcohol, and the solution thereby concentrated. On adding an equal volume of strong alcohol, the proteid was precipitated. This was filtered off, washed with absolute alcohol and ether, and dried over sulphuric acid. It then weighed 0.72 gram which shows that the proteids had been almost wholly precipitated by dialysis and coagulation.

This substance gave a nearly clear solution with distilled water, not made clearer by adding a few drops of sodium chloride solution. With caustic potash and sulphate of copper, a pink color was developed which had a distinct violet tinge, and was by no means so red as that given by pure proteoses and peptones.

The aqueous solution heated to 85° gave a flocculent coagulum which apparently, represented most of the substance. From this, it would appear that true proteoses are present in extremely small amounts.

Dried at 110°, this preparation, **40,** contained, ash-free, 13.60 per cent. of nitrogen. Being thrown down by strong alcohol, it could scarcely be pure, and the nitrogen determination is only of value, as indicating that the coagulum mainly consisted of proteid.

Of these preparations, **25, 27** and **32,** are unquestionably mixtures of phaseolin and phaselin. Excluding these three and also **39** and **40,** evidently impure, the remaining agree fairly well, as is shown by the following table:

SUMMARY OF ANALYSES OF PHASELIN FROM THE KIDNEY BEAN.

	26	**28**	**29**	**30**	**31**	**33**
Carbon	----	51.57	----	51.59	51.98	----
Hydrogen	----	6.92	----	6.71	6.82	----
Nitrogen	14.57	14.48	14.81	14.84	14.53	14.85
Sulphur } Oxygen }	----	27.03	----	26.87	26.68	----
	------	100.00	------	100.00	100.00	------

	34	**35**	**36**	**37**	**38**	Average
Carbon	51.38	51.37	51.41	52.19	51.27	51.60
Hydrogen	6.91	7.10	7.28	7.24	7.22	7.02
Nitrogen	14.67	14.71	14.59	14.79	14.32	14.65
Sulphur } Oxygen }	27.04	26.82	0.47 26.25	25.78	0.51 26.68	0.49 26.24
	100.00	100.00	100.00	100.00	100.00	100.00

It is probable that these analyses pretty closely represent the true composition of this proteid, the various preparations having been made under such diverse conditions as to exclude the possibility of their being mixtures of the phaselin with non-proteid substances.

Preparations **26** and **28** were precipitated by heat, **29** and **30** by acid. Preparations **31, 34** and **35** were thrown down by alcohol, extracted by water from the precipitate so produced, and separated from the solution—**31** by acid, and **34** and **35** by dialysis in alcohol. Finally, **36, 37** and **38** were obtained by fractional dialysis in water.

There is some difficulty in deciding to what class of proteids phaselin should be assigned. It most nearly agrees with the globulins, being precipitated by dialysis after nearly all the salts are removed, and thereby largely converted into an insoluble form. Complete precipitation is not accomplished, even by prolonged dialysis in distilled water, and it may be questioned whether the precipitation that occurs on dialysis in water, is not the result of transformation into "albuminate."

Nitric acid in sufficient quantity gives a precipitate which, on warming, does not dissolve in the manner characterizing proteoses. Saturation with sodium chloride, gives only a slight precipitate, but further addition of acetic acid, occasions an abundant precipitate. With copper sulphate and caustic potash, a violet color is produced.

The coagulum produced by heat, dissolves in $\frac{1}{10}$ per cent. hydrochloric acid when heated to 80°. The temperature at which coagulation commences, varies with the amount of salts present, a turbidity usually appearing between 40° and 50° in solutions which have been dialyzed until the greater part of the phaseolin has been separated. The 10 per cent. sodium chloride extract of the bean meal, became turbid at 52°–55°, flocks forming at 68°–70°. The aqueous extract of the meal, heated to 60° gave a turbidity but slightly increased by boiling. When 10 per cent. of sodium chloride was added to the aqueous extract, turbidity occurred at 37° and flocks formed at 52°. The coagulation of this proteid by heat, proceeds very slowly and is completed only by very prolonged heating, for days even, at a temperature considerably higher than that at which flocks first appear.

Amount of Proteids in the Kidney Bean.

The quantities of these two proteids occurring in the kidney bean cannot be accurately determined, owing to the difficulties encountered in separating them. An approximate estimate is as follows:

1. A sample of freshly ground air-dry bean meal yielded by combustion, 3.785 per cent. of nitrogen. Considering all the nitrogen to exist as proteids containing 16 per cent. of this element, the proportion of proteids in the bean meal would be (3.785 × 6.25 =) 23.65 per cent.

2. Twenty grams of bean meal were treated repeatedly with 10 per cent. sodium chloride solution, until no more proteids could be extracted. The residue, after washing with water, alcohol and ether, weighed air-dry 11.41 grams and contained 1.877 per cent. or 0.214 grams of nitrogen, equivalent to 1.338 grams of salt-insoluble proteid, which amounts to 6.69 per cent. of the meal. The salt-soluble proteids were accordingly (23.65 − 6.69 = 16.96) 17 per cent. of the meal.

3. In making preparations **4, 5, 6** and **7,** p. 190, the phaseolin obtained from the salt-extract amounted to 14.77 per cent. This when weighed was not altogether pure or dry, but on the other hand, a part of this proteid existing in the salt extract, was not recovered, so that it may be fairly assumed that the meal contains about 15 per cent. of salt-soluble phaseolin. This deducted from the 17 per cent. of total salt-soluble proteids, leaves 2 per cent. for phaselin, reckoned water-free, other proteids being present in very minute quantity.

4. The preparations **36, 37, 39** and **40,** pp. 204–6 were obtained from one and the same portion, 400 grams, of bean meal, after phaseolin had been as completely removed as practicable. These preparations after drying over sulphuric acid, weighed respectively 6.00, 1.60, 0.63 and 0.72 grams, their total weight being 8.95 grams, equal to 2.24 per cent. of the meal. Their average nitrogen content was 14.54 per cent. very nearly that of phaselin. Making liberal allowance for impurities and incomplete drying, they represent about 2 per cent. of phaselin.

5. Twenty grams of bean meal were extracted as completely as possible with $\frac{2}{10}$ per cent. potash-water. The washed and air-dry residue weighed 11.27 grams, and contained 0.91 per cent. or 0.1026 grams of nitrogen, equal to 0.611 grams of (water-free) proteid, insoluble in alkali, or to 3.06 per cent. of the meal. The alkali-soluble proteid amounted therefore to (23.65 − 3.06 = 20.59) 20.6 per cent. of the meal.

6. On pages 193–4 is recorded that the proteid insoluble in salt solution, but dissolved by $\frac{2}{10}$ per cent. potash, **15,** contained 16 per cent. of nitrogen and accordingly had nearly the composition of phaseolin. It is, therefore, probable that the proteid undissolved by salt-solution, is phaseolin. On this assumption, the kidney bean examined, contains about 21.5 per cent. of phaseolin, and about 2 per cent. of phaselin.

7. The foregoing data are summarized as follows:—The "white medium field bean" contains approximately.

Phaselin, salt-soluble	2	per cent.
Phaseolin, salt-soluble	15	"
Phaseolin? salt-insoluble, alkali-soluble	3.5	"
Phaseolin? insoluble in salt and in $\frac{2}{10}$ per cent. alkali	3	"
Total proteids	23.5	"

Schulze, Steiger and Maxwell have stated * that 10 per cent. of the nitrogen of the seeds of the horse bean (*Vicia faba*) the vetch and the pea, exists in non-proteid form. Should such prove to be the case with the kidney bean, then its total proteids would be about 21 per cent. instead of 23.5 per cent.

* Versuchs Stationen xxxix, 306.

CONCLUSION.

The kidney bean contains two globulins characterized by great solubility in very dilute saline solutions, and by yielding precipitates with acids which are soluble in sodium chloride solutions. One of these globulins, *phaseolin*, probably forms about 20 per cent. of the seed, and has the following composition, which is the average of analyses of 24 different preparations:—

Phaseolin.

Carbon	52.58
Hydrogen	6.84
Nitrogen	16.47
Sulphur	0.56
Oxygen	23.55
	100.00

This is the proteid described by Ritthausen in 1884, to which he assigned very nearly the same composition as that above given.

The other proteid, *phaselin*, is much more soluble, remaining in solution after the phaseolin has separated. It is slowly coagulated by heat at temperatures varying with the amount of salts present and the rapidity of heating. It is precipitated by acids, on prolonged dialysis yields insoluble or albuminate modifications, and has more nearly the properties of a globulin than of any other recognized class of proteids. It has an unusually low nitrogen and high oxygen content as shown by the subjoined average of the analyses of 11 different preparations:

Phaselin.

Carbon	51.60
Hydrogen	7.02
Nitrogen	14.65
Sulphur	0.49
Oxygen	26.24
	100.00

In addition to these two globulins, the extracts were found to contain an extremely small amount of *proteose*.

May, 1893.

THE PROTEIDS OF COTTONSEED.

BY THOMAS B. OSBORNE AND CLARK G. VOORHEES.

The only reference to the proteids of cottonseed which we can find was made by Ritthausen in 1881 (Jour. f. prakt. Chem., xxiii, 485), who stated that he had been unable to obtain crystals of proteid matter from this seed and also that he would soon publish his completed investigations of the proteid bodies of this as well as of several other seeds which he named. Papers on the proteids of the other seeds mentioned by him were subsequently published, but we have not found anything relating to those of cottonseed. Since so long a time has elapsed, we feel warranted in assuming that Ritthausen has abandoned his intention of reporting the results of his investigation. The importance which cottonseed meal has assumed as a cattle-food of late years, makes it desirable to understand its chemical composition, especially as regards the nitrogen compounds which it contains so abundantly. Our results are not as satisfactory as we hoped for when we undertook this work but we have decided to publish them as they stand and shall endeavor to make them more complete in the future. The difficulties encountered are due to the presence of substances which render filtration of the extracts extremely slow and to the large amount of coloring matters taken up from the seed together with the proteids, which could be separated only with difficulty and large loss of substance. The material used in our investigation consisted partly of seed from which the cotton had been removed, but which otherwise was in the condition in which it was harvested. We separated the kernels from these seeds by chopping them in a wooden bowl and sifting out the larger fragments of husk. We thus succeeded in obtaining meal nearly free from hulls. This meal was bruised in a mortar and freed from most of the oil by extraction with benzine and from benzine by drying in the air at the temperature of the room. Samples of commercial cottonseed meal from which the oil had been expressed by the usual process were also used and gave the same result when extracted, and therefore in the following account of our experiments, no special mention is made of the origin of the meal employed.

a. Extraction with Water.

100 grams of cottonseed meal were extracted with 3 liters of distilled water and the filtered extract saturated with ammonium sulphate. The small precipitate so produced was filtered off, dissolved in water, the solution filtered clear and placed in a dialyzer. After remaining a week in running water no precipitation occurred, showing the absence of any notable quantity of globulin soluble in the dilute saline solution produced by the salts of the seed with the water used in the extraction. The dialyzed solution gave no immediate coagulum on boiling, proving the absence of albumins. The solution was then evaporated over a lamp and, after boiling some time, a light, bulky coagulum gradually separated. When the solution became quite concentrated, the coagulum was filtered off, washed with water, alcohol and ether, dried over sulphuric acid and found to weigh 0.25 gram. The filtrate from this coagulum was evaporated to small volume on a water-bath and precipitated by pouring into absolute alcohol. The precipitated proteid was then washed with absolute alcohol and ether and weighed, when dry, 0.40 gram. Accordingly, 0.65 per cent. of the oil-free meal, consisted of water-soluble proteose-like matter. The amount of this substance was so small, and the difficulty of preparing it in a state of purity so considerable, that it was not further examined. Other experiments, both with water and saline solution, fully confirmed the results here described and left no doubt that the amount of water-soluble proteid is very small.

b. Extraction with Sodium Chloride Solution.

When treated with 10 to 20 per cent. sodium chloride solution, the cottonseed meal yields a slightly acid extract of a yellowish-pink color which is viscid, and difficult to filter. When heated slowly, this extract becomes turbid at 44°, flocks, in small amount, separating at 64°. Filtered after heating to 70°, the solution becomes turbid when heated again to 70° and flocks in larger amount separate at 93°.

Saturation with sodium chloride gives a slight precipitate. Dilution of the extract with water yields an abundant precipitate which is redissolved on warming and again separates in the form of spheroids when cooled.

50 grams of oil-free meal were extracted with 10 per cent. sodium chloride solution, and the meal washed with the same solution as long as any proteid could be extracted. The extract and washings were saturated with ammonium sulphate, the precipitate produced filtered off, dissolved in dilute sodium chloride brine, filtered and dialyzed for four days. The solution was then removed from the dialyzer and the precipitated globulin filtered off, washed with water, alcohol and ether, and dried over sulphuric acid. There was thus obtained 7 grams or 14 per cent. of light yellowish proteid which when dried at 110°, had the composition given below, Preparation **1**.

A second preparation was made by treating 100 grams of meal with 3 liters of 20 per cent., sodium chloride solution for 48 hours and, after filtering, saturating the extract with ammonium sulphate. The meal-residue was again treated with 20 per cent. sodium chloride brine and after filtering the extract, it was saturated with ammonium sulphate and added to the first.

The ammonium sulphate precipitate was filtered off and dissolved in 10 per cent. sodium chloride solution, yielding a deep brown liquid. This was filtered clear and dialyzed till free from chlorides when the precipitate was filtered off and treated in the usual way. There resulted 15.83 grams of globulin of a slightly yellowish color which had the composition stated below, Preparation **2**.

A third preparation was obtained by extracting 100 grams of meal with water and then treating the residue with 20 per cent. sodium chloride solution.

The salt-extract was filtered, saturated with ammonium sulphate and otherwise treated in the manner already described in making preparations **1** and **2**. Only 8.39 grams of globulin were recovered, indicating a conversion into the insoluble modification, through contact with water.

The composition of this preparation **3**, is shown by the following figures.

COTTON SEED GLOBULIN.

	1				2				3	
	I.	II.	Av.	Ash-free.	I.	II.	Av.	Ash-free.		Ash-free.
Carbon	51.85	----	51.85	51.91	51.75	----	51.75	51.86	51.66	51.77
Hydrogen	6.78	----	6.78	6.79	6.87	----	6.87	6.88	6.73	6.74
Nitrogen	18.02	18.12	18.07	18.09	17.90	18.15	18.03	18.07	17.93	17.97
Sulphur	0.68	----	0.68	0.68	0.67	----	0.67	0.67	0.71	0.71
Oxygen	----	----	----	22.53	----	----	----	22 52	----	22.81
Ash	0.11	----	0.11	----	0.21	----	0.21	----	0.22	----
				100.00				100.00		100.00

The properties and composition of this substance are so similar to those of the vegetable vitellin found in the seeds of flax, hemp, wheat and other seeds, it seemed probable that the three preparations just described were not entirely pure and that if freed from all foreign matters they would agree more closely with the globulin of the seeds just named. Three preparations were accordingly made, substantially in the manner already described and, after drying over sulphuric acid, they were redissolved in 10 per cent. sodium chloride brine and the resulting clear solutions were dialyzed. The globulin thus reprecipitated was filtered off, thoroughly washed with water, alcohol and ether and when dried at 110° analyzed with the following results:

COTTON SEED GLOBULIN. EDESTIN.

	4		5		6			
		Ash-free.		Ash-free.	I.	II.	Av.	Ash-free.
Carbon	51.59	51.75	51.56	51.93	51.68	51.58	51.63	52.05
Hydrogen	6.68	6.70	6.92	6.97	7.11	6.92	6.97	7.02
Nitrogen	18.72	18.78	18.40	18.52	18.66	18.40	18.53	18.68
Sulphur	0.75	0.75	0.50	0.51	0.66	----	0.66	0.66
Oxygen	----	22.02	----	22.07	----	----	----	21.59
Ash	0.33	----	0.74	----	0.82	----	0.82	----
		100.00		100.00				100.00

We next attempted to detect the presence of other globulins in the sodium chloride extract. One kilogram of cottonseed meal was extracted with 10 per cent. sodium chloride solution and as the extract after straining through cloth was quite concentrated and could not be filtered, it was shaken with ether so as to remove oil and other substances soluble in that liquid. On standing, a part of the aqueous solution separated, leaving a supernatant layer consisting of an emulsion which long standing failed to resolve. Addition of alcohol, instead of breaking up the emulsion, transformed it into a jelly-like mass of considerable solidity. The unemulsified part of the extract, after standing some time, was decanted and dialyzed free from chlorides. The dialyzed solution was allowed to stand until the globulin had deposited when the supernatant liquid was decanted. The separated globulin was treated with 10 per cent. sodium chloride brine and the solution filtered very nearly clear. This solution was then dialyzed for 18 hours, during which time a large precipitate formed which was filtered off, washed with water, alcohol and ether, and when dried over sulphuric acid weighed 23.63 grams, Preparation **7.** The filtrate was found to be practically free from proteids. The

solution decanted from the first precipitation of the globulin contained a large amount of very finely divided substance that would not settle. A little sodium chloride was therefore added which dissolved the suspended globulin. The solution was next saturated with ammonium sulphate and the large precipitate filtered off, dissolved in water, the solution filtered perfectly clear, and dialyzed for several days. It was then removed from the dialyzer and allowed to stand until the suspended globulin had mostly settled out. The milky solution was then decanted from the sediment and the latter washed with water, alcohol and ether. After drying over sulphuric acid it weighed 8.58 grams. Preparation **8.** The solution decanted from **8,** after repeated filtration was obtained clear and was again dialyzed. After several days a very small precipitate formed which when subjected to the usual treatment weighed but 0.82 grams. This was much colored and evidently impure. The solution filtered from this precipitate was saturated with ammonium sulphate and yielded only a very small precipitate which appeared to consist mostly of proteose. The emulsion obtained by shaking the original extract with ether, after standing some days gave no evidence of resolution. The jelly-like mass was therefore broken up and thrown on a filter. A clear quick-running filtrate was obtained which was dialyzed for 5 days and deposited a globulin, that, after the usual treatment, weighed 8.43 grams. Preparation **9.** All these preparations were analyzed with the following results:

COTTON SEED GLOBULIN. EDESTIN.

	7				8		9	
	I.	II.	Av.	Ash-free.		Ash-free.		Ash-free.
Carbon	51.59	51.45	51.52	51.75	51.38	51.44	51.10	51.33
Hydrogen	7.04	6.70	6.87	6.90	6.70	6.70	6.88	6.91
Nitrogen	18.76	18.71	18.74	18.82	18.49	18.51	18.47	18.55
Sulphur	0.61	----	0.61	0.61	----	} 23.05	0.60	0.60
Oxygen	----	----	----	21.92	----		----	22.61
Ash	0.46	----	0.46	----	0.12	----	0.46	----
				100.00		100.00		100.00

The above analyses show that the first three preparations were not quite pure and the extract last made affords satisfactory evidence that no other salt-soluble globulin exists in the cottonseed in noteworthy amount. In the following table the analyses of the purer preparations may be compared together.

SUMMARY OF ANALYSES OF COTTONSEED GLOBULIN. EDESTIN.

	4	5	6	7	8	9	Average.
Carbon	51.75	51.93	52.05	51.75	51.44	51.33	51.71
Hydrogen	6.70	6.97	7.02	6.90	6.70	6.91	6.86
Nitrogen	18.78	18.52	18.68	18.82	18.51	18.55	18.64
Sulphur	0.75	0.50	0.66	0.61	} 23.05	0.60	0.62
Oxygen	22.02	22.08	21.59	21.92		22.61	22.17
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The table subjoined shows that this substance agrees in composition with the vitellin which exists in the seeds of wheat, maize, hemp, castor bean, squash and flax. As the properties of the preparations obtained from all these sources are substantially alike, there can be little doubt that one and the same proteid exists in them all. For this body we adopt the name *Edestin*, from the Greek ἐδεστός, signifying edible, in view of its occurrence in so many important food-stuffs.

COMPOSITION OF EDESTIN FROM VARIOUS SEEDS.

	Wheat kernel.	Maize kernel.	Hemp seed.	Castor bean.	Squash seed.	Flax seed.	Cotton seed.
Carbon	51.03	51.71	51.28	51.31	51.66	51.48	51.71
Hydrogen	6.85	6.85	6.84	6.97	6.89	6.94	6.86
Nitrogen	18.39	18.12	18.84	18.75	18.51	18.60	18.64
Sulphur	0.69	0.86	0.87	0.76	0.88	0.81	0.62
Oxygen	23.04	22.46	22.17	22.21	22.06	22.17	22.17
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The considerable differences in carbon and nitrogen in the above analyses amounting in the extreme cases to 0.7 per cent. are, in general, not greater than the discrepancies between analyses of preparations from the same seed. In the seeds of wheat and maize, other water- and salt-soluble proteids occur in considerable quantities and it is probable that the crystallized preparations obtained from hemp, castor bean, squash and flax more truly represent the composition of edestin than the amorphous or spheroidal substance yielded by the cereal seeds.

The slight differences in the deportment of solutions of these preparations of edestin may be reasonably attributed to admixtures of traces of other proteids.*

c. *Extraction with Potash-water.*

After extraction with water and sodium chloride solution a considerable amount of proteid was always found in the residual meal which could be partly removed by $\frac{2}{10}$ per cent. potash solution. All attempts to obtain the proteid thus extracted in a pure state, have hitherto entirely failed. Much coloring matter passes into the alkaline solutions, and when the proteid is precipitated goes down with it and cannot be removed by any process we have hitherto applied.

When freshly prepared, the alkaline extracts, as well as the meal moistened with the alkali, are of a bright reddish yellow color, but on exposure to the air they rapidly darken and finally become greenish-black. So much gummy matter is also extracted by alkaline solutions that it is almost impossible to filter them clear. As a result no preparations were obtained, the analysis of which could shed any light on the composition of the proteid which they represented. The residue of meal after treatment with potash still contains a notable quantity of nitrogen.

* See paper on Crystallized Vegetable Proteids, by T. B. Osborne, Am. Chem. Journal, xiv, p. 688.

d. *Amounts of the different forms of proteids in Cottonseed.*

As already shown, the proteid matter of cottonseed soluble in water, consists almost wholly of proteose. Making full allowance for incomplete extraction and loss, this does not exceed 0.75 per cent. of the oil-free meal. The highest yield of globulin recovered in the preceding extractions was 15.83 per cent. of the oil-free meal, and contained 42.3 per cent. of the total nitrogen. After repeated extraction with potash water, the residue contained, in the case where extraction was most complete, 11.4 per cent. of the total nitrogen, showing that 88.6 per cent. of the total nitrogen had been dissolved. The difference between the percentage of nitrogen removed by sodium chloride solutions and that extracted by weak potash, represents the proteid dissolved by potash-water which is not soluble in saline solutions, and which corresponds to 46.3 per cent. of the total nitrogen, assuming all this nitrogen to be present in proteid form.

These data may be tabulated as follows:—

	Per cent. of— Air-dry and oil-free bean meal.	Total nitrogen.
		2.0
Proteose	0.75	42.3
Salt-soluble proteid. Edestin	15.83	44.3
Alkali-soluble and salt-insoluble proteid	----	11.4
Proteid insoluble both in salt and alkali	----	
		100.0

METHODS TO DETERMINE THE AVAILABILITY OF ORGANIC NITROGEN IN FERTILIZERS.

I. PEPTIC DIGESTION. RESULTS OF OUR FORMER EXPERIMENTS.

In the Report of this Station for 1885, pp. 115–131, is an account of experiments on the solubility in pepsin-hydrochloric acid of such organic nitrogenous matters as are commonly used in mixed fertilizers and also of certain materials which, though known to be very inferior as sources of nitrogen to crops, are yet put upon the market for use as fertilizers.

The conclusions from our experiments and those of Drs. Shepard and Chazal, our predecessors in this work, were given substantially as follows:

"1. The nitrogen of dried blood (red and black, 4 samples), cotton seed (4 samples), castor pomace and maize refuse (each 1 sample) was in every case soluble in pepsin-hydrochloric acid, by 24 hours digestion, to the extent of 75 per cent. or more.

2. The nitrogen of fish (10 samples), dried animal matter (tankage, horse meat, etc., 3 samples), and of bone (20 samples), was in every case soluble to the extent of over 52 per cent.

3. The nitrogen of leather, steamed or extracted by benzine, was in no case soluble to the extent of over 36 per cent. That of horn shavings, bone dust, ground horn and hoof, cave guano, felt waste and wool waste was considerably less soluble than the nitrogen of leather.

4. This method divides the organic nitrogenous matters used in fertilizers into two classes. In one more than one-half of the nitrogen is soluble, in the other scarcely more than one-third is soluble. To the first class belong all the materials whose nitrogen is known to be readily 'available' in the usual sense. Of the second class, the most soluble are leathers variously manipulated, which are comparatively valueless as ingredients of commercial fertilizers. To some extent this method is therefore a measure of the agricultural value of nitrogen. How far it is a measure must be determined by vegetation-experiments under accurately controlled conditions, in which nitrogen is supplied in the same materials which have been tested by digestion-experiments.

In the mean time the method has decided value because in many cases it will distinguish in mixed fertilizers between such forms of nitrogen as the general sense of practical farmers accepts as available and such as the same tribunal condemns as inert."

II. PEPTIC DIGESTION. TRIALS MADE IN 1893.

a. The Method.

Preliminary to the tests of mixed fertilizers in 1893 and in order to still further prove the method and to compare the efficiency of the pepsin now obtainable with that of the pepsin used in the experiments of 1885, certain raw materials containing nitrogen were first examined.

With raw materials the method pursued was as follows:

One gram of the substance, pulverized to pass circular holes $\frac{1}{50}$ in. in diameter, was brought into a 150 c. c. flask, with 100 c. c. of pepsin-hydrochloric acid solution.*

This solution was prepared by mixing 5 grams of Parke and Davis' pulverized pepsin (guaranteed to dissolve 2,000 times its weight of coagulated white of egg) in 1,000 c. c. of hydrochloric acid diluted to a strength of two-tenths per cent.

The flasks containing the weighed substance together with pepsin solution were kept for 24 hours loosely corked in a water-bath having a constant temperature of 40° C.

At the end of the 2d, 5th, 8th and 11th hours, 2 c. c. of a ten per cent. hydrochloric acid solution were added.

After twenty-four hours' digestion the contents of the flasks were filtered and nitrogen was determined, by the Kjeldahl method, in the washed and dried residues.

b. Digestion of Raw Materials mostly of Known Good Quality.

Ground Bone.—The nitrogen of eight samples of fine, clear, hard bone, presumably the ground sawings and shavings from the manufacture of bone and "ivory" goods, had an average solubility of 96.5 per cent. The highest observed solubility was 99.5, the lowest 94.3.

The average nitrogen-solubility of the other 21 samples of bone, which included raw and steamed bone as well as bone from glue factories, was 88.9 per cent. The highest solubility was 97.1, the

* This digestive solution will be commonly referred to as pepsin simply.

lowest 69.2. A single exception to the above statement was a sample sent to the Station as "Preston's Ground Bone," No. **3750.** It was a mixed fertilizer containing 3.52 per cent. of nitrogen, 7.33 per cent. of phosphoric acid and 3.50 per cent. of potash. The nitrogen-solubility of this sample was only 59.7 per cent. The sample gave reactions which are characteristic of leather.

Dried Blood.—A sample of "English Dried Blood" had a nitrogen-solubility of 94.2 per cent., one of black blood of 83.8 per cent.

Tankage.—In three samples the average amount of nitrogen dissolved was 73.6 per cent.; the highest 82.1, the lowest 66.2 per cent.

Dry Ground Fish.—The nitrogen of two samples was soluble to the extent of 75.6 and 75.8 per cent.

Ammonite.—The nitrogen dissolved from a single sample was 78.2 per cent.

Cotton Seed Meal.—The average nitrogen-solubility of five samples of decorticated upland meal was 86.4 per cent. The lowest solubility was 81.4, the highest 91.6 per cent.

The nitrogen-solubility of three samples of undecorticated "Sea Island" meal was considerably less. The average solubility was 77.7; highest 82.6, lowest 74.3 per cent.

Castor Pomace.—The average nitrogen-solubility of four samples was 88.5 per cent.; highest 90.0, lowest 85.7.

Linseed Meal.—The solubility of the nitrogen of one sample tested was 83.8 per cent. The nitrogen of a mixed fertilizer, **3853,** in which linseed meal is used as the source of nitrogen, had a solubility in the pepsin of 87.7 per cent.

Pea Meal.—The nitrogen of a single sample was soluble in pepsin solution to the extent of 92.2 per cent.

c. Digestion of Cheap "Ammoniates," used as Adulterants.

The following are results of tests made on samples of certain suspicious articles which were offered to "the trade" during the season of 1893.

We are credibly informed that in many places where tanning or boot and shoe making are large industries, the hide and leather scraps are bought up and "manufactured" for the fertilizer trade. There are at least two kinds of material put on the market from these sources. One consists of tanners' refuse, from which the grease is first extracted and which is then pressed in bags. This has a snuff-brown color. Another consists of leather chips which, after grease has been removed, are made brittle by acid or heat. This stuff, when ground, is not unlike dried blood in appearance, but when unmixed has the smell of leather and where benzine has been used to extract grease, the odor of this solvent becomes evident on pulverizing the leather. Thousands of tons of this material are manufactured yearly.

Various forms of wool waste, as well as horn and hoof meal are also known to be in the market and are often sold under the name of "animal matter" or "tankage."

The articles examined are briefly described as follows:

A. "Animal matter, running about 10 per cent. ammonia." Price $2.50 per unit of ammonia, March 25, 1893.

B. "Tankage." Price very low. Its appearance is much like that of dried blood. It smells like leather and when pulverized emits a faint odor of benzine.

C. "Sample of 50 tons fine ground Animal Matter, testing about 10 per cent. ammonia. $2.40 per unit f. o. b."

D. "Tankage made in Philadelphia to amount of 300 tons at least, testing about 10 per cent. ammonia. Price $2.40 per unit."

E. "Fine Ground Animal Matter testing about 10 per cent. ammonia. 60–80 tons at $2.50 per unit ex. steamer N. Y."

F. "Tankage." $2.50 per unit ex. ship.

G. "Ammonite, Type A. Testing about 17 to 18 per cent. ammonia. Probably could secure 25 tons a month at $2.60 ex. ship."

Samples A, B, D, E, are unquestionably in great part leather.

These "goods" are well adapted to use in compounding fertilizers. They "analyze well" and, at the prices quoted, supply nitrogen for from 14.6 to 15.8 cents per pound wholesale, which, mixed with the materials required for the "Superphosphates" sold in Connecticut, would be "valued" by this Station at 17½ cents and would cost the purchasers on the average 24½ cents per pound. See pages 37–41, where the average cost of nitrogenous superphosphates is shown to exceed the average valuation by 40½ per cent.

NITROGEN OF INFERIOR "AMMONIATES" AND ITS SOLUBILITY IN PEPSIN.

	Total Nitrogen in per cent. of the substance.	Pepsin-soluble Nitrogen in per cent. of the substance.	Pepsin-soluble Nitrogen in per cent. of total Nitrogen.
A	7.70	2.68	34.8
B	7.27	2.58	35.5
C	7.78	2.51	32.2
D	8.07	4.23	52.4
E	8.07	3.18	39.4
F	7.64	2.88	37.7
G	13.72	5.73	41.8

A comparison of the results of these tests made in 1893 with those made on similar materials in 1885 shows substantial agreement and proves that the pepsin solutions used in the two series of trials were alike in their solvent action.

d. DIGESTION OF MIXED FERTILIZERS.

Every mixed fertilizer analyzed at this Station during the season of 1893 was tested with pepsin-hydrochloric acid to determine the solubility of its organic nitrogen in that reagent. The object of this treatment was to learn if there are fertilizers of this class in the Connecticut market whose organic nitrogen is so far insoluble as to make their further examination desirable.

One gram of the mixed fertilizer was washed on a filter with about 250 c. c. of cold water to remove soluble salts and the residue was treated with pepsin solution as already described.

It is unnecessary to give in detail the nitrogen-solubility of each of the 125 brands of mixed fertilizers examined in this manner. The general results are as follows:

SOLUBILITY IN PEPSIN OF THE ORGANIC NITROGEN OF 125 MIXED FERTILIZERS.

Over 90	p. c. of Organic Nitrogen of	3	Brands is soluble in Pepsin.
Between 80 and 90	" " "	22	" " "
" 70 " 80	" " "	62	" " "
" 60 " 70	" " "	18	" " "
" 50 " 60	" " "	12	" " "
" 40 " 50	" " "	6	" " "
Under 40	" " "	2	" " "

The organic nitrogen of the three brands that head the above table is that of hard, clear bone.

In so far as this method, in its present development, can indicate, a fertilizer, 60 per cent. of whose organic nitrogen is pepsin-soluble, may be regarded as satisfactory.

There is indeed no reason to condemn a fertilizer whose nitrogen-solubility is but 50 per cent., without further evidence. But when the nitrogen-solubility is under 50 per cent. the fact in itself is suspicious.

Of the 125 brands of mixed fertilizers examined, this method accordingly finds that 105 were above suspicion, 12 were near the danger line, and 8 were to be suspected of containing some comparatively worthless form of organic nitrogen. The method cannot at present do more than create a strong presumption for or against the quality of the goods.

III. PUTREFACTIVE DECAY, EXPERIMENTS OF 1893.

a. THE METHOD.

It was sought to determine, in a considerable number of fertilizers, the quantity of nitrogen which is made soluble by putrefactive processes.

The tests were made as follows:

Bone, fish, dried blood and all other materials which were free from nitrates and salts of potash and ammonia, were brought directly into flasks for putrefaction.

Of mixed and acidulated fertilizers, duplicate portions of two grams each, were washed on filters with about 250 c. c. of cold water, to remove soluble matters.

The washed residues, or two grams of raw material containing no soluble salts, were brought into flasks with 350 c. c. of distilled water and 10 c. c. of a solution in which raw beef and horse manure had been allowed to putrefy for some days.

The flasks stood in an outbuilding exposed to summer temperature, in a dim light and protected from insects. From time to time their contents were shaken up and the evaporated water was replaced.

After forty-eight days the solutions were all filtered, nitrogen was determined in some of the residues, the others were washed back into the flasks with 350 c. c. of tolerably pure lake-water from the service pipes. To each was added 10 c. c. of putrid filtrate from the foregoing filtrations.

The flasks were left in the outbuilding till late in September when they were brought into the laboratory, where they remained at a nearly uniform temperature of about 70° F. After 79 days from the beginning of the test, nitrogen was determined in certain of the samples; after 145 days certain others were examined and the test was concluded after 215 days. The results are as follows:

b. Putrefaction of Raw Materials.

It appears that in many cases there was considerable dissolving of nitrogen after the lapse of 145 days, in some instances as much as 9 per cent. became soluble during the last two months.

In a considerable number of cases, the quantity of nitrogen dissolved by putrefaction, during 7 months, does not agree with or bear any very definite relation to the quantity dissolved by pepsin solution.

The most striking discrepancies are observed with ground bone. All the samples were pulverized to pass holes of $\frac{1}{25}$ inch, but while in four cases the correspondence of percentages by the two methods is fair, in five other cases there is no agreement whatever.

The widest discrepancies occurred with the samples of hard raw bone, which it is evident are likely to be less finely ground than the steamed or soft bone and, if pulverized to the same degree, are less easily penetrated and dissolved by the putrefactive agencies.

Extremely fine pulverization might have increased the nitrogen-solubility in putrefaction very considerably and thus have made a more satisfactory agreement with the results of the peptic digestion.

The nitrogen of cottonseed meal, linseed meal and castor pomace was quite readily dissolved during putrefaction though not to the same extent as with pepsin solution.

It is noticeable that the nitrogen of the two samples of undecorticated meal is much less soluble than that of clear decorticated meal under putrefaction as well as in pepsin solution.

In the single samples of fish, blood and ammonite there was substantial agreement between the results of the two methods.

Solubility of Organic Nitrogen in various Raw Materials.

	Total Organic Nitrogen (in per ct. of substance.)	Organic Nitrogen Dissolved (in per cent. of total Nitrogen) by Peptic Digestion in 24 hrs.	by Putrefaction in 48,	79,	145,	215 days.
Fish	8.06	75.6	---	78.5	---	---
Blood	11.88	94 2	78.2	72.4	---	---
Ammonite	13.51	78.2	---	---	88.0	87.6
Linseed Meal	5.98	83.8	74.6	81.6	---	---
Cotton Seed Meal	8.08	91.6	73.0	82.1	---	---
" "	6.64	82.0	---	---	75.9	72.4
" undecorticated	3.97	74.3	41.8	40.8	---	---
" "	3.71	76.1	---	---	46.9	45.8
Castor Pomace	5.39	90.0	---	---	72.2	80.3
" "	4.39	85.7	---	---	66.1	---
" "	4.64	88.4	62.5	74.1	---	---
"Bone"	4.07	95.9	11.8	19.1	---	---
"	4.10	94.4	---	---	47.3	55.1
"	3.91	91.6	35.0	42.2	---	---
"	4.24	97.1	37.7	43.1	---	---
"	4.18	94.5	---	---	29.9	34.2
"	3.26	83.1	---	---	78.9	---
"	1.52	92.1	---	---	71.1	75.7
"	1.76	80.7	66.5	80.0	---	---
"	3.94	81.5	---	---	80.7	85.8
"	2.76	85.5	---	---	77.2	83.7

Lastly, the two methods of determining nitrogen-solubility fairly agree in the case of three nitrogenous materials, known to be of inferior quality, as appears below.

	Nitrogen-Solubility in Pepsin Solution.	under Putrefaction.
F. "Tankage"	37.7 per cent.	35.2–37.0
C. "Ground Animal Matter"	32.2 "	41.5–42.7
G. "Ammonite A"	41.8 "	37.1–47.6

c. Putrefaction of Mixed Fertilizers.

The next table presents the general results of the tests of mixed fertilizers by the putrefactive method and a comparison with the peptic digestion of the same articles.

There is seen to be a practical conformity between the indications of the two methods, though in many cases the agreement is not close.

ORGANIC NITROGEN DISSOLVED OUT OF MIXED FERTILIZERS.

In per cent. of total Nitrogen

By Pepsin in 24 hrs.	By Putrefaction in 145 days.			By Putrefaction in 215 days.		
	No. of tests.	Extremes.	Average.	No. of tests.	Extremes.	Average.
80–90 p. c.	3	73–83 p. c.	77.0 p. c.	3	71–86 p. c.	79.9 p. c.
70–80 "	6	68–74 "	71.2 "	9	68–84 "	73.8 "
60–70 "	6	60–71 "	65.5 "	6	62–72 "	67.2 "
50–60 "	3	62–67 "	64.7 "	4	59–67 "	61.8 "
Under 50 "	2	52–58 "	55.0 "	1	----	54.5 "

IV. COMPARISON OF THE TESTS OF NITROGEN-SOLUBILITY WITH THE RESULTS OF VEGETATION-CULTURES IN 1893.

a. DESCRIPTION OF FERTILIZERS CHOSEN FOR THESE TRIALS.

Six samples were selected from those examined by the previously described tests, for a more thorough study of their nitrogen-solubility and also of their crop-producing power, and will be referred to as A, B, C, D, E and F.

E is a so-called "complete manure" which, judged simply by the solubility of its nitrogen in pepsin, would be above any suspicion.

D, a "ground bone," having reactions indicating the presence of leather and A, a "complete fertilizer" are of rather questionable value as far as their nitrogen-solubility is concerned. C, a "special potato manure" is even more suspicious; and B, a "flour of bone phosphate" is certainly condemned by the low solubility of its nitrogen in pepsin. To this series was added F, which, though it contained some leather, yet had a nitrogen-solubility of over 70 per cent. A 100 pound bag of this material had been received with the statement that it was leather, prepared by a special process, believed to render it available for plant food. Subsequent inquiry showed that it contained a good deal of tankage with some leather. The solubility of its nitrogen in pepsin first indicated to us that the article was better than originally represented.

b. PEPTIC DIGESTION OF THE ORIGINAL SAMPLES.

A considerable quantity of each of the materials just described was ground to pass a sieve with round holes $\frac{1}{50}$ inch in diameter,

and each was a second time examined with reference to its nitrogen-solubility in pepsin solution with the subjoined results.

NITROGEN-INVENTORY AND DIGESTION OF THE ORIGINAL SAMPLES.

	A.	B.	C.	D.	E.	F.
Nitrogen as Nitrates*	---	1.65	---	---	.76	----
Nitrogen as Ammonia*	.89	.17	.08	---	---	----
Nitrogen, Organic*	2.12	1.29	3.40	3.57	2.78	10.24
TOTAL NITROGEN*	*3.01*	*3.11*	*3.48*	*3.57*	*3.54*	*10.24*
Per cent. of the Organic Nitrogen which is soluble in pepsin solution†	*55.2*	*41.1*	*49.1*	*63.8*	*85.6*	*82.40*
Organic Nitrogen insoluble in water*	1.87	1.15	2.84	3.05	2.44	6.58
Per cent. of the Organic Nitrogen insoluble in water, which is soluble in pepsin solution†	49.2	33.9	34.1	57.8	81.9	72.7

c. REMOVAL OF SOLUBLE NITROGEN FROM THE ORIGINAL SAMPLES. PREPARATION OF TEST SAMPLES.

Some of the materials contained nitrogen as nitrates or ammonia-salts. In order to test the crop-producing power of the *organic* nitrogen it was necessary to remove these soluble forms of this element.

A considerable quantity of each trial-fertilizer was therefore washed, first by decantation and then on filters, with cold water, till the washings were colorless and contained only the slightest traces of either sulphuric acid or chlorine.

By this means were removed all ammonia-salts and nitrates, as well as that portion of the organic nitrogen which was soluble in water.

The washed residues were dried at a temperature not above 90° F., thoroughly mixed and kept in securely stoppered bottles.

The determinations of total nitrogen and the solubility of the nitrogen in pepsin solution, of these prepared test samples, are given below.

NITROGEN-INVENTORY AND DIGESTION OF THE TEST SAMPLES.

	A.	B.	C.	D.	E.	F.
Total Organic Nitrogen*	3.30	2.38	5.73	4.17	4.43	10.03
Organic Nitrogen† soluble in pepsin	44.5	26.8	29.8	49.6	83.3	66.3

* Per cent. reckoned on Test Sample.

† Per cent. reckoned on Total Organic Nitrogen.

These results on solubility, obtained from the washed residues of large quantities of material, confirm, in a general way, the results previously obtained with washed residues from a single gram of material.

d. Putrefaction of Test Samples.

The effect of putrefaction on the solubility of nitrogen in these washed samples was studied in the following manner.

Into narrow-necked flasks of about 500 c. c. capacity were weighed duplicate portions of each of the six materials under experiment, together with .12 grams of tobacco ash, which had been slightly acidified with phosphoric acid and dried. 300 c. c. of water from the city service pipes were added to each flask and the contents were boiled briskly for an hour. Before cooling, the necks of the flasks were filled with sterilized cotton plugs.

To each flask was next added .05 gram sodium carbonate, sufficient to neutralize any free acid and to give the contents an extremely slight alkaline reaction and finally was introduced 1 c. c. of a putrid extract from a mixture of rotting meat and manure.

The flasks were placed in a water-bath which was kept at a constant temperature of 100° F. during the day and allowed at night to sink to the temperature of the room, which did not vary much from 76° F.

From time to time the flasks were gently shaken and after twenty-one days their contents were filtered, and the residues, without washing, were brought back into the flasks with 300 c. c. of water and the same quantities of tobacco ash, sodium carbonate and putrefying solution as before and let stand for fifty-two days longer.

In the filtrates just mentioned were determined both the total nitrogen and that portion of it which was volatile when distilled with magnesium oxide. This volatile portion is designated "as ammonia" in the following tabulated statement.

To conclude the experiment, the contents of the flasks were again filtered, the residues were thoroughly washed and the filtrates with the washings were examined as above described. The nitrogen of the residues was also determined.

Following are the results. The duplicate tests are given in detail and the average of the two is stated in the general result.

Solution of Organic Nitrogen during Putrefaction of Test Samples.

	A.		B.		C.		D.		E.		F.	
Total Nitrogen in Test Samples	3.30	3.30	2.38	2.38	5.73	5.73	4.17	4.17	4.43	4.43	10.03	10.03
After 21 days: Nitrogen in solution as Ammonia	.93	.90	.21	.21	1.19	1.23	.84	.82	1.72	1.96	3.28	3.12
" " Organic	.25	.25	.16	.16	.32	.30	.66	.74	.41	.31	2.20	2.01
Total	1.18	1.15	.37	.37	1.51	1.53	1.50	1.56	2.13	2.27	5.48	5.13
Per cent. of the total Nitrogen gone into solution	*35.4*		*15.5*		*26.5*		*36.6*		*49.6*		*52.8*	
After 73 days: Additional Nitrogen in solution as Ammonia	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
" " Organic	.12	.14	.09	.11	.16	.14	.06	.12	.08	.10	.11	.08
Total	.12	.14	.09	.11	.16	.14	.06	.12	.08	.10	.11	.08
Per cent. of total Nitrogen gone into solution since the previous filtration	*4.0*		*4.1*		*2.6*		*2.1*		*2.0*		*1.0*	
Total Nitrogen in solution as Ammonia	.93	.90	.21	.21	1.19	1.23	.84	.82	1.72	1.96	3.28	3.12
" " " Organic	.37	.39	.25	.27	.48	.44	.72	.86	.49	.41	2.31	2.09
" " not recovered*	.73	.82	---	.51	1.48	1.41	.48	.46	1.57	1.40	1.82	2.16
" " left undissolved	1.27	1.19	†	1.39	2.58	2.65	2.13	2.03	.65	.66	2.62	2.66
Per cent. of total Nitrogen in solution as Ammonia	27.6		8.8		21.1		19.9		41.5		31.9	
" " " Organic	11.5		10.9		8.0		19.4		10.1		21.9	
" " " escaped*	23.7		21.4		25.3		11.2		33.4		19.8	
" " " left undissolved	37.2		58.9		45.6		49.5		15.0		26.4	
	100.0		100.0		100.0		100.0		100.0		100.0	

* Escaped into the air as Ammonia or other gas. † Lost by accident.

In these experiments, where every thing was favorable to bacterial growth, the putrefactive process was practically completed within three weeks. Very little more nitrogen was dissolved during the succeeding 52 days.

A very considerable quantity of nitrogen, amounting in one case to a third of the whole quantity in the flask, escaped from the flasks, whether altogether as ammonia or in some other gaseous form was not determined. The greater rapidity of the putrefactive process here as compared with that observed in the experiments described on page 225 is explained by the higher temperature, the presence of a nutritive solution which favored bacterial growth and possibly, by the use, in the last tests, of city water exclusively, in place of distilled water which has been claimed to be unfavorable to bacteria.

Comparing these results with the solubilities in pepsin, it appears that B was the least soluble. If we call the solubility of B in each case 100, the relative solubility of the others will be as follows:

	A.	B.	C.	D.	E.	F.
Relative Nitrogen-solubility in pepsin solution	166	100	111	185	311	247
" " under putrefaction	153	100	132	122	207	179

The two fertilizers most soluble in pepsin are most soluble under putrefaction, the one least soluble in pepsin is also least soluble under putrefaction, but there is no very close agreement in the results by the two methods.

The pepsin method is more convenient and rapid, the putrefaction method might be regarded as a nearer approach to the "natural" method by which organic nitrogenous matters are disintegrated in the soil and prepared for appropriation by plants. It is not certain, however, that putrefaction gives a better indication of the relative value of fertilizers, as a nitrogen supply to plants, than the pepsin method.

The question still remains whether either treatment is a proper criterion of the availability of the nitrogen of fertilizers.

e. Vegetation Cultures. Description of Method.

As a contribution to the answer of this question the following vegetation experiments were made during the summer of 1893. It is thought best to publish the results now although it is not claimed that they are absolutely decisive. It is hoped that experiment during the coming season may add more to our knowledge of the subject.

The general plan of these experiments was to test the crop-producing power of the organic nitrogen of the different fertilizers, by growing Indian corn with their aid, in pots filled with soil, that was of itself, nearly destitute of nitrogen available to the corn plant. These soils contained potash, phosphoric acid, and all the other elements of plant food, excepting nitrogen, in excess of the requirements of the crop, and were supplied, as required, with sufficient water. Four pots were devoted to each of the six fertilizers. To the soil in one of these four pots was added one decigram of organic nitrogen, supplied by the fertilizer under experiment. The second pot received two decigrams, the third pot four decigrams, and the fourth pot eight decigrams of organic nitrogen. After the crops in these pots had finished growing they were harvested separately, dried and weighed. The crop-producing power of the different fertilizers, is therefore measured and compared by the dry weights of these several crops. The details of the experiment here follow:

Pots.—The pots used were made of "galvanized" iron, wired on the upper edge. They were seven inches in diameter, nine inches deep, the bottom slightly concave, and in the center of the bottom was a hole with a collar $\frac{3}{4}$ of an inch in diameter, which could be closed with a rubber stopper. Each pot was supported on three iron legs, so that the lowest point of the collar referred to was $3\frac{3}{4}$ inches above the platform on which the pot stood. The general appearance of the pots may be seen by reference to the plate facing page 234.

The Artificial Soil consisted of sifted anthracite coal ashes, to which five per cent. of peat moss had been added. The coal ashes, fresh from the Station steam heater, were sifted through a wire sieve having square meshes, four to the inch. The ashes were perfectly neutral in reaction, and contained $\frac{6}{100}$ of one per cent. of nitrogen. The peat moss was from a fresh bale, which we are informed, is imported for stable bedding. It was sifted, and only that part was used which passed a sieve with about six meshes to the inch. This peat has a slight acid reaction, one gram neutralizing about .0033 grams of barium hydroxide. Distilled with magnesia, four grams yielded no trace of ammonia. The peat moss contains $\frac{49}{100}$ of one per cent. of nitrogen. This mixture of peat and ashes contained 18.4 per cent. of moisture and when saturated with water, held 101 per cent. of that liquid.

The Supply of Fertilizer Ingredients.—Phosphoric acid was supplied in the form of Thomas slag and phosphatic guano. Four grams of the former and one gram of the latter, containing together .94 grams of phosphoric acid, were added to each pot and were more than sufficient to neutralize the acid reaction of the peat contained in the artificial soil. Potash was supplied to each pot in the form of one gram of muriate of potash.

Charging the Vegetation Pots.—After thorough washing and drying, each pot was fitted with a rubber stopper beneath and a piece of wire gauze over the hole in the bottom and washed fine quartz gravel was poured in, till the weight of the pot and contents was exactly 2000 grams. The layer of gravel was from $\frac{1}{4}$ to $\frac{1}{2}$ inch deep in the shallowest part.

At the side of each pot within was placed vertically a glass tube of about $\frac{1}{6}$ inch bore, planted below in the gravel and projecting about $\frac{1}{2}$ inch above the upper rim of the vessel. Into each pot were next poured 2000 grams of the artificial soil which had been already thoroughly intermixed with 5 grams of the phosphates before mentioned, and with the weighed amount of organic nitrogen designed for that pot, as well as with 100 grams of water—the whole charge being pressed down to the same level in all the pots. 100 c. c. of water, containing in solution 1 gram of pure potassium chloride, was poured slowly, without flooding, over the surface.

Water was then very carefully poured on the surface of each pot till the total weight of pot and contents was 5800 grams.

The pots were filled on the 25th of June. On the 27th, 5 kernels of "Early Minnesota" corn, a dwarf variety, were planted an inch deep and at the same distance apart in each pot. The seeds had been selected from near the butts of the ears and were very nearly uniform in weight.

150 grams of garden soil were shaken up with 1500 c. c. of water, and after the coarser particles had subsided 10 c. c. of the water-extract were added to each pot.

The soil having shrunk together somewhat, 300 grams more of artificial soil were added to each pot.

As soon as the maize plants were an inch high, two of them were extirpated and buried just below the surface of the soil, leaving three to grow.

In addition to the 24 pots which contained added nitrogen in the various forms and amounts already given, two pots were set

up like the others in all respects except that no nitrogen was added to them beyond what was contained in the artificial soil.

Water.—The water used was from the city service pipes,* freed from all suspended matters by filtering through unglazed porcelain in the Pasteur-Chamberland Filter and was very pure, containing about 40 parts of total solids per million.

During the early stages of growth the water-content of the soil in the pots was brought to 35 per cent.—determined by weighing the pots—and then allowed to sink to 20 per cent. before watering again. It was soon seen that the plants suffered from lack of water, and thereafter the water-content was brought at each watering to 40 per cent. and not allowed to sink below 30 per cent. At each watering 100 c. c. of water were poured on the surface and the rest was supplied through the glass tube to the bottom.

The pots stood in a small greenhouse, which though not well suited for these experiments was the only safe place at our disposal. Large insects were excluded by netting. Constant care was required to prevent damage by small spiders.

As the bottom leaves of the plants died they were cut off and preserved in bottles suitably labeled and were weighed with the plants to which they belonged.

In these trials it was necessarily planned that the maize plants be furnished equally with all the requisites for healthy development, except that the nitrogen supply should be so decidedly less than the plants could utilize, that the dimensions and especially the weights of the crops would fairly indicate the relative availability of the nitrogen as well as the rate of its supply, in case of the several substances used as sources of this element.

The plants were, accordingly, small and imperfectly developed, because of their nitrogen-hunger; but they were entirely healthy and thrifty in appearance and, with few exceptions, put forth both "tassels" and "silk" (staminate and pistillate flowers). The latter it was attempted to fertilize, by use of the pollen from corn growing in the garden near by, but, as was doubtless to be reasonably expected, the flowers were in every instance abortive.

Accordingly, the great differences manifested in the growth of the crops in the several series, can only be explained by the differ-

* The water of Wintergreen Lake, filtered through paper, contained in June, 1890, 40.5 parts of total solids (of which 10 were lost by ignition), and 0.555 parts of nitrogen, per million.

ences in the availability of the nitrogen supply. These differences are well illustrated by Plate III.

The following table gives in round numbers the quantities of water evaporated from the several pots and crops under experiment. The letters A, B, C, etc. refer to the six different fertilizers described on page 226. Four pots were supplied with nitrogen from each of these fertilizers and are numbered 1, 2, 3 and 4. In every case pot 1 received one-tenth of a gram of nitrogen, pot 2 two-tenths of a gram, pot 3 four-tenths of a gram and pot 4 eight-tenths of a gram of nitrogen. The gram nearly equals $15\frac{1}{2}$ grains and $28\frac{1}{3}$ grams make nearly an ounce avoirdupois.

WATER EVAPORATED FROM POTS AND PLANTS (grams).

Series,	A	B	C	D	E	F
Pot 1,.....	2270	2420	2740	2260	3550	3200
" 2,.....	4080	3570	4450	2470	5550	3830
" 3,.....	5900	4900	6790	3990	6220	6540
" 4,.....	9590	7000	8600	5710	9090	8200
Totals.....	21840	17890	22580	14430	24410	21770

When the plants had evidently ceased to increase, and new upper leaves were growing only at the expense of the old lower ones which had become yellow, shrunken and dry, the crops were harvested by cutting close to the soil.

The several crops were immediately dried at 120° F.; thereafter they were kept for 24 hours exposed to the air of a dry room and thus, in the air-dry state, were weighed with results as below given. These weights do not include the roots, which could not be separated from the soil.

WEIGHTS OF THE AIR-DRY CROPS (grams).

Series,	A	B	C	D	E	F	No nitrogen added.
Pot, 1,...	9.0	7.3	9.7	5.7	9.9	7.7	3.0 } av. 3.25
" 2,...	14.0	10.6	15.5	8.4	17.4	14.2	3.5
" 3,...	27.9	18.0	28.0	11.5	28.4	26.4	
" 4,...	48.2	27.0	45.4	23.6	44.4	33.8	
Totals ...	99.1	62.9	98.6	49.2	100.1	82.1	

The soil without any added nitrogen was thus shown to be able to produce $3\frac{1}{4}$ grams of dry substance, hence the net yield, which can certainly be attributed to the added organic nitrogen, is found by subtracting $3\frac{1}{4}$, say 3.3, from the gross weight of the several crops.

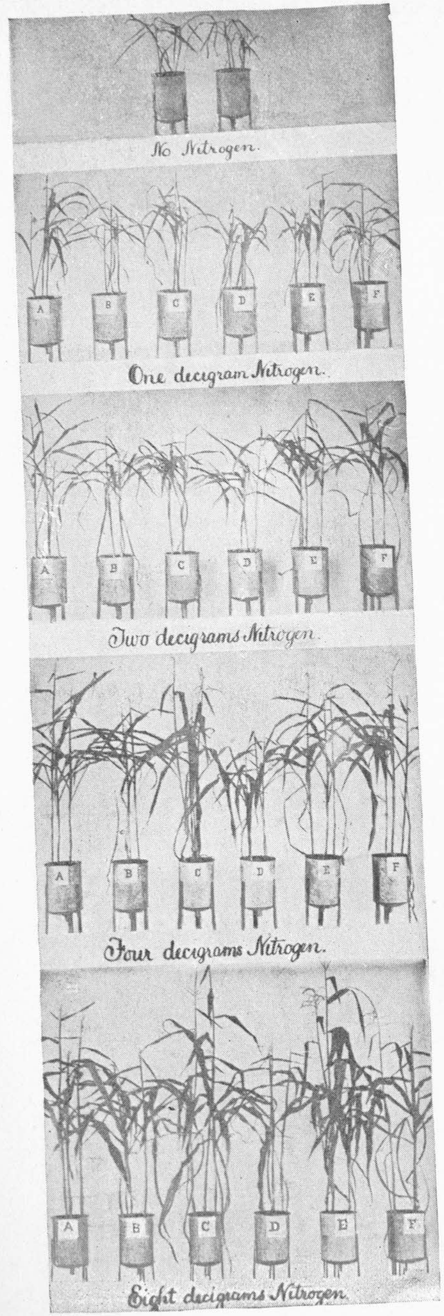


PLATE III.

The next tabular statement gives the quantities of crop-increase attributable to the organic nitrogen of the several fertilizers under trial.

WEIGHT OF AIR-DRY CROP-INCREASE (in grams).

Series,	A	B	C	D	E	F
Pot 1,	5.7	4.0	6.4	2.4	6.6	4.4
" 2,	10.7	7.3	12.2	5.1	14.1	10.9
" 3,	24.6	14.7	24.7	8.2	25.1	23.1
" 4,	44.9	23.7	42.1	20.3	41.1	30.5
Totals	85.9	49.7	85.4	36.0	86.9	68.9

The proportionate quantities of nitrogen added to the four pots in each series were to each other as the numbers 1, 2, 4, 8. The next table exhibits the proportionate increase of crop produced by the several applications of nitrogen—the increase of the first pot of each series being taken as 1.

RELATIVE CROP-INCREASE DUE TO NITROGEN ADDED.

	Relative quantities of nitrogen added.	Series, A	B	C	D	E	F
Pot 1,	1	1	1	1	1	1	1
" 2,	2	1.9	1.8	1.9	2.1	2.1	2.5
" 3,	4	4.3	3.7	3.9	3.4	3.8	5.3
" 4,	8	7.9	5.9	6.6	8.5	6.2	7.0

The above table shows that, as was intended, the nitrogen in all these experiments was present in minimum quantities relative to the other needful elements of plant food, so that the crop-increase kept fairly parallel with the increase of nitrogen. Larger supplies of nitrogen would have increased the crop still more but a point would soon have been reached, where the crop-increase would lag behind the increase of nitrogen in the fertilizer, till finally, increasing the nitrogen would have no further effect on the weight of crop, because some other kind of plant food would come to be in relative minimum and would thenceforth limit the development of the plants.

The increased yield due to the nitrogenous fertilizer is greatest in series E. If we reckon the yield in series E, in each case, as 100 then the *relative yields* produced by the several fertilizers are as follows:—

Crop-Increase stated in per cent. of Greatest Gain.

Series,	A	B	C	D	E	F
Pot 1,	86	61	97	36	100	66
" 2,	76	52	87	36	100	77
" 3,	98	58	98	33	100	92
" 4,	109	57	102	49	100	74
Average,	**92**	**57**	**96**	**39**	**100**	**77**

So far as these experiments are a correct measure, the relative crop-producing power of the several fertilizers is expressed by the last average figures above given.

If the crop-increase is a fair measure of the effect of the organic nitrogen used to fertilize the soil of the pots in which these crops were produced, then the quantities of nitrogen contained in the crops, especially in so far as derived from the fertilizers, ought to stand closely related to and parallel with the weights of the crops. To what extent such is the case, is to be seen from the following tables:—

Quantities of Nitrogen in the Crops (grams).

	A	B	C	D	E	F	*No nitrogen added.*
Pot 1,	.044	.036	.052	.030	.048	.041	.017 } av. 0185
" 2,	.077	.058	.079	.047	.078	.067	.020 }
" 3,	.148	.099	.137	.067	.151	.114	
" 4,	.270	.178	.304	.142	.275	.193	
Totals,	.539	.372	.572	.286	.552	.415	

Deducting from the above figures, the average amount of nitrogen in the two crops raised in the pots to which no fertilizer, (and no nitrogen) was added, we obtain the weights of—

Nitrogen-Increase in the Crops (grams).

	A	B	C	D	E	F
Pot 1,	.026	.018	.034	.012	.030	.023
" 2,	.059	.040	.061	.029	.060	.049
" 3,	.130	.081	.119	.049	.133	.096
" 4,	.252	.160	.286	.124	.257	.175
Totals,	.467	.299	.500	.214	.480	.343

Relative Nitrogen-Increase in Crops.

	Relative amounts of nitrogen added.	Series, A	B	C	D	E	F
Pot 1,	1	1	1	1	1	1	1
" 2,	2	2.3	2.2	1.8	2.4	2	2.1
" 3,	4	5.0	4.5	3.5	4.1	4.4	4.2
" 4,	8	9.7	8.9	8.4	10.3	8.6	7.6

Nitrogen-Increase stated in per cent. of Greatest Gain.

Series,	A	B	C	D	E	F
Pot 1,	87	60	113	40	100	76
" 2,	98	66	101	48	100	82
" 3,	98	61	89	37	100	72
" 4,	98	62	111	49	100	68
Average,	**95**	**62**	**104**	**44**	**100**	**75**

Comparing the last four tables with the four immediately preceding ones, it is manifest that the Crop-Increase and Nitrogen-Increase kept very even pace. This is also shown by the averages of increase in the table above and in the following:

In the subjoined table are brought together in one statement the nitrogen-solubilities in pepsin and under putrefaction, and the nitrogen-availabilities, of the several fertilizers, as indicated by gain of crops and gain of nitrogen in crops, all expressed in per cent. of the solubility or availability of the nitrogen in the best fertilizer E.

Comparison of Peptic, Putrefactive and Culture Tests.

	A	B	C	D	E	F
Relative nitrogen-solubility by pepsin	53	32	36	59	100	79
" " " putrefaction	74	48	64	60	100	87
Relative crop-producing power	92	57	96	39	100	77
" gain of nitrogen	95	62	104	44	100	75

The nitrogen of sample E shows throughout the greatest peptic and putrefactive solubility as well as greatest crop-producing capacity and with one exception (C) has given the most nitrogen to the crops. Sample B has yielded the least soluble nitrogen to pepsin and under putrefaction, but D, in the culture test, is least effective as a fertilizer. Samples A, C and E which vary so widely in the peptic and putrefactive solubility of their nitrogen, manifest very little difference in their average crop-producing powers as measured by either the crop-increase or gain of nitrogen by the crops.

It is evident that the tedious vegetation-cultures are the only true test of the availability of organic nitrogen, while the pepsin-digestion may give useful indications, but cannot be depended on for decisive results.

If opportunity offers it is purposed to continue investigations in these or similar directions.

FEEDING STUFFS.

(For Tables of Analyses see pages 248 to 251.)

Hay from Wheat and Rye.

Regarding these samples of hay, Mr. E. C. Birge of Southport writes that to provide enough coarse feed for his herd he finds advantage in raising rye or wheat to be cured for hay, immediately following and preceding his corn or other hoed crop and on the same land. By this means a crop covers the land the whole year round, and is growing at all seasons when the ground is not frozen. Mr. Birge judges that he thus gets more coarse fodder for winter use than is possible in any other way.

The hoed land is manured whenever convenient, summer or winter. The fields where corn was cut in September, 1893, and which were then seeded to rye, were manured in the succeeding winter and bushharrowed and rolled in the spring of 1894, to lay down the corn stubble and prevent its interference with cutting the rye in early June. The land will then be turned over and planted to corn. Common pasture land, after three successive corn crops with rye or wheat between, is seeded to clover.

After clover, corn or potatoes and rye or wheat follow again.

4124. Wheat-Hay, sowed Sept. 20, 1892, after potatoes, top-dressed in the winter, cut June 24th, when the seed was just going into the dough stage. Cured in good order and put into the barn June 30. The stubble was immediately turned under for corn. Yield about 2 tons per acre.

4126. Rye-Hay, sowed Sept. 6, 1892, after corn. Cut June 3d, 1893, cured in good order and put into barn June 6th. Yield about 1½ tons per acre.

4125. Rye-Hay, sowed Sept. 28, 1892, after corn which yielded 24 tons per acre. Cut June 8, 1893, cured in good order and put in barn June 10. Yield about 2 tons per acre.

4127. Rye-Hay, sowed after corn Oct. 11, 1892. Cut May 22, 1893, to clear the ground for corn. This was poorly cured, rained on while spread. Yield about one ton per acre.

The analyses, on pages 248–249, indicate that these cereal crops cured as hay, have, with the exception of **4127,** rather less protein and more fiber than average hay from mixed meadow grasses.

The higher content of protein in **4127,** as well as its smaller yield per acre, are explained by the fact that it was cut earlier than the other lots.

Maize Meal.

4132 is made from No. 2 old crop yellow corn in a roller mill.

4134 is made from new yellow corn in a roller mill.

Both of the above were drawn from stock of S. E. Brown, Collinsville.

4133 is made from old mixed corn ground on burr stones, sent by S. E. Brown, Collinsville.

4107, 4108 and **4109** are samples of meal drawn by our agent from stock of B. H. Palmer & Son, Norwich, Hatch, Bailey & Co. and Raymond Bros., of South Norwalk.

By-Products from Maize Meal.

These feeding stuffs mostly come from the factories of starch and glucose, of which the five largest in the United States together are said to be able to work up 120,000 bushels of corn daily. Glucose is made by chemical treatment of starch.

The preliminary processes by which the starch is separated from the other parts of the kernel are essentially the same in all factories, and are stated by the representative of one of them to be as follows:

The corn is ground with water between stones and first passed over sieves which retain the hull or chaff, while the starch mixed with the so-called "gluten" runs to settling tanks. The starch being specifically heavier than the gluten sinks to the bottom, while the gluten lies above the starch. When both have completely settled, the clear water first, and next the gluten, are run off, leaving the starch.

The Chicago Sugar Refining Co., of Chicago, Ill., makes Chicago Gluten Meal, Maize Feed and Corn Bran. The Chicago Gluten Meal is the clear "gluten" from the settling tanks, dried and perhaps ground. It is a granular, yellow or yellowish-brown material without decided odor. A single analysis is given, **4102.** It is a highly nitrogenous feed, nearly as rich in protein as cotton-seed meal, but containing much less fat or oil and but very little mineral matter. Its use in cattle rations would be about the same as that of cotton-seed meal. The Chicago Maize Feed is a mixture of gluten meal and hulls, not dissimilar from Buffalo Gluten Feed.

The Chicago Corn Bran, of which a single analysis, **4103,** is given in the table, consists of the hulls left on the sieves and of the corn chits or germs from which the oil has been partly extracted.

This material, as the analysis shows, has rather more protein than maize kernels of good quality and more than twice as much fat with correspondingly less nitrogen-free extract. Probably it cannot be economically used by feeders who have a plenty of home-raised corn.

The Charles Pope Glucose Co., of Geneva and Venice, Ill., make Cream Gluten Meal and Germ Feed. This brand of Gluten Meal is made of the "gluten" of the settling tanks like the Chicago Gluten. It is like the latter in appearance, has about the same percentage of protein, but twice as much oil as the Chicago Gluten Meal, and so compares more nearly with cotton-seed meal in composition. Two analyses appear in the table, **4084, 4106,** the former from stock of Smith, Northam & Co., Hartford. Cost $25.00 per ton.

Pope's Germ Feed is very like the Chicago Corn Bran in its origin and composition. See analysis **4105.**

The American Glucose Co., of Buffalo, N. Y., and Peoria, Ill., which is by far the largest company in the business, makes but one kind of feed, sold under the name Buffalo Gluten Feed. It consists of all those parts of the kernel not directly used to make glucose and contains therefore all the "gluten," hulls and oil of the kernel. Two analyses appear in the table, **4104** and **4069,** the latter sent by T. S. Gold, West Cornwall. It cost $20.00 per ton in car lots, in bags, delivered at West Cornwall.

This gluten feed is a more concentrated food than wheat bran, containing some 6 per cent. more of protein and two to three times as much oil as the latter, and more non-nitrogenous extract with less fiber and mineral matter.

Two samples of Hominy Chops, **4129** from F. H. Stadtmueller of Elmwood, and **4145** sent by Horace Burr of Winchester Center and bought of Noble Bennett, Winsted, both residues from the manufacture of hominy, are included in the table.

Wheat Feeds.

Three analyses of winter wheat bran, Nos. **4096, 4097** and **4098,** from stock of Browning & Gallup, New London, E. A. Buck & Co. and W. D. Grant of Willimantic, are given in the table; and two of spring wheat bran, Nos. **4099** and **4100,** from J. W. & F. J. Doon, Willimantic, and Arnold Rudd of New London.

While single analyses of winter wheat bran and spring wheat bran may show some variations, the averages of large numbers of analyses prove no constant difference in composition between the two.

White Wheat Bran **4110,** Red Wheat Bran **4111,** both from stock of Spencer & Pierpont, Waterbury, and Canada Bran **4112,** from stock of W. T. Hatch, South Norwalk, are preferred by some but they do not vary essentially in composition from the ordinary kinds. Whether the fineness of bran affects its digestibility is a question frequently asked but which has never, to our knowledge, been the subject of feeding experiments.

In the table are given five analyses of Wheat Middlings:

4091 and **4095** are from stock of Arnold Rudd, New London, **4092** from A. O. Beckwith, Norwich, **4093** from Smith & Northam, Hartford, and **4094** from B. H. Palmer & Son, Norwich. There is no great difference in chemical composition between these feeds and bran. They are a little richer in protein and are much more finely ground and lighter colored than the brans.

4089 from Hatch, Bailey & Co., and **4090** from M. T. Hatch, both of South Norwalk, are "Fine Wheat Feeds." These differ essentially from wheat bran and middlings. They are fine, white and floury, have comparatively little mineral matter and fiber and correspondingly more nitrogen-free extract. The quantities of protein and also of fat are not different from those of bran and middlings.

Oats and Oat Feeds.

The analyses made on samples drawn in the Connecticut market show the wide variations which are constantly met with in all preparations of oats used for cattle food.

The ground oats **4136** have the composition of clear oats.

The "Oat Feed" and "Oat Middlings" we are informed are made by the American Cereal Co. We have been unable to learn whether brands of definite composition and quality are put on the market by this company, but it is certain that "Oat Feed" is a general name in the feed market which is applied to fine feed rich in protein and also to chaffy coarse feed that is much poorer in protein than clear oats.

The samples of Oat and Corn Feed **4137** and **4138** are of inferior value, containing less protein than either corn or oats of good quality.

Rye, Barley and Buckwheat Feeds.

4146, Buckwheat Flour sent by T. F. Griswold, Little Haddam, is used for the table and not for cattle food. It has the average composition of the article, is low in protein (5.8 per cent. as against 10.8 in wheat flour), and correspondingly richer in starchy matter (80.5 per cent. as against 75 per cent. in wheat flour).

Strikingly different in composition is the buckwheat bran **4076** sold by W. F. Olmstead of Bridgeport. This must be the residue left from preparing the flour from the *hulled* seeds. It is rich in proteids (25.62 per cent.), containing more than wheat bran or Buffalo Gluten Feed and contains also as much fat as bran. At $19.00 per ton it should be a very economical feed, *judged simply by its chemical composition.*

4147, Buckwheat Feed sent by F. W. Holmes, Salisbury, from Eggleston & Sellick's mill, is a product evidently containing a good deal of the hulls mixed with the bran, as is shown by the large quantity of "fiber" in it. It contains rather more proteids, however, than corn meal.

The sample of ground rye **4130** was sent by F. H. Stadtmueller of Elmwood. There is no evident reason why clean rye may not be fed to cows in the same quantity as corn meal. The composition of the two is not very unlike.

The suspicion with which rye is regarded by feeders probably comes from the fact that when it is affected with ergot, as sometimes happens in very wet seasons, its use as a feed is unsafe.

The presence of ergot in rye can be readily detected by the eye.

Two analyses of "Damaged Barley," **3782** and **4054,** represent grain which had been malted and probably overheated in the kiln so that it could not be used for brewing. The samples had a slightly scorched smell. The process of malting merely brings the starch and other matters of the seeds into more soluble form but does not destroy or remove any considerable part of them.

This feed has been used in considerable quantity by several feeders in the State with good results. Cows relish it and it imparts no noticeable ill flavor to the milk.

Cotton Seed Meal.

Samples **4073** from Wheeler & Howes, Bridgeport; **4074** from A. A. Beckwith, Norwich; **4075** from Wm. M. Terry & Co., Bridgeport; **4143** and **4144** sent by Clarence A. Hammond, Elliott, and purchased of the Charlotte Oil and Fertilizer Co., Charlotte, N. C., represent the average quality of clear decorticated meal, the most concentrated feeding stuff in the market and, if used solely as a fertilizer, the cheapest source of available organic nitrogen.

3856 is undecorticated Sea Island Meal, containing little more than half as much proteids as the hulled meal and, at present prices, very uneconomical to purchase either as feed or fertilizer.

Linseed Meal, Old and New Process.

Much of the linseed meal in market is the pulverized cake left after ground flax-seed has been subjected to extreme pressure for extraction of the oil. This "Old Process" meal retains from 5 to 11 per cent. of oil. The Cleveland Linseed Oil Co. controls patents for removing the oil by solvents instead of pressure. Their Linseed Meal, called "New Process," contains much less oil and more protein than the other. **4080** is from the Platt Mill Co. of Waterbury, **4081** from E. A. Buck & Co., Willimantic, **4082** from Wheeler & Howes, Bridgeport, **4083** from A. A. Beckwith, Norwich, and **4128** was sent by F. H. Stadtmueller, Elmwood.

Pea Meal.

3746, sent by T. S. Gold, West Cornwall, probably consists of the shells or outer coating of peas, ground with other refuse, from a split-peas factory. Cows do not relish this meal on account of its bitter taste and even sheep prefer bran.

Miscellaneous Feeds.

"Proteina," of which two analyses are given, **4078** from stock of Browning & Gallup, New London, **4079** from E. A. Buck & Co., Willimantic, appears to be a mixture of corn, oat hulls, linseed meal and perhaps gluten meal.

It may be most fairly compared, as far as chemical composition goes, with Buffalo Gluten Feed, but its price is, at present rating, too high to make it an economical feed.

Special Cow Feed **4077** sold by Hatch, Bailey & Co., South Norwalk, is said to be composed of 40 pounds of gluten meal, 40 pounds of hominy chops, 15 pounds of oats and 5 pounds of linseed meal in every 100 pounds.

Assuming that the "gluten meal" of the formula is gluten *feed* with 22 per cent. of proteids instead of 36 or 38, such a formula ought to make a considerably richer feed, containing some 4 per cent. more of protein than is in the sample.

3748 is a sample of Special Made Mill Feed of the United States Milling Co., Jersey City, N. J., which it is claimed "will keep sound and sweet longer than any in the market, thereby insuring those who handle this feed a better return for their money than any other feed."

The analysis shows it to be a less concentrated feed than wheat bran. In the circular received from the manufacturer nothing is stated as to the ingredients which enter into this "special made feed."

4072 is a sample of Elevator Screenings sent by W. L. Buckland of Burnside. It is used chiefly as poultry food but to some extent for cattle. It is to be judged rather by inspection than chemical analysis. It consists of damaged grain mixed with seeds of cockle and a host of other weeds. Its use either for poultry or cattle makes pretty certain a further seeding of the farm with noxious weeds.

4122 is a sample of "Nutriotone" made by the Thorley Food Co. of Chicago, Ill., and widely advertised and sold in Connecticut at the present time. It contains a considerable quantity of some leguminous seed, some linseed meal and perhaps other feeding stuffs, together with aromatic substances, (fenugreek, aniseseed, caraway and the like), and over ten per cent. of salt. The analysis shows its value in a general way *as a feed.* The material however is claimed to be rather in the nature of a tonic having medicinal properties, than of a feeding stuff, as is judged from the fact that the prescribed dose for cattle is two tablespoonfuls with each feed. The use of such condimental cattle foods has been proved by Sir John Lawes to be without any advantage for healthy animals, as shown by the following quotation from the Second Annual Report of this Station for the year 1878, pp. 125–6:

"Mr. Lawes, of Rothamsted, England, made a most thorough practical trial on the use of condiments in feeding, and demonstrated that there was no profit in it. One of his trials was made on twenty sheep (ten fed with plain food, ten with condiment) and continued twenty-eight weeks, when the animals were slaughtered and marketed. The extra cost of feeding ten sheep with condiment was £3, 4s., the result of the feeding being alike with condiment and with plain food."*

* Experiments on the Question whether the use of Condiments increases the Assimilation of Food by Fattening Animals, or adds to the Profits of the Feeder: by J. B. Lawes, F.R.S. Edinburgh Veterinary Review, 1862.

"Mr. Lawes has stated* that while sheep ate no more food under the stimulus of condiments than without, pigs did eat a larger quantity, but the pigs assimilated no more and got no benefit from the increased consumption."

"Other testimony to the same effect may be found in the agricultural journals of Great Britain, where condimental foods were extensively tested fifteen to twenty years† ago."

Here may also be noticed the Silver Live Stock Powder, which is sold in this State for $1.00 per pound. According to the advertising circular the "Silver Live Stock Powder contains an element that the nature of animals require, from which the habits of civilization have deprived them."

"Formerly when an animal was sick, the first thing to know was the name of the disease and then to find a remedy. Since the discovery of the Live Stock Powder or Nature's Sovereign Remedy," the writer goes on to say that he does not care to know what the ailment is.

The "Sovereign Remedy" consists essentially of ground bone, having a dark color and slight odor of coal tar.

The Valuation of Mill Feeds.

In a following table are given the average cash ton prices of the mill feeds commonly found in our markets. These figures are based on quotations made to us by twenty-two leading feed dealers of this State in December last.

From the average composition of the different feeds and their cost, has been calculated, by the method described in the Report of this Station for 1888, page 141, the average cost per pound of protein, fat, etc.

It was found that at present prices the average cost of these ingredients in mill feeds is as follows:

Protein costs	2.3	cents per pound.
Nitrogen-free Extract and Fiber	.94	" "
Fat	1.14	" "

The following table gives the articles on which this calculation was based, the market prices of these articles, and their "valuation" calculated from the average cost of the food ingredients:

* Journal Royal Agricultural Society of England, xxiii., p. 425.
† Now thirty to forty years ago.

	Average cost per ton.	Valuation per ton.
Cotton Seed Meal	$27.50	$27.96
Linseed Meal, old process	29.75	25.12
Linseed Meal, new process	28.25	24.83
Wheat Bran	18.75	20.13
Wheat Middlings	20.50	21.46
Rye Bran	20.00	20.24
Corn Meal	20.50	18.24
Gluten Meal	25.50	27.93
Hominy Chops	20.00	19.27
Malt Sprouts	18.50	22.14
Oat Feed	21.00	20.12
Buffalo Gluten Feed	21.25	23.85
	$271.50	$271.29

The sums total of the cost prices and valuations are very nearly alike, proving the correctness of the calculation by which the costs of protein, fat, etc., were obtained.

Similar calculations made in 1888 and in 1890 gave the following as the cost of the ingredients named:

	1888.	1890.	1893.
Protein (N × 6.25)	1.6 cents per pound.	1.4	2.3
Fat	4.2 " "	2.9	1.14
Nitrogen-free Extract and Fiber	.96 " "	1.4	.94

The same feeds, with one or two exceptions, were used in the calculations of the three years and the chemical analyses were essentially the same. Hence these wide variations in cost prices of protein, fat, etc., are chiefly to be explained by changes in the relative cost of highly nitrogenous feeds as compared with the more starchy ones.

The prices of feeds in our market bear no relation at present to their relative value as cattle food. It is a striking commentary on the situation that the most concentrated of our feeding stuffs is also the cheapest source of organic nitrogen as a fertilizer. The quantity of cotton seed meal used as a feed in this State is very much less than the quantity used as manure.

By the use of the above schedule of prices may be calculated the "valuation" of certain feeds. The schedule is *only applicable to mill feeds* of the same general kind as those named in the table; it is not applicable to coarse fodder, roots, etc.

Such a "valuation" does not have any reference to the digestible substance or to the feeding value of the article. It simply serves to show whether the crude food ingredients contained in the feed cost more or less than the general average of mill feeds.

Thus from the valuations in the following table of analyses it appears that when clear cotton-seed meal is quoted at $26 to $27 per ton its crude food ingredients cost less pound for pound than those of mill feeds on the average, but that in undecorticated meal at $22.50 the crude food ingredients cost as much as in ordinary mill feeds or even more.

Judged in the same way the crude food ingredients of linseed meal are more costly than in most other feeds, and the same is true of the samples of "provender" whose analyses and valuations are given on pages 250 and 251.

Yet linseed meal ought not to be discarded simply because its crude food ingredients cost more in our market than those of other feeds. Many experienced feeders claim that it is actually worth more both because of its nutritive value and also because of its regulative and medicinal effect on the digestive system. While the food ingredients of cotton seed meal are cheaper than those of other feeds, the nature of the feed places strict limitations on its use, particularly for dairy stock.

The indications which this "valuation" furnishes are, however, suggestive, and may be helpful in studying the chemical analyses in the table.

Cost, Valuation and Analyses of Feeding Stuffs.

Number.		Cost per Ton.	"Valuation."	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract, (Starch, Gum, etc.)	Fat.	Analyses, Calculated Water-Free. Ash.	Protein.	Fiber.	Nitrogen-Free Extract, (Starch, Gum, etc.)	Fat.
4124	**Wheat Hay**	----	----	11.29	3.10	4.61	30.25	49.36	1.39	3.49	5.18	34.11	55.65	1.57
4126	**Rye Hay**	----	----	10.24	4.02	5.81	38.36	40.28	1.29	4.46	6.47	42.74	44.88	1.45
4125	"	----	----	9.52	3.83	5.21	37.68	42.22	1.54	4.23	5.77	41.66	46.65	1.69
4127	"	----	----	10.27	5.28	6.71	37.83	38.67	1.24	5.89	7.46	42.18	43.09	1.38
4132	**Maize Meal**	----	$19.02	12.47	1.04	9.57	1.50	71.41	4.01	1.18	10.94	1.71	81.60	4.57
4134	"	----	17.93	16.57	.65	8.20	1.78	69.37	3.43	.78	9.82	2.13	83.17	4.10
4133	"	----	18.61	14.08	1.07	9.17	1.97	69.72	3.99	1.23	10.70	2.30	81.12	4.65
4107	"	$20.00	19.06	12.30	1.08	9.62	1.41	71.59	4.00	1.22	10.96	1.60	81.66	4.56
4108	"	23.50	18.89	12.50	1.00	9.12	1.25	72.37	3.76	1.14	10.41	1.42	82.74	4.29
4109	"	22.00	19.12	12.18	1.08	9.75	1.82	71.19	3.98	1.23	11.11	2.07	81 06	4.53
	By-Products from Maize Meal.													
4102	Chicago Gluten Meal	----	27.93	8.43	.62	38.94	.85	45.14	6.02	.68	42.52	.94	49.29	6.57
4103	Chicago Corn Bran	----	20.57	8.24	.40	11.19	12.10	59.22	8.85	.44	12.19	13.17	64.56	9.64
4084	Pope's Cream Gluten Meal	25.00	28.13	8.49	.65	38.56	1.12	37.27	13.95	.70	42.13	1.21	40.71	15.25
4106	Pope's Cream Gluten Meal	----	27.47	6.84	.55	35.00	1.00	43.21	13.40	.59	37.57	1.07	46.38	14.39
4105	Pope's Germ Feed	----	20.82	7.26	.50	11.25	12.49	58.04	10.46	.54	12.14	13.46	62.57	11.29
4104	Buffalo Gluten Feed	----	24.42	8.04	.40	24.87	7.45	48.16	11.08	.43	27.05	8.11	52.37	12.04
4069	Buffalo Gluten Feed	20.00	23.18	11.58	.67	22.62	6.83	44.93	13.37	.75	25.59	7.71	50.82	15.13
4129	Hominy Chops	----	19.57	10.93	2.55	11.12	4.29	64.01	7.10	2.86	12.49	4.83	71.91	7.91
4145	Hominy Chops	20.00	19.25	11.66	2.65	10 35	5.20	61.93	8.21	3.00	11.72	5.88	70.10	9.30
	Wheat Feeds.													
4096	Winter Wheat Bran	18.00	20.35	11.34	6.55	17.31	8.40	51.19	5.21	7.39	19.52	9.48	57.74	5.87
4097	" "	20.00	20.10	11.35	6.40	16.31	11.02	49.99	4.93	7.22	18.40	12.43	56.40	5.55
4098	" "	18.00	20.52	11.30	6.03	17.62	7.50	53.00	4.55	6.80	19.87	8.46	59.75	5.12
4099	Spring Wheat Bran	18.00	20.12	11.75	6.25	16.56	10.08	50.42	4.94	7.08	18.77	11.42	57.13	5.60
4100	" "	19.00	20.04	10.84	6.81	16.12	10.42	51.59	4.22	7.62	18.08	11.69	57.88	4.73
4110	White Wheat Bran	20.00	19.78	10.50	6.45	14.62	8.18	56.17	4.08	7.20	16.33	9.16	62.75	4.56
4111	Red Wheat Bran	19.00	20.36	9.97	6.40	16.37	8.73	53.91	4.62	7.11	18.19	9.69	59.88	5.13
4112	Canada Bran	20.00	19.63	11.04	6.95	14.87	8.61	54.26	4.27	7.81	16.72	9.67	61.00	4.80
4101	Bran	18.50	20.20	11.21	6.56	16.69	10.22	50.37	4.95	7.39	18.79	11.51	56.73	5.58
4094	Red Middlings	20.00	21.17	9.37	4.27	17.31	7.87	55.49	5.66	4.72	19.09	8.67	61.23	6.29
4091	Winter Wheat Middlings	21.00	21.94	11.37	2.87	20.69	3.02	57.71	4.34	3.30	23.33	3.39	65.10	4.88
4092	" " "	23.00	22.02	10.50	3.75	20.94	4.20	55.48	5.13	4.18	23.40	4.69	62.00	5.73
4093	Spring Wheat Middlings	19.00	21.36	9.92	4.99	18.87	7.00	53.46	5.76	5.54	20.93	7.80	59.34	6.39
4095	" " "	21.00	20.98	11.59	3.00	17.43	3.87	59.64	4.47	3.39	19.72	4.38	67.45	5.06
4089	Fine Wheat Feed	22.00	21.31	11.90	1.40	17.69	.85	63.24	4.92	1.59	20.08	.95	71.80	5.58
4090	" " "	22.00	21.56	12.09	1.45	18.87	1.40	61.89	4.30	1.64	21.47	1.59	70.41	4.89

COST, VALUATION AND ANALYSES OF FEEDING STUFFS—*Continued.*

Number.		Cost per Ton.	"Valuation."	Analyses.						Analyses, Calculated Water-Free.				
				Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract, (Starch, Gum, etc.)	Fat.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract, (Starch, Gum, etc.)	Fat.
	Oats, Oat Feed and Provender.													
4136	Clear Ground Oats	----	$19.72	9.67	3.29	11.53	11.12	58.83	5.56	3.65	12.77	12.31	65.12	6.15
4139	Oat Feed	----	19.66	8.88	4.43	11.94	14.02	57.76	2.97	4.86	13.11	15.39	63.37	3.27
4140	"	----	20.22	7.89	4.04	12.81	13.05	57.78	4.43	4.37	13.90	14.19	62.72	4.82
4141	Oat Middlings	----	22.28	6.52	3.40	18.45	5.13	58.32	8.18	3.64	19.74	5.49	62.38	8.75
4086	Provender	$22.00	19.28	12.24	1.05	10.31	3.20	68.93	4.27	1.21	11.76	3.66	78.50	4.87
4087	"	24.00	19.23	12.20	1.10	10.13	3.32	68.75	4.50	1.25	11.54	3.78	78.30	5.13
4088	"	24.00	19.09	12.37	.95	9.62	2.70	69.87	4.49	1.09	10.97	3.08	79.74	5.12
4137	Oats and Corn Feed	----	18.54	10.10	2.85	7.51	10.35	65.84	3.35	3.17	8.33	11.52	73.25	3.73
4138	" "	----	18.78	10.08	2.77	8.28	9.38	65.98	3.51	3.06	9.19	10.41	73.45	3.89
	Rye, Barley and Buckwheat Feeds.													
4146	Buckwheat Flour	----	----	12.08	.91	5.79	.25	80.48	.49	1.05	6.59	.28	91.52	.56
4076	Buckwheat Bran	19.00	22.92	12.84	3.53	25.62	3.72	48.45	5.84	4.04	29.40	4.27	55.59	6.70
4147	Buckwheat Feed	16.00	19.49	10.67	2.79	11.43	28.66	43.69	2.76	3.13	12.79	32.08	48.90	3.10
4130	Ground Rye	----	19.00	13.21	1.70	10.75	2.25	70.07	2.02	1.96	12.38	2.58	80.76	2.32
4085	New York State Rye Feed	20 00	20.49	10.31	2.80	14.87	3.60	65.68	2.74	3.12	16.58	4.01	73.24	3.05
3782	Damaged Barley	14.50	20.34	7.48	2.17	12.06	6.15	70.29	1.85	2.35	13.03	6.65	75.97	2.00
4054	Damaged Barley	----	19.37	11.88	2.19	11.56	5.60	66.87	1.90	2.49	13.12	6.36	75.87	2.16
4073	**Cotton Seed Meal,** decorticated	27.00	26.70	8.92	7.25	38.56	4.38	29.68	11.21	7.95	42.34	4.81	32.59	12.31
4074	" " "	27.00	28.43	8.58	6.63	44.56	5.25	25.71	9.27	7.25	48.77	5.74	28.14	10.10
4075	" " "	27.00	30.34	8.35	5.52	50.38	3.90	20.74	11.11	6.03	54.97	4.25	22.63	12.12
4143	" " "	26.00	28.53	9.64	6.40	45.44	4.37	24.45	9.70	7.08	50.30	4.82	27.07	10.73
4144	" " "	26.00	28.16	9.92	6.74	44.56	5.23	24.18	9.37	7.49	49.46	5.81	26.84	10.40
3856	" " undecorticated	23.50	22.53	10.08	5.00	23.19	18.39	36.86	6.48	5.56	25.79	20.45	41.00	7.20
4080	**Linseed Meal,** Old Process	30.00	25.19	10.34	5.37	33.06	7.87	34.55	8.81	5.99	36.87	8.78	38.54	9.82
4081	" "	31.00	25.85	10.99	5.12	36.31	7.30	35.24	5.04	5.75	40.80	8.20	39.59	5.66
4082	" "	31.00	24.21	9.03	4.40	27.69	8.50	40.22	10.16	4.83	30.44	9.34	44.22	11.17
4083	" New Process	33.00	26.59	10.45	5.42	39.19	7.60	34.49	2.85	6.05	43.76	8.49	38.52	3.18
4128	" "	----	25.84	11.76	5.37	37.25	9.06	33.42	3.14	6.10	42.20	10.27	37.87	3.56
3746	**Pea Meal**	20.00	22.12	12.40	3.66	23.13	8.89	50.74	1.18	4.17	26.42	10.15	57.92	1.34
	Miscellaneous Articles.													
4078	Proteina	25.00	23.33	9.80	2.03	23.50	8.47	47.20	9.00	2.25	26.06	9.34	52.35	10.00
4079	Proteina	24.00	23.46	9.56	2.37	24.06	9.42	45.66	8.93	2.63	26.60	10.39	50.50	9.88
4077	Special Cow Feed	24.00	20.37	10.68	1.86	13.56	6.77	61.03	6.10	2.07	15.18	7.57	68.35	6.83
4135	Pratt's Food for Horses and Cattle	----	20 83	10.80	4.22	16.99	4.90	57.26	5.83	4.72	19.06	5.50	64.20	6.52
3748	U. S. Milling Co.'s Special Mill Feed	21.00	21.03	8.00	3.03	14.94	4.27	63.71	6.05	3.29	16.25	4.64	69.25	6.57
4072	Elevator Screenings	12.00	----	11.27	5.07	16.50	10.55	52.34	4.27	5.71	18.59	11.89	59.00	4.81
4122	Nutriotone	----	----	7.72	19.41	22.12	6.97	37.76	6.02	21.02	23.98	7.55	40.93	6.52

LITERATURE OF FUNGOUS DISEASES.*

By W. C. Sturgis, Mycologist.

A Provisional Bibliography of the more important works published by the U. S. Department of Agriculture and the Agricultural Experiment Stations of the United States from 1886 to 1893 inclusive, on Fungous and Bacterial Diseases of Economic Plants.

CONTENTS.

The preparation of the following bibliography, already printed as Bulletin 118, has occupied what time and attention I have been able to spare from other duties during the past three years. Although meanwhile other publications have appeared covering the same ground, the present work has been prepared for publication in the hope that it might still prove of some value to intelligent farmers and horticulturists as well as to the mycologists of Experiment Stations.

General scope and plan of this Paper.—The determination of a fungus which is the cause of a specific disease of any economic plant is of course a matter for the specialist alone, but there seems to be no reason why any intelligent man should not be able to recognize, within certain limits, the cause of a diseased condition of a certain plant, provided only that he be furnished

* Including diseases caused primarily by Bacteria.

with a list of all diseases to which that particular plant is liable, each disease being characterized by a common name more or less expressive of the effect which the agent of disease produces, or of some evident peculiarity of that agent whether vegetable or animal. It is solely with the fungous and bacterial parasites of economic plants that this bibliography has to do, and it has been thought advisable to give to the common names of the diseases recorded, a prominence which might serve to render the latter more readily recognizable.

Such recognition of a fungous disease being thus partially provided for, references are given to such publications as careful study has convinced me to be the best as regards the description and illustration of the cause or effect of the disease in question, and any line of treatment which has been tested. This will enable anyone who has access to agricultural libraries or to files of Station publications, to answer for himself many questions which at present he must refer to those who are better informed than himself.

As I have stated above, the ground of this Bulletin has already been covered, notably by certain publications of the Department of Agriculture,—the Experiment Station Record published monthly and giving digests of all publications of the Department and of the Stations; a Card Catalogue of the literature of the Experiment Stations and kindred institutions; and Bulletin 15 of the Office of Experiment Stations, a Handbook of Experiment Station Work consisting of a Popular Digest of the Publications of the Experiment Stations. It will be seen at once that these three sources of information have a very wide scope, an admirable feature in itself but one not altogether adapted to obviate the difficulties of reference which increase rapidly as the literature accumulates. It now frequently requires much labor to discover if a certain parasitic fungus of economic importance has been recorded in Station publications, if any definite line of treatment has been recommended, and if so, where and when. The consequence is that much work is likely to be repeated unnecessarily.

I have thought that by limiting the scope of this bibliography to diseases caused by fungi and bacteria alone, and broadly speaking, to the years 1886–1893, I might eliminate the danger of error incidental to a larger undertaking, and at the same time depend upon a careful and personal comparison of the available Station literature under each subject to enable me to select what seemed to be the best.

Arrangement of topics.—The general arrangement of the work needs little comment. The main subjects are the host-plants and these are arranged alphabetically; under the name of each host-plant are arranged, also alphabetically, the "common names" of the fungous diseases recorded as affecting the plant. References to descriptions and illustrations either of the fungus itself or of its effect upon the host-plant follow, and finally a line of treatment, if any has been recommended or tested, is referred to. All references are arranged chronologically under each of the sub-headings,—*Description* and *Treatment*. The date of publication occupies the right-hand margin of the page. In the case of references to Annual Reports, the number of the Report is given, followed immediately by the year which it covers, and in the margin the date of publication for the sake of uniformity.

Occasionally I have referred to other than Station literature, viz., to Lamson-Scribner's "Fungous Diseases of the Grape and other Plants," and to "Garden and Forest." I have made these exceptions on the ground that both of these publications should be, and probably are, in every library of agriculture, and because the author of the former was for some time connected with the Department of Agriculture, and many of its best publications on economic mycology proceeded from him, while in the columns of Garden and Forest, there appear from time to time important notes upon fungous diseases by Station workers.

Wherever, as in the case of Black-Rot of Grapes or Scab of Apple, a great number of admirable papers have issued from many Stations, I have aimed first to select the fullest and best, and then to select those from widely separated localities in order that some one of the original publications referred to may be accessible to as many observers as possible. This has compelled me to omit many references which might have been recorded since I have thought it best not to record two of equal worth from adjacent States, in case it were possible to substitute for one of them, a publication from a widely different locality.

Common names of fungous diseases.—A word must be said regarding the so-called "common names" selected. Many names such as Black-Knot, Black-Rot, Rust, etc., have made such an impression that, as in the case of flowering plants, it would be unwise to disregard them. In economic mycology however, we are met by a difficulty regarding common names which is not so evident in the nomenclature of flowering plants. In the latter case the common names represent what alone the plants are known by either locally or nationally outside of scientific circles, and they have arisen spontaneously from common observation. In economic mycology on the other hand, many of the "common names" have been invented by the mycologists themselves and most loosely applied. Such, it is true, has not always been the case; thus every one recognizes that the "Rusts" belong to one group of fungi which the botanist calls *Uredineæ*, although doubtless the name first arose among people who were quite ignorant of the cause, but who noticed the rusty color produced uniformly by the disease; so in the case of the "Smuts," a common name fitly given by observant people, although the fungi causing "Smut," all happen to belong to the natural group of the *Ustilagineæ*. In such cases the common name has originated spontaneously and is fairly satisfactory. It is at least natural. But who knows even what one of the great natural groups of fungi is designated by the term "Leaf-Blight" or "Leaf-Spot," "Stem-Rot" or "Mildew?"

Where such confusion has necessarily arisen regarding common names given arbitrarily and with no definite plan or system, it is manifestly impossible to arrange them on any satisfactory lines, and it would be an impertinence for one observer to attempt all the desirable changes. Deeming it expedient for the reasons explained, to make use of common names in the present paper, and to give them a decided prominence, I have endeavored to group them as far as possible in conformity with the natural scientific arrangement, and in doing so, have ventured to change only a few which seem to have been originally bestowed with the least imaginable forethought. Such changes have been made chiefly in those diseases of the leaves which have been indiscriminately called "Leaf-Blight" or "Leaf-Spot." The former of these terms I have, with few exceptions, confined to conidial fungous forms belonging to the group of *Hyphomycetes* and producing upon the leaves attacked indeterminate or effused areas, which sometimes involve the whole leaf in a condition most aptly described by the term "Blight." The perithecial forms whether acigerous, pycinidial, or spermogonial, I have grouped together under the general term "Leaf-Spot," since the diseased areas produced by such forms in the leaf-tissue are often

circumscribed in outline, giving the leaf a spotted appearance, and not infrequently become separated from the leaf altogether producing the appearance described as "shot-hole." That on this basis the same disease must at one time be called "Leaf-Blight" and later "Leaf-Spot," is very true, but it seems to be one of the lesser evils attending the use of common names. The term "Scab," I have limited to hyphomycetous fungi which produce upon either the leaves or fruit attacked determinate spots occupied by a dense growth of the fungus and more or less indurated, although here again I have thought it best to denominate as "Scab" certain fungi which may not produce any definite scabby appearance, but which nevertheless belong to genera such as *Fusicladium*, *Fusarium*, *Cladosporium* and the like, to which belong those fungi which were originally and aptly called "Scab-fungi." I have done this because it seems best to make these common names depend more upon scientific principles than upon some indefinite effect produced on the tissues of the host. Under the general term "Anthracnose," I have followed established precedent in including conidial forms belonging, with one exception, to the group of the *Melanconieæ*. That exception is the genus *Vermicularia* in which, though grouped with the *Sphaeropsideæ*, forms are included in which the perithecium is obsolete and which therefore approach the genus *Colletotrichum*. In cases where hyphomycetous fungi related to those which cause "Leaf-Blight," attack fruit and produce a decided decay, I have thought best to speak of them as "Fruit-Mould," and in some cases where similar effects are produced upon the leaves, as "Leaf-Mould," it being doubtful in some of these instances whether the attack is of a truly parasitic nature or does not more nearly resemble the process by which any dead organic substance becomes "mouldy."

Finally, I have followed established precedent in the use of common names wherever it seemed that the name so applied was one actually in common use, outside of scientific circles, to designate a specific disease of an economic plant. Such names I have not felt at liberty to change, although, upon a scientific basis, a change might appear both practicable and desirable. Such cases are the "White-Rust" (*Cystopus*) of the Beet, Cabbage, Radish and Turnip, the "Frenching" (*Fusarium*) of Cotton, the "Damping-off" (*Pythium*) of seedlings, "Plum-pockets" (*Taphrina*), "Leaf-curl" (*Exoascus*) of Peach, etc.

It will be noted that the familiarly descriptive term "Rot" has been applied to a great number of fungous diseases, a slight degree of system and clearness being secured by some qualifying prefix indicating where practicable, the portion attacked.

Nomenclature.—I have relied upon several sources for the scientific names which I have used. For the Phænogams I have followed Gray's Manual, and the Index Kewensis of Hooker and Jackson so far as that work has as yet appeared. For the fungi I have relied almost entirely upon Farlow & Seymour's Provisional Host-Index of the Fungi of the United States.

Abbreviations.—Little need be said regarding the abbreviations used, since most of them are readily intelligible. Among the publications referred to *Journ. Mycol.*, stands for the *Journal of Mycology*, at present issued serially by the Department of Agriculture, Division of Vegetable Pathology; *Scribner, Fung. Dis.*, refers to "*Fungous Diseases of the Grape and other Plants*," by F. Lamson Scribner, published by the J. T. Lovett Company, Little Silver, N. J., 1890; and *Gar. and For.* refers to the horticultural monthly "*Garden and Forest*," published from the Tribune building, New York City. The two latter publications are occasionally referred to for reasons stated above.

The names of States are abbreviated according to the usual custom; *Bulletin* and *Report* are abbreviated respectively to *Bull.* and *Rep.*, and, as already explained are arranged chronologically according to date of publication. Where two Stations exist in one State, they are distinguished by separate titles; thus *N. Y. Corn. Univ. Agr. Exp. Sta.*, refers to the Experiment Station connected with Cornell University at Ithaca, N. Y. The publications under the heading *U. S. Dept. Agr.*, and abbreviated to *Circ.* and *Farm. Bull.*, are occasional issues of the Department of Agriculture called *Circulars* and *Farmers Bulletins* which give information of value to farmers and others in a simple and concise form.

The abbreviations which precede the references will require more extended explanation. *Descr.*, indicates that in the work referred to, the fungus or its effect on the plant has been described; if followed by *Illus.*, the fungus or its effect has also been illustrated. *Occ.*, indicates that the occurrence of the fungus has been noted, with no further comment. *Treat.*, stands for Treatment, the abbreviation in parenthesis which follows being explanatory; (*rec.*), indicates that a definite line of treatment has been recommended, though based upon analogy and not

upon any direct experiment; (*pos.*), that a positive line of treatment has been proved successful by definite experiments the results of which are recorded; (*neg.*), either that some treatment has been tried and has given negative results, or that nothing has yet been attempted in this direction. It may be well to note that *Cf*, the usual abbreviation of *Compare*, refers the reader to some other portion of the paper for further information.

In preparing this article for publication I am only too conscious that critical eyes will detect many errors and omissions. I have attempted to include only the best publications of permanent value relative to fungous diseases which have issued from the Department of Agriculture and the Agricultural Experiment Stations, between and including the years 1886 and 1893, though I have not always limited myself to those dates. Many will doubtless dissent from my judgment in the selection of papers as worthy of record; such critics I would ask kindly to inform me of any such errors or omissions in order that they may be corrected if possible and advisable.

Alfalfa.

(*Medicago sativa*, L.)

Leaf-Spot (*Pseudopeziza Medicaginis*, (Lib.) Sacc.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 3, 1890, pp. 79–82. (1891)
Treat. (rec.), Del. Agr. Exp. Sta., Rep. 3, 1890, p. 82. (1891)

Root-Rot (*Ozonium auricomum*, Lk.)
Occ., Tex. Agr. Exp. Sta., Bull. 22. (1892)
Cf., Cotton (Root-Rot).

Almond.

(*Prunus* (*Amygdalus*) *communis*, L.)

Leaf-Blight (*Cercospora circumscissa*, Sacc.)
Descr. Illus., Journ. Mycol., Vol. vii, p. 66. (1892)
Treat. (pos.), Journ. Mycol., Vol. vii, p. 232. (1893)

Apple.

(*Pirus malus*, L.)

Black-Rot (*Sphaeropsis Malorum*, Berk.)
Descr., Scribner, Fung. Dis., p. 81. (1890)
Cf. Quince (Black-Rot).

Fire-Blight (*Micrococcus amylovorus*, Burrill.)
Descr., Colo. Agr. Exp. Sta., Rep. 1, 1888, pp. 64–69. (1888)
N. C. Agr. Exp. Sta., Bull. 92, p. 89. (1893)
Treat. (rec.), Colo. Agr. Exp. Sta., Rep. 1, 1888, pp. 69 & 70. (1888)
N. C. Agr. Exp. Sta., Bull. 92, p. 89. (1893)
Cf. Pear (Fire-Blight).

Fruit-Spot (*Phyllachora pomigena*, (Schw.) Sacc.)
Descr., Vt. Agr. Exp. Sta., Rep. 5, 1891, p. 133. (1892)

Leaf-Spot (*Phyllosticta pirina*, Sacc.)
Descr., Vt. Agr. Exp. Sta., Rep. 6, 1892, p. 83. (1893)
Va. Agr. Exp. Sta., Bull. 17, p. 62. (1892)
Treat. (rec.), Va. Agr. Exp. Sta., Bull. 17, p. 64. (1892)

Powdery-Mildew (*Podosphaera oxyacanthae*, (DC.), DBy.)
Treat. (pos.), U. S. Dep. Agr., Sec. Veg. Path., Circ. 8, p. 8. (1889)
Journ. Mycol., Vol. vi, p. 14. (1890)
U. S. Dep. Agr., Farm. Bull. 7, p. 14. (1892)
Cf. Journ. Mycol., Vol. vii, p. 256.

Ripe-Rot or Anthracnose (*Gloeosporium fructigenum*, Berk.; *G. versicolor*, B. & C.)
Descr. Illus., U. S. Dep. Agr. Rep. for 1887, p. 348. (1888)
Journ. Mycol., Vol. vi, p. 164. (1891)
Treat. (pos.), Journ. Mycol., Vol. vi, p. 172. (1891)
Ky. Agr. Exp. Sta., Bull. 44, p. 20. (1893)
Cf. Grape (Ripe-Rot).
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326–333.

Rust (*Gymnosporangium macropus*, Lk., Syn. *Roestelia pirata*, (Schw.) Thaxter).
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 370–378. (1889)
Scribner, Fung. Dis., p. 84. (1890)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1888, p. 379. (1889)
U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, p. 46. (1890)
Iowa Agr. Exp. Sta., Bull. 13, p. 43. (1891)
N. C. Agr. Exp. Sta., Bull. 92, p. 86. (1893)
Cf. Conn. Agr. Exp. Sta., Bull. 107.

Scab (*Fusicladium dendriticum*, (Wallr.) Fckl.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 341. (1888)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1887, p. 346. (1888)
U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, pp. 27 & 36. (1890)
U. S. Dep. Agr., Div. Veg. Path., Bull. 3, pp. 35 & 36. (1892)
Va. Agr. Exp. Sta., Bull. 17, p. 63. (1892)
N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 48, pp. 297 & 298. (1892)
N. C. Agr. Exp. Sta., Bull. 92, p. 87. (1893)
Conn. Agr. Exp. Sta., Bull. 115, pp. 3 & 4. (1893)

Barley.

(*Hordeum sp.*)

Ergot (*Claviceps purpurea*, Tul.)
See Rye (Ergot.)

Leaf-Blight (*Scolecotrichum graminis*, Fckl., and *Helminthosporium graminum*, Rab.)
Descr. and Illus., U. S. Dep. Agr., Rep. for 1886, p. 129. (1887)
Descr., Journ. Mycol., Vol. vii, pp. 96 & 97. (1892)

Rust (*Puccinia graminis*, P. and *P. Rubigo-vera*, (DC.) Wint.)
See Oats and Wheat (Rust).

Smut (*Ustilago Hordei*, (P.) Kell. & Sw., and *U. nuda*, (Jens.) Kell. & Sw.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 9, 1891, pp. 244–246. (1892)
Treat. (pos.), Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 246. (1892)
Cf. Oats and Wheat (Smut).

Bean.

(*Phaseolus vulgaris*, L.; *Faba vulgaris*, L., &c.)

Anthracnose (*Colletotrichum Lindemuthianum*, (Sacc. & Magn.) Bri. & Cav.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 361. (1888)
N. Y. Agr. Exp. Sta., Bull. 48, pp. 310 & 318. (1892)
Treat. (pos.), N. Y. Agr. Exp. Sta., Bull. 48, pp. 320–326. (1892)
U. S. Dep. Agr., Bot. Div., Bull. 8, p. 65. (1889)
N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 284. (1892)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326–333.

Blight (Bacterial).
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 48, pp. 329–331. (1892)
N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 283. (1893)
Downy-Mildew (*Phytophthora Phaseoli*, Thaxter).
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 167–170. (1890)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 171. (1890)
Conn. Agr. Exp. Sta., Rep. 17, 1893, p. 77. (1894)
Leaf-Spot (*Phyllosticta* sp.)
Descr. N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 287. (1892)
Powdery Mildew (*Erysiphe Martii*, Lév.)
Treat. (pos.), Journ. Mycol., Vol. v, p. 214. (1889)
Rust (*Uromyces appendiculatus*, (P.) Lév.)
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 48, p. 331. (1892)
Treat. (neg.), N. Y. Agr. Exp. Sta., Bull. 48, p. 333. (1892)

Beet.

(*Beta vulgaris, L.*)

Blight (Bacterial).
Descr., Ind. Agr. Exp. Sta., Bull. 39, pp. 54–58. (1892)
Leaf-Blight (*Cercospora longissima*, C. and E.)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 15, pp. 239–242. (1891)
Treat. (rec.), Iowa Agr. Exp. Sta., Bull. 15, p. 243. (1891)
Root-Rot (*Rhizoctonia Betae*, Kühn.)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 15, pp. 244–248. (1891)
Treat. (rec.), Iowa Agr. Exp. Sta., Bull. 15, p. 250. (1891)
Rust (*Uromyces Betae*, (P.) Kühn).
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 351. (1888)
Descr., Iowa Agr. Exp. Sta., Bull. 15, p. 235. (1891)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 353. (1888)
Iowa Agr. Exp. Sta., Bull. 15, p. 236. (1891)
Scab (*Oospora scabies*, Thaxter.)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 15, p. 251. (1891)
Ind. Agr. Exp. Sta., Bull. 39, p. 58. (1892)
Treat. (rec.), Ind. Agr. Exp. Sta., Bull. 39, p. 60. (1892)
Cf. Potato (Scab).
White-Rust (*Cystopus Bliti*, (Biv.) Lév.)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 15, pp. 237 & 238. (1891)

Blackberry.

(*Rubus villosus*, Ait. *vars.*)

Anthracnose (*Glœosporium Venetum*, Speg.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 358–360. (1888)
Ohio Agr. Exp. Sta., Bull. Vol. iv, No. 6, p. 124. (1891)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1887, p. 361. (1887)
Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 172. (1890)
Ohio Agr. Exp. Sta., Bull. Vol. iv, No. 6, p. 119. (1891)

Blight (Bacterial)
Occ., Ohio Agr. Exp. Sta., Bull. Vol. iv, No. 6, p. 129. (1891)
Cf. Raspberry (Blight.)
Leaf-Spot (*Septoria Rubi*, Westd.)
Descr., Ohio Agr. Exp. Sta., Bull. Vol. iv, No. 6, p. 126. (1891)
Treat. (neg.), Journ. Mycol., Vol. vii, p. 22. (1891)
(rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 129. (1893)
Rust (*Caeoma* (*Uredo*) *luminatum*, Lk.; Syn. *Puccinia Peckiana*, Howe.)
Descr., Ohio Agr. Exp. Sta., Bull. Vol. iv, No. 6, p. 127. (1891)
Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 224. (1891)
Descr. Illus., Ill. Agr. Exp. Sta., Bull. 29, pp. 273–281 & 286. (1893)
Treat. (pos.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 224. (1891)

Buckwheat.

(*Fagopyrum esculentum*, Mœnch.)

Leaf-Blight (*Ramularia rufomaculans*, Pk.)
Descr., Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 98. (1891)
Treat. (rec.), Conn. Agr. Ex. Sta., Rep. 14, 1890, p. 98. (1891)

Cabbage.

(*Brassica oleracea*, L.)

Club-Root (*Plasmodiophora Brassicæ*, Wor.)
Descr., N. J. Agr. Exp. Sta., Bull. 50, p. 14. (1888)
Descr. Illus., Journ. Mycol., Vol. vii, pp. 79–84. (1892)
N. J. Agr. Exp. Sta., Bull. 98. (1893)
Treat. (rec.), Journ. Mycol., Vol. vii, p. 85. (1892)
N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)
N. J. Agr. Exp. Sta., Bull. 98, pp. 13–16. (1893)
Downy Mildew (*Peronospora parasitica*, (P.) Tul.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 349. (1891)
N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)
Leaf-Blight (*Macrosporium Brassicæ*, Berk.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 349. (1891)
White Rust (*Cystopus candidus*, (P.) Lév.)
Occ., N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)

Carnation.

(*Dianthus Caryophyllus*, L.)

Anthracnose (*Colletotrichum* sp.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 301. (1892)
Gar. and For., Vol. v, p. 594. (1892)
Treat. (rec.), Gar. and For., Vol. v, p. 595. (1892)
Anthracnose (*Vermicularia subeffigurata*, Schw.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 363. (1891)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 363. (1891)

Leaf-Spot (*Septoria Dianthi*, Desm.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 363. (1891)
Gar. and For., Vol. v, p. 594. (1892)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 363. (1891)
Gar. and For., Vol. v, p. 594. (1892)

Rust (*Uromyces caryophyllinus*, (Schrank) Schrt.)
Descr. Illus., Gar. and For., Vol. v, pp. 18 & 19. (1892)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 302. (1892)
Treat. (rec.), Gar. and For., Vol. iv, p. 595. (1891)
Gar. and For., Vol. v, p. 19. (1892)
(pos.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 302. (1892)

Catalpa.

(*Catalpa Bignonioides*, Walt.)

Leaf-Blight (*Macrosporium Catalpae*, Ell. & Mart.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 364 & 365. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 366. (1888)

Leaf-Spot (*Phyllosticta Catalpae*, Ell. & Mart.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 364 & 365. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 366. (1888)

Celery.

(*Apium graveolens*, L.)

Blight (Bacterial).
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 257 & 258. (1892)
(?) Descr., N. Y. Agr. Exp. Sta., Bull. 51, pp. 134 & 136. (1893)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 258. (1892)
N. Y. Agr. Exp. Sta., Bull. 51, p. 136. (1893)

Leaf-Blight (*Cercospora Apii*, Fres.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 117–120. (1887)
N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 250. (1892)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 251 & 252. (1892)
(pos.), Conn. Agr. Exp. Sta., Rep. 16, 1892, pp. 44 & 45. (1893)
Conn. Agr. Exp. Sta., Bull. 115, p. 17. (1893)

Leaf-Spot (*Phyllosticta Apii*, Halsted.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 253 & 254. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 254. (1892)

Leaf-Spot (*Septoria Petroselini*, Desm., *var. Apii*, Br. & Cav.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 255 & 256. (1892)
N. Y. Agr. Exp. Sta., Bull. 51, pp. 137 & 138. (1893)
Treat. (rec.), N. Y. Agr. Exp. Sta., Bull. 51, pp. 139–141. (1893)
Cf. Del. Agr. Exp. Sta., Rep. 4, 1891, pp. 63–65.

Rust (*Puccinia bullata*, (Pers.) Schrt.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 256 & 257. (1892)

Cherry.

(*Prunus Cerasus*, L.)

Black Knot (*Plowrightia morbosa*, (Schw.) Sacc.)
Descr. Illus., Scribner, Fung. Dis., p. 111. (1890)
Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 200. (1891)
N. J. Agr. Exp. Sta., Bull. 78. (1891)
N. Y. Agr. Exp. Sta., Bull. 40. (1892)
Treat. (rec.), N. Y. Agr. Exp. Sta., Bull. 40, p. 33. (1892)
Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 236–238. (1893)
Conn. Agr. Exp. Sta., Bull. 115, p. 9. (1893)

Fruit-Mould (*Oidium fructigenum*, Kze. & Schm.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, p. 349. (1889)
Ky. Agr. Exp. Sta., Rep. 2, 1889, pp. 31–34. (1890)
Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 213. (1891)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1888, p. 352. (1889)
(pos.), Ky. Agr. Exp. Sta., Rep. 2, 1889, pp. 35–42. (1890)

Leaf-Spot (*Cylindrosporium Padi*, Karst.)
Descr. Illus., Scribner, Fung. Dis., p. 119. (1890)
Iowa Agr. Exp. Sta., Bull. 13, pp. 61–65. (1891)
Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 176. (1890)
U. S. Dep. Agr., Rep. for 1890, p. 396. (1891)
Iowa Agr. Exp. Sta., Bull. 17, pp. 421–431. (1892)
(rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 114. (1893)
Cf. Plum. (Leaf-Spot).

Powdery Mildew (*Podosphaera oxyacanthæ*, (DC.) DBy.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 352–356. (1889)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1888, p. 356. (1889)
(pos.), Iowa Agr. Exp. Sta., Bull. 17, pp. 422–428. (1892)
Cf. Apple (Powdery Mildew).

Rust (*Puccinia Pruni*, Pers.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 353 & 354. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 354. (1888)

Scab (*Cladosporium carpophilum*, Thüm.)
Occ., Iowa Agr. Exp. Sta., Bull. 17, p. 421. (1892)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 23, pp. 918–920. (1894)
Treat. (rec.), Iowa Agr. Exp. Sta., Bull. 23, pp. 920 & 921. (1894)
Cf. Peach and Plum (Scab).

Chestnut.

(*Castanea sativa*, Mill.)

Anthracnose (*Marsonia ochroleuca*, B. & C.)
Occ., Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 234. (1892)

Chrysanthemum.

(*Chrysanthemum*, sp.)

Leaf-Spot (*Septoria* sp. and *Phyllosticta* sp.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 298. (1892)
Treat. (pos.), N. Y. Agr. Exp. Sta., "Leaf-Spot of Chrysanthemums." (1892)

Clematis.

(*Clematis* spp.)

Root-Rot (*Phoma* sp.) ?
Descr., N. Y. Agr. Exp. Sta., Rep. 3, 1884, pp. 383 & 384. (1885)

Clover.

(*Trifolium* spp.)

Rust (*Uromyces Trifolii*, A. & S.) Wint.)
Descr. Illus., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 24. (1890)
Iowa Ag. Exp. Sta., Bull. 13, p. 53. (1891)
Treat. (rec.), N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 24, p. 139. (1890)

Stem-Rot (*Sclerotinia Trifolium*, Erick.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 3, 1890, pp. 84–88. (1891)
Treat. (neg.), Del. Agr. Exp. Sta., Rep. 3, 1890, p. 88. (1891)

Corn.

(*Zea Mays*, L.)

Blight (Bacterial.)
Descr. Illus., Ill. Agr. Exp. Sta., Bull. 6. (1889)
Treat. (neg.), Ill. Agr. Exp. Sta., Bull. 6, p. 174. (1889)

Leaf-Blight (*Helminthosporium graminum*, Rab.)
Occ., Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 171. (1890)

Rust (*Puccinia Maydis*, Bérang.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 390. (1888)
Treat. (neg.), U. S. Dep. Agr., Rep. for 1887, p. 391. (1888)

Smut (*Ustilago Maydis*, Cord.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 380–386. (1888)
Neb. Agr. Exp. Sta., Bull. 11, pp. 25–30. (1889)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, pp. 386 & 387. (1888)
Neb. Agr. Exp. Sta., Bull. 11, p. 35. (1889)
Ohio Agr. Exp. Sta., Bull., Vol. iii, No. 10, p. 271. (1890)

Cotton.

(*Gossypium* spp.)

Anthracnose (*Colletotrichum Gossypii*, Southworth.)
Descr. Illus., Journ. Mycol., Vol. vi, pp. 100–104 & 173–177. (1891)
Ala. Agr. Exp. Sta., Bull. 41, pp. 40–49. (1892)

Blight (Bacterial.)
Descr., Ala. Agr. Exp. Sta., Bull. 27, p. 10. (1891)

"Frenching" or Scab (*Fusarium vasinfectum*, Atkinson.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 41, pp. 19–29. (1892)

Leaf-Blight (*Cercospora gossypina*, Cke.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 355 & 356. (1888)
Ala. Agr. Exp. Sta., Bull. 27, pp. 7 & 8. (1891)

Leaf-Mould (*Macrosporium nigricantium*, Atk. and *Alternaria* sp.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 27, pp. 8–10. (1891)

Leaf-Mould (*Ramularia areola*, Atkinson.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 41, pp. 55–58. (1892)

Leaf-Spot (*Sphaerella gossypina*, Atkinson.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 41, pp. 58–60. (1892)

Root-Rot (*Ozonium auricomum*, Lk.)
Descr. Illus., Tex. Agr. Exp. Sta., Rep. 2, 1889, pp. 67–76. (1890)
Treat. (rec.), Tex. Agr. Exp. Sta., Rep. 2, 1889, p. 81. (1890)
Cf. Alfalfa (Root-Rot.)

Cranberry.

(*Vaccinium Oxycoccus*, L.)

Gall (*Synchytrium Vaccinii*, Thomas.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 64, pp. 4–9. (1889)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 64, p. 16. (1889)
N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 333. (1891)

"Scald" (Fungus Sp. indet.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 64, pp. 30–34. (1889)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 64, pp. 39 & 40. (1889)
Journ. Mycol., Vol. vi, p. 18. (1890)

Cucumber.

(*Cucumis sativus*, L.)

Anthracnose (*Glœosporium*, sp.)
Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 231. (1893)
Occ., Cf. Melon (Anthracnose.)

Blight (Bacterial.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 273–276. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 276. (1892)
Cf. Melon, Potato, Squash and Tomato (Blight).

"Damping-off" or Seedling-Mildew (*Pythium De Baryanum*, Hesse.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 220. (1891)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 221. (1891)

Downy Mildew (*Plasmopara Cubensis*, (B. & C.) Humphrey.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 8, 1890, pp. 210–212. (1891)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 227. (1893)

Leaf-Blight (*Acremonium* sp.)
Descr., Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 227. (1892)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 230. (1893)

Powdery Mildew (*Erysiphe cichoracearum*, DC.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 225. (1893)
Treat. (pos.), N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 31, p. 138. (1891)
Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 225. (1892)

Scab (*Cladosporium cucumerinum*, Ell. & Arth.)
Descr. Illus., Ind. Agr. Exp. Sta., Bull. 19, pp. 8–10. (1889)
Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 227–229. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 229. (1893)

Stem-Rot (*Sclerotinia Libertiana*, Fckl.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 212–224. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 222. (1893)

Currant.

(*Ribes*, spp.)

Anthracnose (*Glœosporium Ribis*, (Lib.) Mont. & Desm.)
Descr. Illus., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 15, p. 196. (1889)
Treat. (rec.), N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 15, p. 197. (1889)

Leaf-Spot (*Septoria Ribis*, Desm., and *Cercospora angulata*, Wint.)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 13, pp. 68 & 69. (1891)
Treat. (pos.), Iowa Agr. Exp. Sta., Bull. 17, pp. 420 & 421. (1892)

Powdery Mildew (*Sphaerotheca mors-uvae* (Schw.) B. & C.)
See Gooseberry (Powdery Mildew.)

Egg-plant.

(*Solanum Melongena*, L.)

Anthracnose (*Glœosporium melongenae*, Ell. & Hals.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 281. (1892)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326–333.

"Damping-off," or Seedling-Mildew (*Pythium DeBaryanum*, Hesse.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 286. (1893)
Cf. Cucumber (Damping-off.)

Fruit-Mould (*Botrytis fascicularis*, (Cord.) Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 357. (1891)

Leaf-Spot (*Phyllosticta hortorum*, Speg.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 11, 1890, pp. 355–357. (1891)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 357. (1891)

Seedling-Rot (*Phoma Solani*, Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 277–279. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 279. (1892)

Stem-Rot (*Nectria Ipomœae*, Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 281–283. (1892)

Fig.

(*Ficus Carica*, L.)

Rust (*Uredo Fici*, Cast.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 117. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 117. (1893)

Scab (*Fusarium roseum*, Lk.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 117. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 117. (1893)

Filbert.

(*Corylus Avellana*, L.)

Black Knot (*Cryptosporella anomala*, (Pk.) Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 287. (1893)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 289. (1893)
Cf. Hazel (Black Knot.)

Geranium.

(*Pelargonium sp.*)

Rot (Bacterial.)
Descr. Illus., Journ. Mycol., Vol. vi, p. 114. (1891)

Gooseberry.

(*Ribes Grossularia*, L.)

Leaf-Spot (*Septoria Ribis*, Desm., and *Cercospora angulata*, Wint.)
Cf. Currant (Leaf-Spot.)

Leaf-Spot (? *Sphaerella Grossulariae*, (Fr.) Awd.)
Iowa Agr. Exp. Sta., Bull. 13, p. 70. (1891)

Powdery Mildew (*Sphaerotheca mors-uvae*, (Schw.) B. & C.
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 373–378. (1888)
Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 240. (1893)
Descr., N. C. Agr. Exp. Sta., Bull. 92, p. 131. (1893)
Treat. (pos.), N. Y. Agr. Exp. Sta., Rep. 6, 1887, p. 349. (1888)
N. Y. Agr. Exp. Sta., Bull. 36, p. 645. (1891)
N. C. Agr. Exp. Sta., Bull. 92, p. 131. (1893)

Rust (*Aecidium Grossulariae*, Schum.)
Descr., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 241. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 241. (1893)

Grape.

(*Vitis spp.*)

Anthracnose (*Sphaceloma ampelinum*, DBy.)
Descr. Illus., Scribner, Fung. Dis., pp. 72–80. (1890)
Tenn. Agr. Exp. Sta., Bull. Vol. iv, No. 4, pp. 111 & 112. (1891)
Treat. (rec.), N. Y. Agr. Exp. Sta., Rep. 9, 1890, pp. 336 & 337. (1891)
Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 102. (1891)
Tenn. Agr. Exp. Sta., Bull. Vol. iv, No. 4, p. 112. (1891)
N. C. Agr. Exp. Sta., Bull. 92, p. 121. (1893)

Bitter-Rot (*Melanconium fuligineum*, (Scrib. & Viala.) Cav.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 324 & 325. (1888)
Descr., N. Y. Agr. Exp. Sta., Rep. 9, 1890, p. 325. (1891)
Treat. (neg.), U. S. Dep. Agr., Rep. for 1887, p. 325. (1888)
(rec.), Scribner, Fung. Dis., p. 40. (1890)
Cf. N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 61, pp. 302–305.

Black-Rot (*Laestadia Bidwellii*, (Ell.) Viala & Ravaz.
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 109–111. (1887)
Del. Agr. Exp. Sta., Bull. 6, pp. 18–27. (1889)
Scribner, Fung. Dis., pp. 8–14. (1890)
Tenn. Agr. Exp. Sta., Bull. Vol. iv, No. 4, pp. 98–101. (1891)
Treat (pos.), U. S. Dep. Agr., Sec. Veg. Path., Circ. 6. (1889)
U. S. Dep. Agr., Farm. Bull. 7, pp. 15 & 16. (1892)
Del. Agr. Exp. Sta., Bull. 15, p. 7. (1892)
U. S. Dep. Agr., Div. Veg. Path., Bull. 3, p. 31. (1892)
Tex. Agr. Exp. Sta., Bull. 23, pp. 228–231. (1892)
Conn. Agr. Exp. Sta., Bull. 115, p. 11. (1893)

Downey Mildew (*Plasmopara viticola*, (B. & C.) Berl. & De Ton.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 96–99. (1887)
Tenn. Agr. Exp. Sta., Bull. Vol. iv, No. 4, p. 108. (1891)
Mich. Agr. Exp. Sta., Bull. 83, pp. 9–12. (1892)
Treat. (pos.), Ohio Agr. Exp. Sta., Bull. Vol. iii, No. 10, p. 263. (1890)
U. S. Dep. Agr., Farm. Bull. 4, p. 8. (1891)
Tenn. Agr. Exp. Sta., Bull. Vol. iv, No. 4, p. 110. (1891)
Conn. Agr. Exp. Sta., Bull. 115, p. 12. (1893)

Leaf-Blight (*Cercospora viticola*, (Ces.) Sacc.)
Descr. Illus., Scribner, Fung. Dis. pp. 60–62. (1890)
Descr., N. Y. Agr. Exp. Sta., Rep. 9, 1890, p. 324. (1891)
Treat. (neg.), N. Y. Agr. Exp. Sta., Rep. 9, 1890, p. 324. (1891)
(rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 122. (1893)

Powdery Mildew (*Uncinula spiralis*, B. & C.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 105–108. (1887)
Mich. Agr. Exp. Sta., Bull. 83, p. 11. (1892)

Powdery Mildew (*Uncinula spiralis*, B. & C.)
Descr., N. Y. Agr. Exp. Sta., Rep. 9, 1890, pp. 322 & 323. (1891)
Treat. (pos.), U. S. Dep. Agr., Farm. Bull. 4, p. 8. (1891)
Ind. Agr. Exp. Sta., Bull. 38, p. 17. (1892)
N. C. Agr. Exp. Sta., Bull. 92, p. 120. (1893)

Ripe-Rot or Anthracnose (*Glœosporium fructigenum*, Berk.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1890, p. 408. (1891)
Journ. Mycol., Vol. vi, pp. 164–171. (1891)
Cf. Apple (Ripe-Rot.)

Root-Rot (*Armillaria mellea*, (Wallr.) Fr. and *Dematophora necatrix*, Hartig.)
Descr. Illus., Scribner, Fung. Dis., pp. 64–69. (1890)
N. C. Agr. Exp. Sta., Bull. 92, p. 122. (1893)
Treat. (rec.), Scribner, Fung. Dis., pp. 70 & 71. (1890)
N. C. Agr. Exp. Sta., Bull. 92, p. 122. (1893)

White-Rot (*Coniothyrium Diplodiella*, (Speg.) Sacc.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 325 & 326. (1888)
Scribner, Fung. Dis., pp. 41–44. (1890)
Descr., N. Y. Agr. Exp. Sta., Rep. 9, 1890, p. 324. (1891)
Treat. (pos.), U. S. Dep. Agr., Sec. Veg. Path., Bull. 11. (1890)

Hazel.

(*Corylus*, spp.)

Black-Knot (*Cryptosporella anomala*, (Pk.) Sacc.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 242. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 243. (1893)
Cf. Filbert (Black-Knot).

Hollyhock.

(*Althaea rosea*, Cav.)

Anthracnose (*Colletotrichum Malvarum*, (Braun. & Casp.) Southworth.)
Descr. Illus., Journ. Mycol., Vol. vi, pp. 46–48. (1890)
Treat. (pos.), Journ. Mycol., Vol. vi, p. 50. (1890)
N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)

Leaf-Blight (*Cercospora Althaeina*, Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 361. (1891)
Cf. Garden and Forest, March 26, 1890.

Leaf-Spot (*Phyllosticta Althaeina*, Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 297. (1892)

Rust (*Puccinia Malvacearum*, Mont.)
Descr. Illus., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 25, p. 154. (1890)
Treat. (rec.), N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 25, p. 155. (1890)
Cf. N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 361.

Horseradish.

(*Cochlearia Armoracia*, L.)

Leaf-Blight (*Ramularia Armoraciæ*, Fckl.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 360. (1891)
Leaf-Spot (*Septoria Armoraciæ*, Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 360. (1891)

Hydrangea.

(*Hydrangea Hortensia*, Siebold.)

Leaf-Spot (*Phyllosticta Hydrangeæ*, Ell. & Ev.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 298. (1892)
Cf. Garden and Forest, Vol. iv, p. 177, 1891.

Lettuce.

(*Lactuca sativa*, L.)

Downy Mildew (*Bremia Lactucæ*, Regel.)
Descr. Illus., N. Y. Agr. Exp. Sta., Rep. 4, 1885, p. 253. (1886)
Treat. (pos.), Journ. Mycol., Vol. vi, p. 17. (1890)
Mass. (Hatch) Agr. Exp. Sta., Bull. 4, pp. 11–14. (1889)
Vt. Agr. Exp. Sta., Rep. 5, 1891, p. 141. (1892)
Leaf-Rot (*Botrytis vulgaris*, Fr.)
Descr., Mass. Agr. Exp. Sta., Rep. 9, 1891, pp. 219–221. (1892)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 221. (1892)
Leaf-Spot (*Septoria consimilis*, Ell. & Mart.)
Descr. Illus., Ohio Agr. Exp. Sta., Bull. 44, pp. 145 & 146. (1892)
Stem-Rot (Bacterial.)
Descr., Vt. Agr. Exp. Sta., Rep. 6, 1892, p. 87. (1893)
Treat. (rec.), Vt. Agr. Exp. Sta., Rep. 6, 1892, p. 88. (1893)

Maple.

(*Acer*, spp.)

Leaf-spot (*Phyllosticta acericola*, Cke. & Ell.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 383–386. (1889)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1888, p. 386. (1889)

Melon.

(*Cucumis*, spp.)

Anthracnose (*Colletotrichum lagenarium*, (Pass.) Ell. & Hals.)
Descr., U. S. Dep. Agr., Bot. Div., Bull. 8, p. 64. (1889)
Treat. (pos.), Md. Agr. Exp. Sta., Rep. 4, 1891, p. 387. (1892)
Blight (Bacterial.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 273 & 274. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 276. (1892)
Cf. Cucumber, Potato, Squash and Tomato (Blight.)
Downy Mildew (*Plasmopara Cubensis*, (B. & C.) Humphrey.)
See Cucumber (Downy Mildew.)

Mignonette.

(*Reseda odorata*, L.)

Leaf-Blight (*Cercospora Resedæ*, Fckl.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1889, pp. 429 & 430. (1890)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1889, p. 431. (1890)

Nasturtium.

(*Tropæolum Majus*, L.)

Leaf-Blight *Alternaria*, sp., and *Pleospora Tropæoli*, Hals.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 290–293. (1893)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 299. (1892)

Oats.

(*Avena sativa*, L.)

Blight (Bacterial.)
Descr., Journ. Mycol., Vol. vi, p. 72. (1890)
Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 225. (1891)
Rust (*Puccinia coronata*, Cda., *P. graminis*, P., and *P. Rubigo-vera*, (DC.) Wint.)
Descr. Illus., Kan. Agr. Exp. Sta., Bull. 38. (1893)
Treat. (neg.), Journ. Mycol., Vol. vii, pp. 225 & 226. (1893)
Cf. Wheat (Rust.)
Smut (*Ustilago Avenæ*, (P.) Jensen.)
Descr. Illus., Kans. Agr. Exp. Sta., Bull. 8. (1889)
N. Dak. Agr. Exp. Sta., Bull. 1. 1891)
U. S. Dep. Agr., Div. Veg. Path., Farm. Bull. 5. (1892)
R. I. Agr. Exp. Sta., Bull. 15. (1892)
Treat. (pos.), Kan. Agr. Exp. Sta., Bull. 15, pp. 128–130. (1890)
N. Dak. Agr. Exp. Sta., Bull. 1, pp. 25–28. (1891)
U. S. Dep. Agr., Div. Veg. Path., Farm. Bull. 5. (1892)
R. I. Agr. Exp. Sta., Bull. 15, pp. 6–8. (1892)

Olive.

(*Olea Europæa*, L.)

Tuberculosis (Bacterial.)
Descr. Illus., Journ. Mycol., Vol. vi, pp. 148–153. (1891)

Onion.

(*Allium Cepa*, L.)

Anthracnose or Rot (*Vermicularia circinans*, Berk.)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 163. (1890)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 164 & 165. (1890)

"Damping-off" or Seedling-Mildew (*Pythium De Baryanum*, Hesse.)
Occ., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 165 & 166.

Cf. Cucumber ("Damping-off.") (1890)

Downy Mildew (*Peronospora Schleideniana*, DBy.)
Descr. Illus., Wis. Agr. Exp. Sta., Rep. 1, 1883, pp. 38–44. (1884)
N. Y. Corn. Univ. Exp. Sta., Rep. 2, 1889, pp. 193 & 194. (1890)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 157. (1890)

Smut (*Urocystis Cepulae, Frost.*)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 129–146. (1890)
Treat. (rec.), Conn. Agr. Exp. Sta., Rept. 13, 1889, pp. 147–153. (1890)
(Transplanting), Conn. Agr. Exp. Sta., Bull. 115, p. 15. (1893)
Cf. Ohio Agr. Exp. Sta., Bull. Vol. iii, No. 9, p. 244.
Tenn. Agr. Exp. Sta., Bull. Vol. v, No. 4, p. 147.

Stalk-Blight (*Macrosporium Sarcinula*, B. *var. parasiticum*, Thm., and *M. Porri*, Ell.)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 158–162. (1890)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 161. (1890)

Orange.

(*Citrus Aurantium*, L.)

Anthracnose (*Colletotrichum adustum*, Ell.)
Occ., Journ. Mycol., Vol. vii, p. 34. (1891)

Leaf-glaze (*Strigula complanata*, Fée.)
Occ., Journ. Mycol., Vol. vii, p. 36. (1891)

Leaf-Mould (*Caprodium Citri*, Berk. & Desm.)
Occ., Journ. Mycol., Vol. vii, p. 35. (1891)
Treat. (rec.), Journ. Mycol., Vol. vii, p. 35. (1891)
(Cf. Bull. Bussey Inst. I, pp. 404–414.)

Scab (*Cladosporium sp.*)
Descr., Fla. Agr. Exp. Sta., Bull. 2, pp. 35 & 36. (1888)
Journ. Mycol., Vol. vii., p. 34. (1891)
Treat. (rec.), Fla. Agr. Exp. Sta., Bull. 2, p. 37. (1888)
Journ. Mycol., Vol. vii, p. 34. (1891)

Orchid.

(*Orchidaceæ.*)

Anthracnose (*Glœosporium sp.*)
Occ., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 298. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 298. (1892)

Pea.

(*Pisum sativum*, L.)

Powdery Mildew (*Erysiphe Martii*, Lév.)
Occ., S. Dak. Agr. Exp. Sta., Bull. 29, p. 39. (1891)
Treat. (rec.), N. Y. Agr. Exp. Sta., Rep. 4, 1885, p. 187. (1886)
Cf. Bean (Powdery Mildew.)

Peach.

(*Prunus Persica*, Benth. & Hook.)

Anthracnose (*Glœosporium laeticolor*, Berk.)
Occ., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 325. (1893)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 328.

Fruit-Mould (*Oidium fructigenum*, Kze. & Schm.)
Descr. Illus., Journ. Mycol., Vol. vii, pp. 36–38. (1891)
Treat. (pos.), Del. Agr. Exp. Sta., Bull. 19, pp. 15 & 16. (1892)
Del. Agr. Exp. Sta., Rep. 5, 1892, p. 66. (1893)
(rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 102. (1893)
Cf. Cherry (Fruit-Mould.)

Leaf-Blight (*Cercospora Persica*, Sacc.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 103. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 103. (1893)

Leaf-Blight (*Cercosporella Persica*, Sacc.)
Occ., Journ. Mycol., Vol. vii, p. 91. (1892)

Leaf-Curl (*Exoascus deformans*, (Berk.) Fckl.)
Descr. Illus., Scribner, Fung. Dis., pp. 127–130. (1890)
N. C. Agr. Exp. Sta., Bull. 92, p. 103. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 103. (1893)

Powdery Mildew (*Sphaerotheca pannosa*, (Wallr.) Lév. (?)
Occ., Journ. Mycol., Vol. vii, p. 90. (1892)

Rust (*Puccinia Pruni*, P.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 353 & 354. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 355. (1888)

Scab (*Cladosporium carpophilum*, Thüm.)
Descr. Illus., Ind. Agr. Exp. Sta., Bull. 19, pp. 5–8. (1889)
Treat. (rec.), Ind. Agr. Exp. Sta., Bull. 19, p. 8. (1889)

Pear.

(*Pirus Communis*, L.)

Dry-Rot (*Thelephora pedicellata*, Schw.)
Descr., Journ. Mycol., Vol. vi, pp. 113 & 114. (1891)
Treat. (pos.), Journ. Mycol., Vol. vi, p. 114. (1891)

Fire-Blight (*Micrococcus amylovorus*, Burrill.)
Descr. Illus., N. Y. Agr. Exp. Sta., Rep. 5, 1886, pp. 275–289. (1887)
Descr., Ala. Agr. Exp. Sta., Bull. 50. (1893)

Fire-Blight (*Micrococcus amylovorus*, Burrill.)
Treat. (rec.), Ill. Agr. Exp. Sta., Bull. 2, pp. 16 & 17. (1886)
(neg.), Mo. Agr. Exp. Sta., Bull. 16, pp. 8 & 9. (1891)
(rec.), Mich. Agr. Exp. Sta., Bull. 83, p. 14. (1892)
Cf. N. Y. Agr. Exp. Sta., Rep. 5, 1886, pp. 300–315.
Cf. Apple (Fire-Blight.)

Leaf-Spot (*Entomosporium maculatum*, Lév.).
Descr. Illus., U. S. Dep. Agr., Report for 1888, pp. 359–362. (1889)
Scribner, Fung. Dis., pp. 101–104. (1890)
Del. Agr. Exp. Sta., Bull. 13, pp. 4–6. (1891)
Treat. (pos.), U. S. Dep. Agr., Sec. Veg. Path., Circ. 8, p. 6. (1889)
Del. Agr. Exp. Sta., Bull. 15, pp. 9 & 10. (1892)
U. S. Dep. Agr., Farm. Bull. 7, p. 15. (1892)
Conn. Agr. Exp. Sta., Bull. 115, pp. 4 & 5. (1893)
Cf. Quince (Leaf-Spot.)

Rust (*Gymnosporangium globosum*, Farl.)
Occ., Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 98. (1891)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 98. (1891)

Scab (*Fusicladium pirinum*, (Lib.) Fckl.)
Descr. Illus., Scribner, Fung. Dis., pp. 98 & 99. (1890)
N. Y. Agr. Exp. Sta., Bull. 67, pp. 191 & 192. (1894)
Treat. (pos.), Del. Agr. Exp. Sta., Bull. 8, pp. 11–14. (1890)
U. S. Dep. Agr., Farm. Bull. 7, p. 15. (1892)
Del. Agr. Exp. Sta., Bull. 28, pp. 30–34. (1892)
Conn. Agr. Exp. Sta., Bull. 115, p. 5. (1893)
N. Y. Agr. Exp. Sta., Bull. 67. (1894)
Cf. Apple (Scab.)

Peppers.

(*Capsicum annuum*, L.)

Anthracnose (*Colletotrichum nigrum*, Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 359. (1891)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 360. (1891)
Cf. N. J. Agr. Exp. Sta., Rep. 13, pp. 332 & 333. (1893)

Anthracnose (*Glœosporium piperatum*, Ell. & Ev.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 358. (1891)
Treat. (rec.), N. J. Agr. Sta., Rep. 11, 1890, p. 360. (1891)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 330 & 331. (1893)

Persimmon.

(*Diospyros*, spp.)

Anthracnose (*Glœosporium*, sp.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 116. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 116. (1893)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326–330.
Cf. Apple (Ripe-Rot or Anthracnose.)

Leaf-Blight (*Cercospora* sp.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 116. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 116. (1893)
Cf. Peach (Leaf-Blight.)

Root-Rot (*Armillaria mellea*, (Wallr.) Fr.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 116. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 116. (1893)
Cf. Grape (Root-Rot.)

Pink (Sweet William.)

(*Dianthus barbatus*, L.)

Rust (*Puccinia Arenariæ*, (Schum.) Wint.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 278–280. (1893)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 280. (1893)

Plum.

(*Prunus* spp.)

Black Knot (*Plowrightia morbosa*, (Schw.) Sacc.)
See Cherry (Black Knot.)

Fruit-Mould (*Oidium fructigenum*, Kze. & Schm.)
See Cherry (Fruit-Mould.)

Leaf-Spot (*Cylindrosporium Padi*, Karst.)
Descr. Illus., N. Y. Agr. Exp. Sta., Rep. 5, 1886, pp. 293–296. (1887)
Iowa Agr. Exp. Sta., Bull. 13, pp. 55–65. (1891)
Treat. (pos.), Ohio Agr. Exp. Sta., Bull., Vol. iv, No. 9, p. 216. (1891)
Journ. Mycol., Vol. vii, p. 255. (1893)
Cf. Cherry (Leaf-Spot.)

Plum-Pockets (*Taphrina Pruni*, (Fckl.) Tul.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 366–369. (1889)
Occ. Illus., Mich. Agr. Exp. Sta., Bull. 83, pp. 18 & 19. (1892)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 111. (1893)

Powdery Mildew (*Podosphæra Oxyacanthæ*, (DC.) DBy.)
See Cherry (Powdery Mildew.)

Rust (*Puccinia Pruni*, Pers.)
See Cherry (Rust.)

Scab (*Cladosporium carpophilum*, Thüm.)
Descr., Journ. Mycol., Vol. vii, pp. 99 & 100. (1892)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 23, pp. 918–920. (1894)
Cf. Cherry and Peach (Scab.)

Poplar.

(*Populus* spp.)

Rust (*Melampsora populina*, (Jacq.) Lév.)
Occ. Treat., Mass. Agr. Exp. Sta., Rep. 9, 1891, pp. 233 & 234. (1892)

Potato.

(*Solanum tuberosum*, L.)

Blight (Bacterial.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 269. (1892)
Del. Agr. Exp. Sta., Rep. 4, 1891, pp. 54–56. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 276. (1892)
Del. Agr. Exp. Sta., Bull. 15, p. 13. (1892)
Cf. Cucumber, Melon, Squash and Tomato (Blight.)

Downy Mildew or Rot (*Phytophthora infestans*, DBy.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 337 & 338. (1889)
Me. Agr. Exp. Sta., Rep., 1889, pp. 172–178. (1890)
Treat. (pos.), Ohio Agr. Exp. Sta., Bull., Vol. ii, No. 6, pp. 162–169. (1889)
U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, pp. 47 & 48. (1890)
R. I. Agr. Exp. Sta., Bull. 14, pp. 186 & 187. (1891)
Vt. Agr. Exp. Sta., Rep. 6, 1892, pp. 57–66. (1893)
Conn. Agr. Exp. Sta., Bull. 115, pp. 15 & 16. (1893)

Leaf-Blight (*Macrosporium Solani*, Ell. & Mart.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 4, 1891, pp. 58 & 59. (1892)
Vt. Agr. Exp. Sta., Bull. 36. (1893)
Treat. (pos.), Del. Agr. Exp. Sta., Rep. 4, 1891, p. 60. (1892)
Vt. Agr. Exp. Sta., Bull. 36. (1893)

Scab (*Oospora scabies*, Thaxter.)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 14, 1890, pp. 81–95. (1891)
N. Dak. Agr. Exp. Sta., Bull. 4, pp. 6 & 7. (1891)
Treat. (pos.), N. Dak. Agr. Sta. Exp., Bull. 9, pp. 31–33. (1893)
R. I. Agr. Exp. Sta., Bull. 26, p. 155. (1893)
Wash. Agr. Exp. Sta., Bull. 8, pp. 137 & 138. (1894)
(Cf. Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 153–160.)
Cf. Beet (Scab.)

Privet.

(*Ligustrum vulgare*, L.)

Anthracnose (*Glœosporium cingulatum*, Atkinson.)
Descr. Illus., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 49, pp. 306–314. (1892)

Quince.

(*Pirus Cydonia.*)

Black-Rot (*Sphæropsis Malorum*, Berk.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 91, pp. 8–10. (1892)
Treat. (rec.), Conn. Agr. Exp. Sta., Bull. 115, pp. 6 & 7. (1893)
Cf. Apple (Black-Rot.)

Fire-Blight (*Micrococcus amylovorus*, Burrill.)
See Apple and Pear (Fire-Blight.)

Leaf-Spot (*Entomosporium maculatum*, Lév.)
Descr. Illus., See Pear (Leaf-Spot.)
Treat. (pos.), U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, pp. 46 & 47. (1890)
Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 150–152. (1892)
Conn. Agr. Exp. Sta., Bull. 115, p. 6. (1893)
Cf. Pear (Leaf-Spot.)

Pale-Rot (*Phoma Cydoniæ*, Sacc. & Schulz.) ?
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 91, pp. 10 & 11. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 91, p. 11. (1892)

Ripe-Rot or Anthracnose (*Glœosporium fructigenum*, Berk.)
See Apple and Grape (Ripe-Rot.)

Radish.

(*Raphanus sativus*, L.)

Club-Root (*Plasmodiophora Brassicæ*, Wor.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, pp. 348 & 349. (1891)
Cf. Cabbage (Club-Root.)

Downy Mildew (*Peronospora parasitica*, (P.) Tul.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 349. (1891)
Cf. Turnip (Downy Mildew.)

White Rust (*Cystopus candidus*, (P.) Lév.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 350. (1891)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 350. (1891)
Cf. Turnip (White Rust.)

Raspberry.

(*Rubus* spp.)

Anthracnose (*Glœosporium Venetum*, Speg.)
See Blackberry (Anthracnose.)

Blight (Bacterial.)
Descr., Ohio Agr. Exp. Sta., Bull., Vol. iv, No. 6, p. 128. (1891)

Leaf-Spot (*Septoria Rubi*, Westd.)
See Blackberry (Leaf-Spot.)

Rust (*Cœoma* (*Uredo*) *luminatum*, Lk.)
See Blackberry (Rust.)

Rose.

(*Rosa* spp.)

Anthracnose (*Glœosporium Rosæ*, Hals.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 282 & 283. (1893)

Downy Mildew (*Peronospora sparsa*, Berk.)
Occ., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 282. (1893)

Leaf-Spot (*Actinonema Rosæ*, (Lib.) Fr.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 366–368. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, pp. 368 & 369. (1888)
(pos.), Mass. (Hatch) Agr. Exp. Sta., Bull. 4, pp. 10 & 11. (1889)
N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 281. (1893)

Powdery Mildew (*Sphærotheca pannosa*, (Wallr.) Lév.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 281. (1893)
Treat. (pos.), Mass. (Hatch) Agr. Exp. Sta., Bull. 4, p. 11. (1889)
N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 281 & 282. (1893)

Rust (*Phragmidium speciosum*, Fr.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 372. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 372. (1888)

Rust (*Phragmidium subcorticium*, (Schrank) Wint.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 369 & 370. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 371. (1888)
N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 282. (1893)

Rye.

(*Secale cereale*, L.)

Ergot (*Claviceps purpurea*, Tul.)
Descr. Illus., S. Dak. Exp. Sta., Bull. 33, pp. 40–43. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 76, p. 20. (1891)
S. Dak. Agr. Exp. Sta., Bull. 33, pp. 43 & 44. (1893)

Rust (*Puccinia graminis*, P., and *P. Rubigo-vera*, (DC.) Wint.)
See Oats and Wheat (Rust.)

Smut (*Urocystis occulta*, (Wallr.) Rabh.)
Occ. Illus., Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 247. (1892)
Treat. (pos.), See Oats and Wheat (Smut.)

Salsify.

(*Tragopogon porrifolius*, L.)

Rot (Bacterial.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 351. (1891)

Sorghum.

(*Sorghum vulgare*, P.)

Blight (*Bacillus Sorghi*, Burrill.)
Descr., Kan. Agr. Exp. Sta., Rep. 1, 1888, pp. 281–301. (1889)
Treat. (rec.), Kan. Agr. Exp. Sta., Rep. 1, 1888, pp. 301 & 302. (1889)

Smut (*Ustilago Sorghi*, (Lk.) Pass., and *U. Reiliana*, Kühn.)
Descr. Illus., Kan. Agr. Exp. Sta., Bull. 23, pp. 95 & 96. (1891)
Treat. (neg.), Kan. Agr. Exp. Sta., Bull. 23, p. 101. (1891)

Spinach.

(*Spinacia oleracea*, Mill.)

Anthracnose (*Colletotrichum Spinaceæ*, Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 70, pp. 6–8. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 70, pp. 13 & 14. (1890)

Downy Mildew (*Peronospora effusa*. (Grev.) Rabh.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 70, pp. 4–6. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 70, pp. 13 & 14. (1890)
Mass. Agr. Exp. Sta., Rep. 8, 1890, pp. 221 & 222. (1891)

Leaf-Spot (*Phyllosticta Chenopodii*, Sacc.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 70, pp. 9 & 10. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 70, pp. 13 & 14. (1890)

Scab (*Cladosporium macrocarpum*, Preuss.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 70, pp. 11 & 12. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 70, pp. 13 & 14. (1890)

White Smut (*Entyloma Ellisii*, Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 70, pp. 10 & 11. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 70, pp. 13 & 14. (1890)

Squash.

(*Cucurbita* spp.)

Anthracnose (*Colletotrichum lagenarium*, (Pass.) Ell. & Hals.)
See Melon (Anthracnose.)

Blight (Bacterial.)
See N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 274–276. (1892)
Cf. Cucumber, Melon, Potato and Tomato (Blight.)

Downy Mildew (*Plasmopara Cubensis*, (B. & C.) Humphrey.)
See Cucumber (Downy Mildew.)

Powdery Mildew (*Erysiphe cichoracearum*, DC.)
Descr. Illus., See Cucumber (Powdery Mildew.)
Treat. (pos.), Corn. Univ. Agr. Exp. Sta., Bull. 35, pp. 330–332. (1891)
Cf. Cucumber (Powdery Mildew.)

Strawberry.

(*Fragaria* spp.)

Leaf-Spot (*Ascochyta Fragariæ*, Sacc.)
Descr. Illus., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 14, pp. 182 & 183. (1889)
Treat. (rec.), N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 14, p. 183. (1889)

Leaf-Spot (*Sphærella Fragariæ*, (Tul.) Sacc.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 334–339. (1888)
N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 14, pp. 171–181. (1889)

Leaf-Spot (*Sphœrella Fragariœ*, (Tul.) Sacc.)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1890, p. 397. (1890)
Ken. Agr. Exp. Sta., Bull. 31, pp. 7-12. (1890)
Md. Agr. Exp. Sta., Rep. 3, 1890, pp. 106-108. (1891)
N. C. Agr. Exp. Sta., Bull. 92, p. 133. (1893)
Conn. Agr. Exp. Sta., Bull. 115, p. 14. (1893)
Powdery Mildew (*Sphœrotheca Castagnei*, Lév.)
Descr., N. Y. Agr. Exp. Sta., Rep. 5, 1886, pp. 291 & 292. (1887)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 239. (1893)
Treat. (rec.), N. Y. Agr. Exp. Sta., Rep. 5, 1886, p. 293. (1887)
Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 243-245. (1893)

Sweet Potato.

(*Ipomœa Batatas*, Lam.)

Black-Rot (*Ceratocystis fimbriata*, Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 7-13. (1890)
Journ. Mycol., Vol. vii, pp. 1-9. (1891)
U. S. Dep. Agr., Rep. for 1891, pp. 376 & 377. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 76, pp. 13 & 14. (1890)
Journ. Mycol., Vol. vii, pp. 9 & 10. (1891)
U. S. Dep. Agr., Rep. for 1891, p. 377. (1892)
Dry-Rot (*Phoma Batatœ*, Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 23-25. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 76, p. 25. (1890)
Leaf-Spot (*Phyllosticta bataticola*, Ell. & Mart.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 27 & 28. (1890)
Scab (*Monilochœtes infuscans*, Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 25-27. (1890)
Soft-Rot (*Rhizopus nigricans*, Ehrb.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 4-6. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 76, pp. 6 & 7. (1890)
Soil-Rot (*Acrocystis Batatas*, Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 14-18. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 76, pp. 18-20. (1890)
Stem-Rot (*Nectria Ipomœae*, Hals.)
See Egg-Plant (Stem-Rot.)
White-Rot (*Penicillium* sp.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 22 & 23. (1890)
White Rust (*Cystopus Ipomœae-panduronœ*, (Schw.) Farl.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 28-30. (1890)

Sycamore.

(*Platanus* spp.)

Anthracnose (*Glœosporium nervisequum*, (Fckl.) Sacc.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 387-389. (1889)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1888, p. 389. (1889)
Cf. Journ. Mycol., Vol. v, p. 51 e. s.

Tomato.

(*Lycopersicum esculentum*, Mill.)

Anthracnose (*Colletotrichum Lycopersici*, Chester.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 4, 1891, pp. 60-62. (1892)
Cf. Del. Agr. Exp. Sta., Rep. 5, 1892, p. 80. (1893)
Anthracnose (*Glœosporium phomoides*, Sacc.)
Occ., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 325. (1893)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326-330.
Blight (Bacterial.)
Descr., Miss. Agr. Exp. Sta., Bull. 19. (1892)
N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 267 & 268. (1892)
N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 45, p. 213. (1892)
Cf. Cucumber, Melon, Potato and Squash (Blight.)
Blight (Bacterial ?)
Descr., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 43, pp. 149-154. (1892)
Blight (Fungus, Sp. indet.)
Descr., Fla. Agr. Exp. Sta., Bull. 21, pp. 25-27. (1893)
Treat. (pos.), Fla. Agr. Exp. Sta., Bull. 21, pp. 32-36. (1893)
Downy Mildew (*Phytophthora infestans*, DBy.)
See Potato (Downy Mildew.)
Fruit-Mould (*Macrosporium Tomato*, Cke., and *Fusarium Solani*, (Mart.) Sacc.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 339-344. (1889)
Treat. (pos.), ? U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, pp. 61-65. (1890)
Leaf-Blight (*Macrosporium Solani*, Ell. & Mart.)
Occ., Del. Agr. Exp. Sta., Rep. 4, 1891, p. 62. (1892)
See Potato (Leaf-Blight.)
Scab (*Cladosporium fulvum*, Cke.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 347 & 348. (1889)
Treat. (pos.), Journ. Mycol., Vol. v, p. 38. (1889)
U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, p. 47. (1890)
N. C. Agr. Exp. Sta., Bull. 84, p. 21. (1892)
Conn. Agr. Exp. Sta., Bull. 115, p. 16. (1893)

Turnip.

(*Brassica compestris*, L.)

Club-Root (*Plasmodiophora Brassicœ*, Wor.)
See Cabbage (Club-Root.)
Downy Mildew (*Peronospora parasitica*, (P.) Tul.)
Occ., Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 222. (1891)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 223. (1891)
Cf. Cabbage (Downy Mildew.)

Powdery Mildew (*Oidium Balsamii*, Mont.)
Occ., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 61, pp. 305 & 306. (1893)
White Rust (*Cystopus candidus*, (P.) Lév.)
Occ., Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 222. (1891)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 223. (1891)
Cf. Cabbage (White Rust.)

Verbena.

(*Verbena* sp.)

Powdery Mildew (*Erysiphe cichoracearum*, DC.)
Occ., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 37, p. 405. (1891)
Treat. (pos.), N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 37, p. 405. (1891)
Cf. Cucumber and Squash (Powdery Mildew.)

Violet.

(*Viola odorata*, L.)

Anthracnose (*Glœosporium Violœ*, B. & Br.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)
Downy-Mildew (*Peronospora Violœ*, DBy.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)
Leaf- Blight (*Cercospora Violœ*, Sacc.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)
Leaf-Spot (*Phyllosticta Violœ*, Desm.)
Descr., Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 231 & 232. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 232–235. (1893)
Root-Rot (*Thielavia basicola*, Zopf.)
Descr., Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 166 & 167. (1892)
Leaf-Mould (*Zygodesmus albidus*, Ell. & Hals.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)

Watermelon.

(*Citrullus vulgaris*, Schrad.)

Anthracnose (*Colletotrichum lagenarium*, (Pass.) Ell. & Hals.)
Occ., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 326. (1893)
Treat. (neg.), Del. Agr. Exp. Sta., Rep. 5, 1892, p. 79. (1893)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326–330.
Del. Agr. Exp. Sta., Rep. 5, 1892, pp. 78 & 79.
Cf. Melon (Anthracnose.)
Leaf-spot (*Phyllosticta* sp., and (?) *Sphœrella* sp.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 5, 1892, pp. 75–78. (1893)

Wheat.

(*Triticum vulgare*, L.)

Ergot (*Claviceps purpurea*, Tul.)
See Rye (Ergot.)
Rust (*Puccinia coronata*, Cda., *P. graminis*, P., and *P. Rubigo-vera*, (DC.) Wint.)
Descr. Illus., Ind. Agr. Exp. Sta., Bull. 26. (1889)
Iowa Agr. Exp. Sta., Bull. 16, pp. 324–326. (1892)
Kan. Agr. Exp. Sta., Bull. 38, pp. 1–3. (1893)
Treat. (neg.), Kan. Agr. Exp. Sta., Bull. 22, pp. 90–93. (1891)
Iowa Agr. Exp. Sta., Bull. 16, pp. 326–329. (1892)
Cf. Oats (Rust.)
Scab (*Fusarium culmorum*, Smith.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 3, 1890, pp. 89 & 90. (1891)
Ohio Agr. Exp. Sta., Bull. 44, pp. 147 & 148. (1892)
Descr., Ind. Agr. Exp. Sta., Bull. 36, pp. 129 & 130. (1891)
Iowa Agr. Exp. Sta., Bull. 18, pp. 502 & 503. (1892)
Smut (*Tilletia fœtans* (B. & C.) Trel., *T. Tritici*, (Bjerk.) Wint., and *Ustilago Tritici*, (P.) Jens.)
Descr. Illus., N. Dak. Agr. Exp. Sta., Bull. 1, pp. 9–20. (1891)
Mich. Agr. Exp. Sta., Bull. 87. (1892)
U. S. Dep. Agr., Div. Veg. Path., Farm. Bull. 5. (1892)
Treat. (pos.), Journ. Mycol., Vol. v, pp. 164 & 165. (1889)
Ind. Agr. Exp. Sta., Bull. 32, pp. 8 & 9. (1890)
Kans. Agr. Exp. Sta., Bull. 21, pp. 70 & 71. (1891)
Mich. Agr. Exp. Sta., Bull. 87, pp. 6 & 7. (1892)
U. S. Dep. Agr., Div. Veg. Path., Farm. Bull. 5, pp. 5–8. (1892)
Wash. Agr. Exp. Sta., Bull. 8, pp. 135 & 136. (1894)

OBSERVATIONS ON THE GROWTH OF MAIZE CONTINUOUSLY ON THE SAME LAND.

In the years 1888 and 1889 a parcel of land containing $1\frac{1}{5}$ acres which had been a meadow for some years previous, was dressed with commercial fertilizers and planted to corn. Fertilizers and crops were weighed and analyzed each year and the enrichment or exhaustion of the soil by the dressing and cropping were as accurately determined as possible.

In the spring of 1890 this land was divided into four strips, each containing three-tenths of an acre, and was dressed as shown in the following diagram.

South.		North.
	Plot A.—Cow Manure at the rate of 10 cords per acre.	
	Plot B.—Hog Manure at the rate of 13½ cords per acre.	
	Plot C.—Fertilizer Chemicals at the rate of 1700 pounds per acre.	
	Plot D.—No manure or fertilizer of any kind.	

Corn was planted in drills four feet apart and the stalks stood singly at distances of ten inches in the drill. The crop from each plot was separately weighed and analyzed.

The several plots have received the same dressing as in 1890 annually since that time, have been planted with the same variety of seed and have been under the same conditions of planting, cultivation and harvesting.

Full particulars regarding the details of the experiment and the results obtained from year to year will be found in the Reports of this Station for 1890, pages 183 to 194; 1891, pages 139 to 149; and 1892, pages 122 to 129.

The experiment was repeated in 1893 precisely as in the three years previous.

The land was plowed May 23d, 1893, and planted with White Edge Dent, May 25th. The crop was "cultivated" four times, it was cut about the 20th of September, and was husked, weighed and housed Nov. 7th.

Considering simply the gross amounts of nitrogen, phosphoric acid and potash which the dressing added to the soil of the several plots and those which the crops removed, it appears from Table VII., to be noticed later, that after the crop of 1893 was harvested there had been added to plot A *per acre, in excess of what had been taken off in crops*, over 700 pounds of nitrogen, 560 of phosphoric acid and 570 of potash, all from cow manure.

The corresponding enrichment of plot B consisted, *per acre*, of over 1,200 pounds of nitrogen, 2,330 of phosphoric acid and 68 of potash, all from hog manure. The very large excess of phosphoric acid in the hog manure is due to the fact that the hogs were fed chiefly on hotel garbage, which contained a large quantity of bones of fowls.

The enrichment of plot C, *per acre*, amounted to over 300 pounds of nitrogen, 683 of phosphoric acid and 129 of potash all from fertilizer-chemicals.

Plot D received fertilizer-chemicals in 1888 and 1889, but in the following four years no dressing of any sort; so that after the harvest of 1893 it had acquired, *per acre*, 73 pounds more of phosphoric acid (from the applications of 1888 and 1889), than the crops had removed, but had lost 257 pounds of nitrogen and 40 pounds of potash.

Plot B also received more "organic matter" from the dressing than plot A, while plot C acquired only an insignificant amount in the dressing of fertilizer-chemicals, and plot D none at all.

Plot A receives annually about 3,207 pounds, plot B about 5,440 pounds and plot C not more than 200 pounds of organic matter.

Gross Yield of the Plots in 1893.

Table I. presents the gross weight of the kernels, cobs and stover harvested on each plot. Inasmuch as the kernels were air-dried on the cob, the weight of the latter in the field-cured condition could not be taken. Hence the weight of the kernels given in the table is slightly higher and that of the cobs slightly lower than it should be. But the error is small.

TABLE I.—GROSS YIELD OF THE PLOTS IN POUNDS PER ACRE. 1893.

	Plot A, Cow manure.	Plot B, Hog manure.	Plot C, Chemicals.	Plot D, No fertilizer.
Kernels	3536.4	3420.7	2630.2	1354.8
Cobs	480.0	455.0	345.5	166.8
Stover	4413.6	3504.3	3114.3	2078.4
	8430.0	7380.0	6090.0	3600.0

DRY MATTER OF THE CROPS OF 1893.

A strict comparison of the yields can only be made on their water-free substance, since the quantity of water in the field-cured crops is large and variable. Such a comparison is made below in Table II.

TABLE II.—DRY MATTER OF THE CROPS, POUNDS PER ACRE. 1893.

	In kernels.	In cobs.	In stover.	Total.
Plot A, cow manure	2223.0	428.7	2625.3	5277.0
Plot B, hog manure	2171.8	406.3	2441.4	5019.5
Plot C, fertilizer-chemicals	1537.9	308.5	2011.8	3858.2
Plot D, no fertilizer	748.5	149.0	1379.6	2277.1

The relative yields of dry matter from these plots for the last four years are given in Table III., the yield of plot A being marked in each case as 100.

TABLE III.—RELATIVE YIELD OF DRY MATTER FROM PLOTS A, B, C, D, FOR FOUR YEARS.

	Plot A.	B.	C.	D.
1890	100	104.7	89.5	73.5
1891	100	92.9	82.0	65.9
1892	100	114.6	98.3	48.9
1893	100	95.1	73.2	43.1
Average	100	102.2	86.6	60.1

It appears that the yields from plots A and B, both of which received heavy dressings of manure in excess of the exhaustion by cropping, have been essentially the same throughout the four years, that of B, however, being slightly larger, on the average.

The yield from C, which was fertilized with chemicals, also supplying considerably more nitrogen, phosphoric acid and potash

than the cropping removed from the soil, is, on the average, somewhat more than four-fifths as large, while the yield of dry matter on the unmanured plot D has steadily fallen and averages but three-fifths of that from plot A.

YIELD OF EACH FOOD INGREDIENT.

In Table IV., page 290, are given the quantities, in pounds per acre, of each food ingredient harvested from the four plots in 1893.

The cobs were not analyzed, but as their amount is relatively very small, the average composition of cobs as determined in other analyses, is used for the calculation.

The yield of each food ingredient from the four plots shows, in general, differences like those already noted in respect to the yield of total dry matter.

TABLE IV.—YIELD OF FOOD INGREDIENTS IN POUNDS PER ACRE. 1893.

	Plot A.				Plot B.				Plot C.				Plot D.			
	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.
Water	1313.4	51.3	1788.3	3153.0	1248.9	48.7	1062.9	2360.5	1092.3	37.0	1102.5	2231.8	606.3	17.8	698.8	1322.9
Ash	27.9	6.7	194.3	228.8	28.0	6.4	156.3	190.7	18.4	4.8	121.8	145.0	8.2	2.3	94.1	104.6
Albuminoids	267.0	11.5	188.0	466.5	244.6	10.9	164.0	419.5	178.1	8.3	158.8	345.2	79.1	4.0	102.9	186.0
Fiber	46.0	144.5	908.8	1099.3	43.8	137.0	879.9	1060.7	30.8	104.0	698.2	833.0	16.5	50.2	445.2	511.9
Nitrogen-free extract	1778.8	263.6	1291.9	3334.3	1752.8	249.7	1206.9	3209.4	1243.8	189.7	1001.6	2435.1	612.9	91.7	717.7	1422.3
Fat	103.3	2.4	42.4	148.1	102.6	2.3	34.3	139.2	66.8	1.7	31.4	99.9	31.8	.8	19.7	52.2
	3536.4	480.0	4413.6	8430.0	3420.7	455.0	3504.3	7380.0	2630.2	345.5	3114.3	6090.0	1354.8	166.8	2078.4	3600.0

COMPOSITION OF THE FIELD-CURED CROPS.

Table V., which follows, exhibits the composition of the crops on the four plots A, B, C, D, for the year 1893.

TABLE V.—ANALYSES OF FIELD-CURED MAIZE, KERNELS AND STOVER, FROM PLOTS A, B, C, D. 1893.

	Analyses of Field-cured Maize.						Analyses, Calculated Water-free.				
	Water.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
KERNELS.											
Plot A	37.14	.79	7.55	1.30	50.30	2.92	1.26	12.01	2.06	80.02	4.65
" B	36.51	.82	7.15	1.28	51.24	3.00	1.28	11.26	2.02	80.71	4.73
" C	41.53	.70	6.77	1.17	47.29	2.54	1.19	11.58	2.00	80.89	4.34
" D	44.75	.61	5.84	1.22	45.23	2.35	1.11	10.56	2.21	81.85	4.27
STOVER.											
Plot A	40.52	4.40	4.26	20.59	29.27	.96	7.39	7.16	34.62	49.22	1.61
" B	30.33	4.46	4.68	25.11	34.44	.98	6.40	6.71	36.04	49.44	1.41
" C	35.40	3.91	5.10	22.42	22.16	1.01	6.04	7.90	34.71	49.79	1.56
" D	33.62	4.53	4.95	21.42	34.53	.95	6.83	7.45	32.26	52.02	1.44

The experiments of the four years show striking differences in the composition both of the kernels and of the stover, differences which are to be attributed to the fertilizers applied, and are presented in Table VI.

TABLE VI.—AVERAGE COMPOSITION OF THE DRY MATTER OF KERNELS AND STOVER OF CROPS OF 1890, 1891, 1892 AND 1893.

	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
KERNELS.					
Plot A	1.40	11.07	1.61	80.70	5.22
" B	1.40	10.74	1.62	81.09	5.15
" C	1.29	10.47	1.67	81.54	5.03
" D	1.26	9.52	1.80	82.57	4.85
STOVER.					
Plot A	6.64	6.17	33.06	52.68	1.45
" B	6.25	6.34	33.21	52.76	1.44
" C	6.15	6.44	33.06	52.96	1.39
" D	5.89	6.08	32.66	53.96	1.41

The dry matter of the kernels from the unfertilized plot D, contains one and a half per cent. less of albuminoids, one third per cent. less of fat and somewhat less ash-ingredients than the dry matter of kernels raised on plot A, which was heavily manured each year. The per cents of nitrogen-free matter and fiber in the kernels from plot D are, on the contrary, higher than in the kernels from plot A.

The kernels from plot C dressed with chemicals, which supplied each year an amount of nitrogen, phosphoric acid and potash greater than the amount removed by the crop, also have a lower per cent. of albuminoids, fat and mineral matter than the kernels from plots A and B, but a higher per cent. of fiber and nitrogen-free extract.

The striking differences in composition of dry matter between the crop from plot D and those from plots A and B illustrate the well-known fact that a deficiency of plant food reduces the quality as well as the quantity of the crop, and affects not only the merely vegetative parts of the plant but also the seed which is least variable in chemical composition.

So far as the differences, in chemical composition and total crop, between plot C, which was dressed with fertilizer-chemicals, and plots A and B which were treated with manure, are significant, they are probably due to other causes than different quantities of crude plant food supplied by the dressing. Plot C has received each year nitrogen, phosphoric acid and potash in surplus, over the quantity removed by the crop, now amounting to more than 300 pounds of nitrogen, 683 of phosphoric acid and 129 of potash. It is not likely that all of this nitrogen is now present in readily available form in the soil, but a considerable portion of this excess is probably now in the soil and is not entirely inert. The same is true of the phosphoric acid and potash. Hence while the *excess* of these ingredients is much greater on plots A and B it is difficult to believe that either of them is relatively deficient in plot C.

The poorer yield and inferior quality of crop on plot C are probably connected with the mechanical and physical condition of the soil which has been greatly modified, in the course of these four years, by the dressing applied. The fact that plot C has received very little organic matter (not more than 200 pounds a year), while A and B have had large dressings of it annually (from 3,000 to 5,000 pounds), has been already noticed.

To complete the data regarding this experiment are given the following tables.

Table VII. gives the quantities of nitrogen, phosphoric acid and potash, in pounds per acre, which were added to the soil in the dressing of 1893 and those which were removed by the crop. It also gives the amounts of these ingredients which have been added to the soil-capital (+) or withdrawn (−) in the six years during which accurate account has been kept.

TABLE VII.—ENRICHMENT OR IMPOVERISHMENT OF SOIL BY SIX YEARS' MANURING AND CROPPING, POUNDS PER ACRE.

	Cow Manure. Plot A.			Hog Manure. Plot B.			Fertilizer Chemicals. Plot C.			No Fertilizer. Plot D.		
	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.
After five years' cropping	+494.5	+447.0	+440.4	+855.0	+1766.4	+43.4	+184.1	+536.7	+95.9	−227.1	+82.5	−29.3
Applied in 1893	286.3	136.4	204 5	419.9	586.5	72.4	172.0	162.0	69.0	00.0	00.0	00.0
Taken off in Crop of 1893	74.6	21.6	74.4	67.1	22.9	47.3	55.2	15.4	35.5	29.8	8.9	10.7
Excess (+) or Deficiency (−) after six years' cropping	+706.2	+561.8	+570.5	+1207.8	+2330.0	+68.5	+300.9	+683.3	+129.4	−256.9	+73.6	−40.0

Table VIII. gives the record of the crops on the four plots for the whole period covered by the experiment and also the percentage composition of the several crops.

TABLE VIII.—YIELD OF DRY MATTER AND "SHELLED CORN" PER ACRE FOR SIX YEARS AND COMPOSITION OF DRY MATTER.

	Year.	Distance of Planting.	Pounds of Dry Matter per Acre.	Bushels of Shelled Corn.	Percentage Composition of Dry Matter: Ash	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
Fertilized alike with chemicals	1888	Stalks 12 inches apart.	7350	75	3.3	7.8	19.4	66.1	3.4
	1888	" 6 " "	7980						
	1889	" 12 " "	6144	60	3.5	6.1	21.7	69.7	3.0
	1889	" 6 " "	6353						
Cow Manure	1890A	" 10 " "	9014	91	4.0	7.9	19.8	65.7	2.6
Hog Manure	1890B	" 10 " "	9436	97	4.2	8.0	19.6	65.5	2.7
Fertilizer Chemicals	1890C	" 10 " "	8070	87	3.9	8.0	21.2	64.4	2.5
No Manure or Fertilizer	1890D	" 10 " "	6626	51	3.8	6.2	20.7	66.7	2.6
Cow Manure	1891A	" 12 " "	8176	103	3.2	7.5	15.5	70.2	3.6
Hog Manure	1891B	" 12 " "	7599	88	3.3	7.6	16.2	69.3	3.6
Fertilizer Chemicals	1891C	" 12 " "	6708	70	3.2	6.4	18.5	68.8	3.1
No Manure or Fertilizer	1891D	" 12 " "	5391	60	3.1	6.0	17.4	70.2	3.3
Cow Manure	1892A	" 12 " "	7181	72	4.0	8.2	19.6	65.1	3.1
Hog Manure	1892B	" 12 " "	8233	84	4.0	8.8	19.3	64.8	3.1
Fertilizer Chemicals	1892C	" 12 " "	7062	86	3.2	8.3	17.5	67.8	3.2
No Manure or Fertilizer	1892D	" 12 " "	3509	38	3.3	7.7	18.8	67.2	3.0
Cow Manure	1893A	" 12 " "	5277	53	4.3	8.8	20.8	63.3	2 8
Hog Manure	1893B	" 12 " "	5020	52	3.8	8.4	21.1	63.9	2.8
Fertilizer Chemicals	1893C	" 12 " "	3858	37	3.8	9.0	21.6	63.0	2.6
No Manure or Fertilizer	1893D	" 12 " "	2277	18	4.6	8.2	22.5	62.4	2.3

The Quantity of Nitrogen in the Soils of the Experimental Plots.

Samples of soil were drawn for analysis in the fall of 1891. The previous history of the plots has been already given on pages 286–7.

The following statement shows how much nitrogen, phosphoric acid and potash had been added to or taken from the original soil-capital, by four years' dressing and cropping, at the time the soils were sampled for analysis. When the whole quantity put on in dressing was greater than that taken off in cropping the excess is marked with the plus (+) sign; when the quantity put on in dressing was less than the quantity removed in cropping this deficiency is marked by a minus (—) sign.

Table IX.—Increase or Decrease of Soil-Capital, from April, 1888, to October, 1891.

	Plot A.	Plot B.	Plot C.	Plot D.
Nitrogen	+302	+ 551	+106	−184
Phosphoric acid	+340	+1220	+404	+ 97
Potash	+331	+ 72	+ 92	− 11

On Oct. 6th, 1891, during moderately dry weather which had prevailed since early in September, four samples of surface soil—from places about equidistant and between the corn rows—were drawn from plot A, four from B, and two each from C and D.

The samples were drawn with a rectangular iron instrument like a box without bottom or cover. The lower edge of this was sharp to divide the soil, the upper edge was wired so as to stand moderate pressure without yielding. This sampler was 8 inches deep, 6 inches long and 6 inches wide.

It contained when full, one-sixth of a cubic foot of earth and enclosed one-quarter of a square foot of surface.

On the spot selected, this sampler was forced down till its upper edge was flush with the surface of the soil. As the sampler was forced down, the soil outside was cut away with a mason's trowel, when necessary, to lessen friction and to remove obstructing pebbles. When the sampler had been driven to the proper depth, the surrounding earth was removed and the trowel was passed horizontally through the soil at the lower edge of the sampler. The enclosed portion of earth constituting the sample could then be lifted without loss, with the trowel under it.

A board was laid on the section of earth above which the sample had been taken, to mark the spot for future reference and to protect it. The hole was then covered with earth till Oct. 28th, when samples of the subsoil were drawn.

The samples of surface soil obtained on the 6th were immediately weighed. From the several samples drawn on each plot smaller samples were taken for separate analysis, and then the remainders of the principal samples from each plot (four on plots A and B, two each on C and D) were thoroughly mixed, thus making a composite sample from each plot. A weighed quantity of each of these samples was quickly dried at a temperature of from 50° to 55° C., and after standing for some time to "air-dry" was again weighed and securely bottled.

The four samples from plot A were first examined to learn what variations of water-content, and of composition otherwise, different parts of the same plot might exhibit.

Each sample was first sifted on round holes $\frac{1}{25}$ of an inch in diameter. The two portions into which the soil was thus separated will be referred to as "coarse earth" and "fine earth." That part of the "coarse earth" from the four samples which passed holes $\frac{1}{12}$ inch in diameter was finely pulverized and its nitrogen determined, by the absolute method, in 10 grams. There was found only 0.024 per cent. Since this portion that passed a $\frac{1}{12}$ inch sieve constitutes not more than half of the "coarse earth" and probably contains practically all of its nitrogen, the nitrogen of the "coarse earth" is so little that it may be disregarded without introducing serious error into calculations. The results of examination of the several portions of soil taken from plot A, are given in the following table.

Table X.—Water and Nitrogen in Four Samples of Surface Soil from Plot A.

	Grams of fresh Soil.	Grams of air-dry Soil.	Per cent. of water lost in air-drying.	Grams of coarse Earth.	Grams of fine Earth.	Per cent. of Nitrogen in fine Earth.	Per cent. of Nitrogen reckoned on entire air-dry surface Soil.
A1	500	450.3	9.9	43.5	406.8	0.174*	0.157
A2	500	446.0	10.8	49.5	396.5	0.162	0.144
A3	500	450.0	10.0	59.5	390.5	0.156	0.135
A4	500	439.2	12.2	53.5	385.7	0.170	0.150
Average	500	446.4	10.7	51.5	394.9	0.165	0.147

The above figures serve to indicate what are the limits of accuracy of ordinary chemical analysis as applied to this soil.

* Duplicate analyses gave 0.176 and 0.172 p. c.

The greatest difference in the amounts of nitrogen found in the fine earth of the four samples, taken from widely separate portions of plot A, is 0.018 per cent. of the soil, or about one-ninth of the average of total nitrogen. The widest divergence from the mean is 0.009 per cent. of the soil, or one-eighteenth of the average total quantity of nitrogen. This 0.009 per cent. corresponds to 233 lbs. of nitrogen per acre of this soil, taken to the depth of 8 inches. The agreement of duplicate analyses* on the same sample is better than could be commonly expected. The differences among the quantities found in the several samples are not greater than might easily occur in several analyses of the same sample. When we reckon from the sample to the acre, the slight and unavoidable errors or variations of analysis mount up to hundred-weights and the results of such calculation must be received with due allowance. They are nevertheless instructive and valuable.

The quantities per cent. of nitrogen found in the composite samples from the surface of the plots (*sursoils*), are stated in Table XI., together with other data obtained by calculation from the weights of the samples in their fresh, air-dry and sifted condition.

Table XI., also comprises the results of similar analyses and calculations made with samples of subsoil, taken on October 28th, by the method already described. These samples represent successive horizontal sections of the plots in 8-inch depths, as stated at head of table.

Table XI.—Water and Nitrogen in Sursoil and Subsoil of Plots A, B, C, D.

	Sursoil to 8 in.	Subsoil 8 to 16 in.	Subsoil 16 to 24 in.	Subsoil 24 to 32 in.
Water lost in air-drying, per cent.				
Plot A	9.38	9.76	9.37	4.46
" B	10.64	11.61	11.70	----
" C	8.33	10.54	5.86	----
" D	9.27	8.93	6.60	----
Weight of air-dry Soil, pounds per acre.				
Plot A	2,585,695	2,830,215	3,000,361	3,079,675
" B	2,605,425	2,733,691	2,787,971	----
" C	2,660,336	2,805,752	3,034,546	----
" D	2,696,061	2,856,247	3,173,433	----

* See footnote on page 297.

	Sursoil to 8 in.	Subsoil 8 to 16 in.	Subsoil 16 to 24 in.	Subsoil 24 to 32 in.
Nitrogen in air-dry "fine earth," per cent.				
Plot A	0.173	0.050	0.027	0.012
" B	0.182	0.089	0.037	----
" C	0.158	0.060	0.018	----
" D	0.133	0.033	0.012	----
Nitrogen in entire Sample, per cent.				
Plot A	0.140	0.031	0.016	0.008
" B	0.143	0.067	0.029	----
" C	0.130	0.050	0.013	----
" D	0.109	0.025	0.009	----
Total Nitrogen, pounds per acre.				
Plot A	3620	877	480	237
" B	3726	1831	808	----
" C	3458	1403	394	----
" D	2939	714	285	----

Note Regarding Methods of Analysis.

Nitrogen was determined in 10 grams of the soils very finely pulverized, by the Dumas or "absolute" method. This quantity of surface soil yielded approximately 14 or 15 c. c. of nitrogen gas.

The apparatus, reagents and manipulation were checked by determining nitrogen in a sample of dried blood which had been carefully analyzed by both the absolute and Kjeldahl methods in 1886 and had then shown 13.40 per cent. of nitrogen.

With the same apparatus and reagents used in these soil-analyses this sample of blood gave 13.45 per cent. of nitrogen by the absolute method and 13.44 and 13.59 per cent. by the Kjeldahl method.

It was also sought to determine nitrogen in the soils by the Kjeldahl and the Jodlbaur-Kjeldahl methods as follows:

Kjeldahl Method.—This was executed in the ordinary way, using 30 c. c. of oil of vitriol instead of 20 c. c.

Jodlbaur-Kjeldahl Method.—To 10 grams of soil, in a digestion flask, were added 10 c. c. of acid-mixture (60 grams salicylic acid in 1,000 c. c. of concentrated oil of vitriol of 66° B.). After standing in the cold for 24 hours, 30 c. c. of oil of vitriol and 1 gram of zinc dust were added, the contents of the flask were boiled till colorless and the ammonia was determined by distillation as usual.

As the following table shows, the agreement of results between these three methods is entirely satisfactory to the chemist. The extreme difference among the eleven determinations is 0.032, the greatest divergence from the average of all is 0.017 and the largest difference on the same subsample is but 0.014 per cent.

PER CENT. OF NITROGEN FOUND.

Sample of Surface Soil.	Dumas Method.	Kjeldahl Method.	Jodlbaur-Kjeldahl Method.	Average by three methods.
A, 1	0.174	----	0.163	0.169
A, 2	0.162	0.150	0.150	0.154
A, 3	0.156	0.156	0.142	0.151
A, 4	0.170	0.159	0.160	0.163
Average	0.166	0.155	0.154	
Average of Averages,		0.158		0.159

ANALYSES OF MAIZE KERNEL.

In the following tables are given analyses of ninety samples of maize kernel together with data regarding the weights of kernel and cob, ratio of weight of kernel to weight of cob, and other information of interest.

The specimens whose analyses are here given were collected in part by Prof. C. S. Phelps and in part by this Station for the Connecticut Exhibit at the Chicago Exposition. The analyses were made in the Station laboratory during 1892 and 1893. The other data in the Tables were furnished by the senders, in answer to a Circular issued in November, 1891. See Report for 1891, p. 196. A few ears of each variety are preserved in the Museum of this Station.

Many of these varieties have been raised continuously on the same farm for a long term of years, the seed having been selected with more or less care each year. The samples were gathered and sent by the growers and probably represent the best of the crop rather than the average.

In studying the tables of analyses it should be remembered that the composition of any specimen is dependent not only on the strain or variety, but also to some degree on the nutrition of the plant. That is, other things being equal, the shelled maize harvested from well-conditioned land, contains, pound for pound, somewhat more protein, fat and ash than that yielded by the same variety of corn, from an impoverished soil.

On page 291 of this Report may be seen a statement of such difference of composition in two samples of White Edge Dent, raised side by side in the same field with and without manure. The grain from the enriched soil, considered water-free, contains 11.26 to 12.01 per cent., that from the unmanured land but 10.56 per cent. of albuminoids (protein $= N \times 6.25$).

To demonstrate any constant difference in the chemical composition of different varieties it would be necessary to produce them under the same conditions of soil, climate, manuring and tillage for a number of years.

The Station solicits samples—of a dozen ears each—of other varieties of corn, preferably those which have been cultivated for a long term of years, in this State, in order to complete our collection of Connecticut varieties and our knowledge of their composition.

No.	Name of Variety.	Class.	Sender's Name and Residence.	No. years raised on same farm.	Date of planting.	Date of cutting.	Distance of hills in the row and between rows, in feet.	Number of stalks in hill.	Average yield of shelled corn in bushels.	Average height of stalks in feet.	Character of Soil.	Manure and Cultivation.	Remarks.
1	Queen of the Prairie.	Yellow dent.	W. H. Brinsmade, Nichols.	1	June 2	Oct. 3	$3\frac{1}{2} \times 3\frac{1}{2}$	4–5	35	10	----	----	Stalks coarse, not as leafy as some.
2	8-Rowed Yellow.	Yellow flint.	Henry Belden, Falls Village.	100	May 26	Nov. 3§	----	----	----	----	----	Cultivated and hoed twice.	Damaged by hail storm.
3	White Dent.	White dent.	W. H. Brinsmade, Nichols.	25	" 28	Sept. 25	$3\frac{1}{2} \times 3\frac{1}{2}$	4	42	10–12	----	Followed rye. Barnyard manure.	Seed originally from Scioto Valley, Ohio.
4	Rhode Island White Cap.	White flint.	H. S. Frost, Cheshire.	----	----	----	----	----	----	----	----	----	----
5	Prairie Queen.	Yellow dent.	M. S. Dyer, Canton.	----	----	----	----	----	----	----	----	----	----
6^{1}	A, Rhode Island White Cap.	White flint.	E. P. Barnes, Norwich.	12	May 10	Sept.	$3 \times 3\frac{1}{2}$	4	25–30	7	----	} Manure plowed in in fall. 200 lbs. fertilizer and 200 hen manure put in hill. Hoed twice in June.	Length of ear and size of kernel have increased under cultivation.
6^{2}	B, Red variety of A.	Red flint.	" " "	----	----	----	----	----	----	----	----	}	This variety planted to cross with previous one.
7	Beers' Yellow Corn.	Yellow flint.	N. S. Platt, Cheshire.	----	----	----	----	----	----	----	----	----	----
8	The Brainard Corn.	"	T. J. Stroud, Shaker Station.	50	----	----	----	----	----	----	----	----	Brought from Canada to Vt. in 1837. From Vt. to Haddam, Ct., 1842. From Haddam to Enfield in 1854 and grown there ever since.
9	Rhode Island Cap.	White flint.	J. J. Copp, Groton.	40	May 20	Aug. 15	$3\frac{1}{3} \times 3\frac{1}{3}$	4	50	$5\frac{1}{2}$–$6\frac{1}{2}$	----	25 ox-cart loads of manure. 300 lbs. fertilizer in hill.	Grows larger than formerly.
10	Early Eight-rowed Canada.	Yellow flint.	" " "	3	" 20	" 15	$3\frac{1}{2} \times 3\frac{1}{2}$	4	40	7	----	6 cords cow manure plowed in. 200 lbs. fertilizer in hill.	Has not changed under cultivation.
11	Red Blaze.	White flint.(!)	" " "	30	" 10	" 25	$3\frac{1}{2} \times 3\frac{1}{2}$	4	50	7–8	----	8 cords manure plowed in. 200 lbs. fertilizer in hill. Cultivated and hoed twice.	" " " "
12	Conn. Eight-rowed Yellow Flint.	Yellow flint.	Wm. J. Jennings, Green's Farms.	60	----	Sept. 1	----	3–4	40	7–8	----	----	Ripens 10–15 days earlier than formerly. Produced more ears and better tipped ones.
13	Allen Corn.	White flint.	A. T. Allen, North Ashford.	75	----	" 7	$2\frac{1}{2} \times 3$	4	65	8	----	Manure spread. Fertilizer in hill. Cultivate 3 times, hoe twice.	----
14	Queen of the Prairie.	Yellow dent.	John Ellwood, Green's Farms.	15	----	" 1	$3\frac{2}{3} \times 3\frac{2}{3}$	4	55	7–8	----	----	Ears have grown larger under cultivation.
15	China Corn (China Tea), (China Tree).	White dent.	Bradley Goodsell, Green's Farms.	48	----	" 10	$3\frac{1}{2} \times 3\frac{1}{2}$	----	50–60	7–8	----	----	Seed from Long Island originally. Later in ripening and less indented than formerly.
16	White Flint.	White flint.	W. J. Jennings, Green's Farms.	----	----	" 5	$3\frac{1}{2} \times 3\frac{1}{2}$	----	45	$6\frac{1}{2}$–9	----	----	Shows some mixture with yellow varieties.
17	Farmers Pride.	White dent.*	P. K. Hoadley, North Guilford.	5	June 4	" 12	$2 \times 3\frac{1}{2}$	4	55	8	----	----	Select seed to grow small cobs, capped ears and regular rows.
18	Longfellow.	Yellow flint.	S. H. Peck, Watertown.	10	----	" 22	$3\frac{1}{2} \times 3\frac{1}{2}$	3–5	150*	7	----	----	Ripens 2–3 weeks earlier than formerly.
19	Bolton.	"	L. Willey, East Hampton.	40	----	" 15	$3 \times 3\frac{1}{2}$	4	40	6	----	Manure plowed in in May. 400–600 lbs. hen manure and plaster in hill.	----
20	Bolton.	"	" "	----	----	----	----	----	----	----	----	20 loads manure. 600 lbs. bone, half in hill and half between rows at first hoeing.	----
21	Hickox Improved Sugar Corn.	Sweet.	D. Fenn & Son, Milford.	20	----	Oct. 15	$3\frac{5}{6} \times 3\frac{5}{6}$	3–4	35	7–8	----	Manured after plowing. Harrowed in.	Selects seed to produce ears of uniform size.
22	Pride of the North.	Yellow dent.	F. S. Hall, Guilford.	----	----	----	----	----	----	----	----	----	----
23	Sanford.	White flint.	Richard Wilcox, Guilford.	19	May 10	Oct. 5	4×4	4–5	50	6–7	----	Manured in winter. 400–600 lbs. fertilizer.	Valuable for fodder. Suckers. Ears not as long as formerly.
24	Benton.	Yellow dent.	D. R. Spencer, Guilford.	100	" 10	" 25	4×4	4–5	65	$7\frac{1}{2}$	----	Raised on barn yard manure. Cultivate 3 times, hoe once.	Has not so large a cob and does not need so long a season as formerly.
25	Angel of Midnight.	Yellow flint.	J. H. Blatchley, Guilford.	----	----	----	----	----	----	----	----	----	----
26	Bird Track.	Red flint.	Ed. Davis, Guilford.	----	----	----	----	----	----	----	----	----	----
27	Early Ohio.	Yellow dent.*	Richard Wilcox, Guilford.	25	May 1	Sept. 27	4×4	3–5	50–80	7	----	Liberal dressing necessary. Cultivate level and shallow.	Shells more corn to the bushel of ears than any he has raised.
28	White Dent.	" †	" " "	6	" 4	Oct. 1	4×4	4	60–70†	7–8	----	Plenty of manure. 300 lbs. fertilizer in hill.	More apt to mix than other varieties. Not good for fodder. Stalks large.
29	Early Mastodon.	" †	----	----	----	----	----	----	----	----	----	----	----

* Red markings. † Between white and yellow. § Harvest.

* Ears. † Maximum.

No.	Name of Variety.	Class.	Sender's Name and Residence.	No. years raised on same farm.	Date of planting.	Date of cutting.	Distance of hills in the row and between rows in feet.	Number of stalks in a hill.	Average yield of shelled corn in bushels.	Average height of stalks in feet.	Character of Soil.	Manure and Cultivation.	Remarks.
30	Eight-rowed Yellow.	Yellow flint.	Bradley Miles, Cheshire.	---	----	----	------	---	----	----	----	----	----
31	Sanford.	White flint.	E. Woodruff, Guilford.	10	May 7	Oct. 10†	4 × 4	4–5	55	9	----	----	----
32	Scioto.*	Red dent.	Thomas Gilbert, Middletown.	---	May 20	Sept. 20	------	---	60	----	Clay loam to red clay.	Cultivate 3 times, hoe twice.	----
33	Eight-rowed Dent.	Yellow dent.	Thomas Scott, Farmington.	65	" 25	Oct. 1	$3\frac{1}{2} \times 3\frac{1}{2}$	3	100*	6–7	Sandy loam.	20 loads manure. Spoonful of fertilizer in hill. Cultivate both ways.	----
34	Red Blade Field Corn.	White flint.	Selden S. Carter, Clinton.	20	June 2	Sept. 16	$3\frac{1}{2} \times 3\frac{1}{2}$	---	50	5	Light, high and dry.	8 cords manure.	Size of ears has increased under cultivation.
35	Red Rose Field Corn.	Red flint.	Geo. L. Rosebrooks, Storrs.	26	May 20	" 10	$3\frac{1}{2} \times 3\frac{1}{2}$	4	75	----	Clay loam.	Stable manure.	From a cross of unnamed varieties made 26 years ago.
36	Storrs' Improved Field Corn.	Yellow flint.	Geo. L. Rosebrooks, Storrs.	24	" 20	" 10	$3\frac{1}{2} \times 3\frac{1}{2}$	4	75	8–10	" "	40 loads manure. Plow in August. Harrow in spring and spread manure and plow it under. Cultivated 3 times, hoed twice.	----
37	Sill's Golden Sheaf or Prolific.	"	Samuel A. Chalker, Saybrook.	3	" 20	" 10	$3\frac{1}{2} \times 3\frac{1}{2}$	3–5	75	6–7	Heavy loam.	Cultivated level and often.	----
38	King Philip.	Red flint.	H. F. Dimock, So. Coventry.	---	--------	--------	--------	---	----	----	----	----	----
39	Twelve-rowed Flint.	Yellow flint.	John S. Wells, Hebron.	30	May 18	Sept. 12	$3\frac{5}{6} \times 3\frac{5}{6}$	---	60	----	Loamy.	15 loads manure, 400 lbs. fertilizer. Both spread and plowed in. Cultivated twice both ways. Hoed twice.	Picked ears to ripen on ground and silage the stalks.
40	Scioto.	White dent.	A. L. Congdon, Westfield.	10	" 10	Sept. 15	$3\frac{1}{2} \times 3\frac{1}{2}$	4	60	7	Gravelly.	600 lbs. fertilizer per acre. Cultivated and hoed 3 times.	----
41	Brigner's Corn.	Yellow flint.	Stephen Brigner, Falls Village.	25	" 12	Sept. 20	$3\frac{1}{3} \times 3\frac{1}{3}$	---	120*	7	Sandy loam.	20 loads manure. Cultivated and hoed twice.	Originally came from Canada. Length of ear has increased.
42	Improved Canada Corn.	"	Chauncey Deming, Farmington.	6–8	" 30	" 6	$3\frac{1}{2} \times 3\frac{1}{2}$	---	125*	----	" "	Manure on turf plowed in. A little fertilizer put on after planting. Cultivated flat both ways.	Stalks and ears are larger and longer than formerly.
43	Canada Improved Corn.	"	M. W. Frisbie, Southington.	---	June 10	" 18	-------		100*	----	Worn out meadow.	Cultivated and hoed twice.	----
44	Ayers' Poor Land Corn.	"	E. C. Ayer, Farmington.	20	May 18	Sept.	$3\frac{1}{2} \times 3\frac{1}{2}$	3–4	40	----	Sandy loam.	Cover in with tobacco ridger. Mark across the ridges for planting. Level culture. 500 lbs. Castor Pomace, 150 lbs. Muriate of Potash, 200 lbs. Bone Superphosphate.	----
45	Early Diamond Corn.	"	W. J. Simpson, Plainville.	---	" 10	" 1	$3\frac{1}{2} \times 3\frac{1}{2}$	---	125*	----	Sandy.	----	----
46	Cross Small Yellow Cap and Angel of Midnight.	"	J. J. Williamson, Woodstock.	---	June 8	" 12	-------	---	100*	----	Loam. Clayey subsoil.	Manure plowed in. Fertilizer in the hill.	----
47	Self-Husking Corn.	Red flint.	Jasper S. Brooks, Moodus.	5	" 1	" 1–10	$3 \times 3\frac{1}{2}$	3–5	100*	----	Gravelly loam.	Cultivated and hoed twice.	----
48	Queen of the North.	Yellow dent.	F. E. Boardman, Westfield.	1	May 11	" 15	$3\frac{1}{2} \times 3\frac{1}{2}$	4–5	45	9	Loam.	Light dressing of manure. 400 lbs. fertilizer in the hill. Cultivated and hoed twice.	----
49	Early Butler Dent.	"	Elbert Manchester, Bristol.	---	" 20	Oct. 1	$3\frac{1}{2} \times 3\frac{1}{2}$	---	100	----	Red loam.	----	----
50	Ashley's Prolific.	Yellow flint.	Carlos Bradley, Ellington.	20	" 8–12	Sept. 1	$3\frac{1}{2} \times 3\frac{1}{2}$	3–5	40–50	----	Gravelly loam.	10–15 loads manure plowed in. Fertilizer in hill. Cultivated both ways and used Prout hoe.	----
51	Horse Tooth Dent.	White dent.	H. E. Savage, E. Berlin.	4	" 17	" 16	Drills.‡	---	50	8	Clay loam.	6 cords manure on sod. Cultivated 4 times, hoed once.	Came from W. Va. Has grown more like a flint corn.
52	Echo Farm Pride.	Yellow flint.	J. B. & L. H. Healy, N. Woodstock.	3	" 30	Nov. 1†	$3\frac{5}{6} \times 3\frac{5}{6}$	4–5	50	7	Loam. Clayey subsoil.	25 loads of manure. Cultivated twice, hoed once.	----
53	Golden Beauty.	Yellow dent.	Geo. W. Thorpe, Meriden.	3	" 1	Oct. 25†	$1 \times 3\frac{1}{2}$	1	75	10	Lightloam, stony	Cultivated 3 times, hoed once.	----

* Cross of 2 varieties brought from Ohio in 1884. † Harvest.
‡ 2 ft. apart in drill. Drill $3\frac{1}{2}$ ft. apart.

* Ears.

No.	Name of Variety.	Class.	Sender's Name and Residence.	No. years raised on same farm.	Date of planting.	Date of cutting.	Distance of hills in the row and between rows in feet.	Number of stalks in a hill.	Average yield of shelled corn in bushels.	Average height of stalks in feet.	Character of Soil.	Manure and Cultivation.	Remarks.
54	Nevins' Improved.	Yellow dent.*	Stephen Hoyt's Sons, New Canaan.	---	June 2	Sept. 20	3×3	4	50	----	Gravelly loam.	Cultivated 4 times, hoed 3 times.	----------
55	New Canaan Improved.	Yellow flint.	Stephen Hoyt's Sons, New Canaan.	---	May 25	" 20	$3\frac{1}{2} \times 3\frac{1}{2}$	---	75*	----	Drained muck swamp.	No manure. Cultivated both ways 5 times and hoed.	----------
56	Leaming.	Yellow dent.	H. E. Savage, E. Berlin.	7	" 26	" 20	$3\frac{1}{2} \times 3\frac{1}{2}$	---	60	8	Clay loam.	6 cords manure. Small quantity fertilizer in hill. Cultivated both ways 4 times and hoed.	----------
57	R. I. State Premium.	Red flint.	Geo. Kane, Rockville.	1	" 24	" 20	2×3	4	65	----	Light loam.	25 loads manure. Plaster and ashes in hill.	----------
58	Top Over Field Corn.	Yellow flint.	C. H. Matthews, Bristol.	---	" 28	" 5	--------	---	100*	----	Sandy loam.	Hand hoed.	----------
59	Holden Corn.	"	E. W. Upham, Union.	20	June 1	"	$2 \times 3\frac{1}{8}$	4	60	5	----------	40 loads manure, 400 lbs. fertilizer.	----------
60	Windsor Corn.	----------	H. H. Knox, W. Suffield.	17	April 25	"	4×4	---	40	----	Sandy loam.	25 ox-cart loads manure, 400 lbs. fertilizer in hill. Cultivated and hoed twice.	----------
61	Early Red Flint.	Red flint.	Chas. C. Shelden, W. Suffield.	12	May 17	Oct.	$3\frac{1}{2} \times 3\frac{1}{2}$	---	65	8	" "	20 loads manure. 500 lbs. fertilizer in hill.	Bought seed for Canada Improved. Selected red ears for seed, which gave early and prolific corn.
62	Minnesota King.	Yellow dent.	Warren A. Doolittle, Clinton.	2	" 10	Sept. 5	$3 \times 3\frac{1}{2}$	2	100*	6	" "	Barnyard manure. Cultivated twice.	Seed came from Minnesota.
63	Ohio Dent.	White dent.	R. F. Woodford, Plainville.	2	--------	" 1	4×4	4	55	----	" "	Harrow with smoothing harrow as soon as it came up. Cultivate both ways.	----------
64	Golden Dent.	Yellow dent.	R. F. Woodford, Plainville.	6	May 3	" 1	4×4	3–4	65	8–10	" "	4 cords coarse manure. Handful of fertilizer in the hill. Cultivate both ways.	----------
65	Chittenden.	Yellow flint.	Russell Church, Westbrook.	---	" 15	Late Sept.	$3\frac{1}{2} \times 3\frac{1}{2}$	---	90*	----	Gravelly loam.	----------	----------
66	Saltzer's Ensilage.	White dent.	F. E. Boardman, Westfield.	1	" 9	Oct. 3	$1\frac{1}{2} \times 3\frac{1}{2}$†	---	90	13	Clayey loam.	Stable manure plowed in. Hen manure in hill. Cultivated and hoed twice.	Does not fully mature. Excellent for silage.
67	Long Island Dent.	"	D. D. Hurd, Clinton.	12	" 15	Sept. 1	4×4	4	50	----	----------	----------	----------
68	Arnold Field Corn.	Yellow flint.	Arnold Warren, S. Coventry.	30	" 10	" 1	$3\frac{1}{2} \times 3\frac{1}{2}$	4	50	6	Light, sandy.	20 cart loads stable manure per acre.	Obtained by crossing a number of varieties.
69	Blake's Yellow Flint.	"	E. F. Blake, New Britain.	35	" 10	" 1	--------	---	120*	----	Clay loam.	Flat cultivation.	----------
70	Kissing Corn.	Red flint.	Samuel A. Chalker, Old Saybrook.	2	" 20	" 15	$3\frac{1}{2} \times 3\frac{1}{2}$	3–5	75	7	Heavy loam.	Cultivated level and often.	----------
71	Hickory King.	White dent.*	Samuel A. Chalker, Old Saybrook.	1	--------	Oct. 1	4×4	---	----	12	----------	----------	Late. Very large. Good for silage.
72	Early Canada.	Yellow flint.	Samuel A. Chalker, Old Saybrook.	3	Late May	Sept. 15	$3\frac{1}{2} \times 3\frac{1}{2}$	3–5	60	6–7	Heavy loam.	Stable manure.	----------
73	New England Dent.	White dent.	D. H. Van Hoosear, Hurlburt St.	14	May 10	" 20	$3\frac{2}{3} \times 3\frac{2}{3}$	4–5	45	$5\frac{1}{2}$	----------	----------	Have selected seed for 10 years from twin ears. The stalks have become smaller but twin ears have increased without decrease in their size or quality.
74	Dutton.	Yellow flint.	A. W. Darrow, Watertown.	---	" 25	" 20	3×3	---	70*	----	Light loam.	8 cart loads manure. 400 lbs fertilizer.	----------
75	R. I. Premium.	White flint.*	H. D. Hale, Glastonbury.	---	June 1	Oct.	$3 \times 3\frac{1}{2}$	---	100*	----	----------	500 lbs. commercial fertilizer.	----------
76	90 Day Canada.	Yellow flint.	" " "	---	" 1	"	$3\frac{1}{2} \times 3\frac{1}{2}$	---	100*	----	----------	" " "	----------
77	Tyler.	White dent.	J. R. Campbell, Wallingford.	25	May 15	Sept. 15	$3\frac{2}{3} \times 3\frac{2}{3}$	7–8	60	7–8	Light loam.	6 cart loads manure per acre. 400 lbs. fertilizer. Cultivated twice, hoed once.	----------
78	12-Rowed Canada.	Yellow flint.*	John E. Tryon, So. Glastonbury.	20	June 1	"	$3\frac{1}{2} \times 3\frac{1}{2}$	---	50	8	----------	700 lbs. fertilizer per acre. Cultivated both ways twice.	Larger and somewhat later than formerly.
79	Brindle.	Red flint.	N. S. Platt, Cheshire.	---	May 20	" 12	$3\frac{3}{4} \times 3\frac{3}{4}$	---	40	----	Heavy loam.	----------	----------

* Indentations slight. † Probably in drills. * Ears.

No.	Name of Variety.	Class.	Sender's Name and Residence.	No. years raised on same farm.	Date of planting.	Date of cutting.	Distance of hills in the row and between rows in feet.	Number of stalks in a hill.	Average yield of shelled corn in bushels.	Average height of stalks in feet.	Character of Soil.	Manure and Cultivation.	Remarks.
80	Tolland Co. Premium.	Yellow flint.	N. R. Grant, Rockville.	---	May 20	Sept. 10	$3\frac{1}{2} \times 3\frac{1}{2}$	---	68	----	Sandy loam.	30 cart loads manure. Cultivated and hoed twice.	----
81	Improved Canada.	"	" " "	---	" 20	" 10	$3\frac{1}{2} \times 3\frac{1}{2}$	---	68	----	" "	30 cart loads manure. Cultivated and hoed twice.	----
82	Doolittle.†	"	N. S. Platt, Cheshire.	100	----	----	----	---	----	----	----	----	----
83	Chapman.	"	George F. King, Storrs.	12	May 20	Sept. 1	$3 \times 3\frac{1}{2}$	---	135*	6	Light loam.	50 cart loads manure. Cultivated and hand-hoed twice.	----
84	Early Champion Improved.	"	John Babcock, So. Windham.	8	" 8	Aug. 25	$3 \times 3\frac{1}{2}$	4	70	$5\frac{1}{2}$	Dark loam.	30 cart loads manure. Cultivated and hand-hoed twice.	Cross of Tolland Co. Yellow and Canada Yellow.
85	Yellow Cap.	"	Sherwood Raymond, Norwich.	12	" 25	Sept. 11	$3\frac{1}{2} \times 3\frac{1}{2}$	4	110*	6	----	Stable manure. Fertilizer in hill.	----
86	Flesh Colored.	Red flint.	N. R. Grant, Rockville.	---	" 20	" 10	$3\frac{1}{2} \times 3\frac{1}{2}$	---	68	----	Sandy loam.	30 cords manure. Cultivated and hoed twice.	----
87	Improved Dutton.	Yellow flint.	John Bishop, Cheshire.	12	" 10	" 15	$3\frac{3}{4} \times 3\frac{3}{4}$	3	50	7	Sandy.	6 cords manure, 200 lbs. fertilizer. Cultivated 3 times, hoed once.	----
88	Cross, Red Dent and Beers' Yellow.	Red flint.	N. S. Platt, Cheshire.	---	" 20	" 12	$3\frac{3}{4} \times 3\frac{3}{4}$	---	40	----	Heavy loam.	----	----
89	R. I. White Cap.	White flint.	C. W. Briggs, Lebanon.	5	" 20	Oct. 10	$3 \times 3\frac{1}{2}$	4	50	$7\frac{1}{2}$	Clay loam.	20 cart loads manure, 200 lbs. fertilizer. Cultivated 3 times, hoed twice.	----
90	Asher-Wright Corn.	Yellow flint.*	Edgar D. White, Andover.	25	June 8	Sept. 20	$3 \times 3\frac{1}{2}$	3–5	71	5–6	" "	20 cart loads manure. Cultivated and hoed twice.	----

* Slight indentations.

† Grown on the Doolittle farm, Cheshire, and by Doolittle family for over 100 years.

* Ears.

No.	Weight of Kernel from one ear, grams.	Weight of Cob from one ear, grams.	Ratio of weight of Cob to Kernel.	Weight of one Ear, grams.	Number of rows of Kernels on the Ear.	Analysis. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, Gum, etc.)	Fat.
1	---	--	1: 5.6	---	14–16	10.45	1.40	10.00	1.52	72.30	4.33
2	143	29	4.9	172	8	9.73	1.45	13.06	1.00	69.43	5.33
3	225	46	4.9	272	12–16	9.10	1.30	9.31	1.60	74.50	4.19
4	110	16	6.7	126	8	9.13	1.15	11 06	1.20	72.53	4.93
5	139	25	5.5	164	16–18	10.49	1.38	10.13	1.79	71.91	4.30
6[1]	131	22	5.8	154	8	9.57	1.10	10.25	1.35	72.35	5.38
6[2]	127	20	6.2	147	8	8.76	1.55	11.25	1.15	72.03	5.26
7	189	26	7.1	216	8	9.58	1.51	11.19	1.00	72.11	4.61
8	208	36	5.8	243	8	10.08	1.39	10.00	.88	73.09	4.56
9	99	16	6.4	114	8	12.60	1.41	9.12	.92	71.18	4.77
10	119	22	5.4	141	8	12.12	1.22	10.50	.94	69.60	5.62
11	162	31	5.2	193	8	11.76	1.39	9.81	.96	70.99	5.09
12	201	50	4.0	252	8	12.92	1.33	10.87	1.15	69.07	4.66
13	146	28	5.2	175	8	12.55	1.45	10.62	.85	69.78	4.75
14	247	--	--	---	20	12.62	1.15	8.81	1.22	71.07	5.13
15	254	47	5.5	300	12–14	14.68	1.79	10.06	1.06	68.26	4.15
16	190	40	4.8	230	8	12.98	1.65	10.44	1.11	68.68	5.14
17	187	35	5.4	222	12–14	9.77	1.39	9.31	1.49	73.40	4.64
18	147	34	4.3	186	8	10.80	1.30	10.93	.95	70.90	5.12
19	151	27	5.5	178	8	13.35	1.44	9.81	.95	69.61	4.84
20	135	24	5.6	159	8	12.55	1.46	9.06	.84	71.59	4.50
21	175	42	4.2	217	8–12	11.85	1.64	12.17	1.52	65.55	7.27
22	237	42	5.6	279	14–18	13.30	1.09	10.12	1.27	69.86	4.36
23	197	43	4.5	241	8	11.98	1.47	12.36	1.08	68.33	4.78
24	295	63	4.6	360	8	14.21	1.38	11.34	1 15	67.42	4.50
25	201	30	6.7	231	8	12.28	1.40	10.80	.80	69.68	5.04
26	208	46	4.5	255	8–10	11.32	1.24	9.78	1.02	72.42	4.22
27	251	55	4.6	305	12–16	11.77	1.58	11.53	1.37	69.43	4.32
28	217	44	5.0	261	12	11.15	1.60	10.99	1.68	70 69	3.89
29	313	70	4.5	383	16–22	13.40	1.12	10.75	1.84	68.39	4.50
30	158	36	4.4	194	8	11.43	1.11	9.97	.99	71.73	4.77
31	232	61	3.8	293	8	14.36	1.08	9.42	.98	69.62	4.54
32	172	32	5.4	204	12–16	12.63	1.00	8.94	1.25	72.12	4.06
33	202	52	3.9	254	8	12.05	1.41	9.48	1.38	71.17	4.51
34	172	38	4.5	210	8	11.68	1.10	10.17	1.21	70 88	4.96
35	155	22	7.0	177	8	11.51	1.26	10.26	.98	71.54	4.45
36	164	21	7.8	185	8	11.89	1.24	10.12	.75	71.33	4.67
37	157	34	4.6	191	8	11.16	.91	9.04	1.39	73.15	4.35
38	169	39	4.3	208	8–10	11.90	1.36	11.53	1.33	69.26	4.62
39	196	37	5.3	233	8–9	12.39	1.25	11.49	1.28	69.34	4.25
40	184	35	5.3	219	14	12.80	1.12	10.07	1.41	70.38	4.22
41	215	43	5.0	258	8	12.97	1.33	11.49	1.31	69.11	3.79
42	158	31	5.1	189	8–10	13.24	1.28	10.26	1.14	69.39	4.69
43	121	15	8.0	136	8	12.52	1.18	12.71	1.09	67.63	4.87
44	165	32	5.1	197	12	12.76	1.10	7.58	.91	72.96	4.69
45	151	27	5.6	178	8	12.61	1.22	10.95	1.15	69.57	4.50

No.	Analysis, Calculated Water-free. Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, Gum, etc.)	Fat.	Analysis, Calculated to Water Content of 14 per cent. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, Gum, etc.)	Fat.
1	1.56	11.16	1.70	80.75	4.83	14.00	1.34	9.60	1.16	69.45	4.15
2	1.61	14.47	1.11	76.90	5.91	14.00	1.38	12.44	.95	66.15	5.08
3	1.43	10.24	1.76	81.96	4.61	14.00	1.23	8.81	1.52	70.48	3.96
4	1.26	12.17	1.32	79.83	5.42	14.00	1.08	10.47	1.12	68.67	4.66
5	1.54	11.33	1.99	80.33	4.81	14.00	1.32	9.75	1.71	69.09	4.13
6[1]	1.22	11.34	1.49	80.00	5.95	14.00	1.05	9.76	1.29	68.78	5.12
6[2]	1.70	12.33	1.26	78.95	5.76	14.00	1.46	10.60	1.08	67.91	4.95
7	1.67	12.38	1.11	79.74	5.10	14.00	1.43	10.65	.95	68.58	4.39
8	1.55	11.12	.98	81.28	5.07	14.00	1.33	9.56	.84	69.91	4.36
9	1.61	10.44	1.05	81.44	5.46	14.00	1.38	8.98	.91	70.03	4.70
10	1.39	11.95	1.07	79.20	6.39	14.00	1.19	10.27	.93	68.11	5.50
11	1.58	11.11	1.09	80 45	5.77	14.00	1.36	9.55	.94	69.19	4.96
12	1.53	12.48	1.32	79.34	5.33	14.00	1.31	10.75	1.12	68.24	4.58
13	1.66	12.14	.97	79.80	5.43	14.00	1.42	10.44	.83	68.63	4.68
14	1.32	10.08	1.40	81.33	5.87	14.00	1.12	8.67	1.20	69.97	5.04
15	2.10	11.79	1.24	80.00	4.87	14.00	1.81	10.14	1.06	68.80	4.19
16	1.90	11.99	1.28	78.92	5.91	14.00	1.63	10.31	1.10	67.88	5.08
17	1.54	10.32	1.65	81.35	5.14	14.00	1.32	8.89	1.41	69.95	4.43
18	1.46	12.25	1.06	79.49	5.74	14.00	1.26	10.55	.92	68.34	4.93
19	1.66	11.31	1.10	80.35	5.58	14.00	1.42	9.73	.95	69.10	4.80
20	1.67	10.37	.96	81.86	5.14	14.00	1.43	8.92	.82	70.40	4.43
21	1.86	13.75	1.72	74.45	8.22	14.00	1.60	11.83	1.48	64.03	7.06
22	1.24	11.66	1.45	80.63	5.02	14.00	1.06	10.03	1.25	69.34	4.32
23	1.67	14 04	1.22	77.63	5.44	14.00	1.43	12.07	1.05	66.77	4.68
24	1.61	13.22	1.33	78.59	5.25	14.00	1.38	11.37	1.13	67.60	4.52
25	1.60	12.30	.91	79.44	5.75	14.00	1.37	10.58	.78	68.33	4.94
26	1.39	11.03	1.15	81.67	4.76	14.00	1.19	9.48	.99	70.25	4.09
27	1.79	13.08	1.54	78.71	4.88	14.00	1.55	11.25	1.32	67.68	4.20
28	1.80	12.37	1.89	79.56	4.38	14.00	1.55	10.64	1.62	68.42	3.77
29	1.29	12.41	2.11	78.99	5.20	14.00	1.10	10.67	1.82	67.95	4.47
30	1.25	11.27	1.12	80.99	5.37	14.00	1.07	9.69	.96	69.66	4.62
31	1.27	11.00	1.15	81.32	5.26	14.00	1.09	9.46	.99	69.94	4.52
32	1.14	10.25	1.42	82.55	4.64	14.00	.98	8.82	1.22	70.99	3.99
33	1.60	10.78	1.58	80.91	5.13	14.00	1.37	9.27	1.36	69.59	4.41
34	1.24	11.52	1.36	80.26	5.62	14.00	1.06	9.91	1.16	69.04	4.83
35	1.42	11.59	1.11	80.86	5.02	14.00	1.22	9.97	.95	69.54	4.32
36	1.40	11.48	.85	80.97	5.30	14.00	1.20	9 87	.73	69.64	4.56
37	1.01	10.16	1.57	82.36	4.90	14.00	.87	8.74	1.35	70.83	4.21
38	1.54	13.09	1.50	78 63	5.24	14.00	1.32	11.26	1.29	67.62	4.51
39	1.42	13.11	1.46	79.16	4.85	14.00	1.22	11.27	1.26	68.08	4.17
40	1.28	11.54	1.62	80.72	4.84	14.00	1.10	9.92	1.39	69.43	4.16
41	1.53	13.20	1.50	79.41	4.36	14.00	1.31	11.35	1.29	68.30	3.75
42	1.48	11.84	1.30	79.98	5.40	14.00	1.28	10.18	1.11	68.79	4.64
43	1.34	14.53	1.23	77.33	5.57	14.00	1.14	12.49	1.05	66.53	4.79
44	1.26	8.69	1.03	83.64	5.38	14.00	1.08	7.47	.89	71.94	4.62
45	1.39	12.54	1.30	79.62	5.15	14.00	1.19	10.78	1.11	68.49	4.43

No.	Weight of Kernel from one ear, grams.	Weight of Cob from one ear, grams.	Ratio of weight of Cob to Kernel.	Weight of one Ear, grams.	Number of rows of Kernels in the Ear.	Analysis.						Analysis, Calculated Water-free.					Analysis, Calculated to Water Content of 14 per cent.					
						Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, Gum, etc.)	Fat.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, Gum, etc.)	Fat.	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, Gum, etc.)	Fat.
46	120	17	1 : 7.0	137	8	13.51	1.36	11.97	1.14	67.18	4.84	1.56	13.86	1.31	77.68	5.59	14.00	1.34	11.92	1.12	66.81	4.81
47	170	31	5.5	201	8–10	11.69	1.20	10.70	.90	70.46	5.05	1.36	12.13	1.02	79.78	5.71	14.00	1.16	10.43	.88	68.62	4.91
48	191	28	6.8	219	12–18	12.53	1.22	10.26	1.40	70.82	3.77	1.39	11.75	1.60	80.98	4.28	14.00	1.19	10.10	1.37	69.66	3.68
49	246	30	8.2	276	16	12.04	1.09	9.73	1.25	71.05	4.84	1.23	11.06	1.41	80.80	5.50	14.00	1.05	9.51	1.21	69.50	4.73
50	123	24	5.1	147	8	12.45	1.01	9.22	.80	71.31	5.21	1.15	10.42	.92	81.56	5.95	14.00	.99	8.96	.79	70.15	5.12
51	221	46	4.8	267	10–14	14.08	1.20	9.63	1.10	69.62	4.37	1.40	11.21	1.28	81.02	5.09	14.00	1.20	9.64	1.10	69.68	4.38
52	223	45	5.0	268	8	12.46	1.10	10.84	.86	69.70	5.04	1.26	12.39	.98	79.62	5.75	14.00	1.08	10.65	.84	68.48	4.95
53	264	53	5.0	317	14–16	11.19	1.20	9.27	1.21	72.38	4.75	1.35	10.43	1.36	81.51	5.35	14.00	1.15	8.97	1.16	70.12	4.60
54	208	48	4.3	256	12–14	14.23	1.35	10.80	1.20	67.84	4.58	1.57	12.59	1.40	79.10	5.34	14.00	1.35	10.83	1.20	68.03	4.59
55	227	42	5.4	269	8	15.39	1.25	9.37	.92	68.42	4.65	1.47	11.08	1.09	80.87	5.49	14.00	1.27	9.53	.94	69.54	4.72
56	242	48	5.0	290	12–20	13.69	1.19	9.09	1.65	70.25	4.13	1.38	10.52	1.90	81.42	4.78	14.00	1.18	9.05	1.63	70.03	4.11
57	105	22	4.8	127	8	12.70	1.27	9.63	1.63	69.70	5.07	1.46	11.03	1.86	79.86	5.79	14.00	1.26	9.48	1.60	68.68	4.98
58	137	18	7.6	155	--	12.37	1.33	11.64	.86	68.58	5.22	1.51	13.28	.98	78.28	5.95	14.00	1.30	11.42	.84	67.32	5.12
59	122	21	5.8	143	8	12.98	1.26	10.45	.86	69.69	4.76	1.45	12.00	.98	80.11	5.46	14.00	1.25	10.32	.84	68.70	4.69
60	182	29	6.3	211	--	13.67	1.23	10.75	1.09	68.93	4.33	1.42	12.44	1.25	79.88	5.01	14.00	1.22	10.70	1.07	68.71	4.30
61	136	23	5.9	159	8	13.84	1.17	11.29	.98	67.80	4.92	1.36	13.09	1.14	78.71	5.70	14.00	1.16	11.26	.98	67.70	4.90
62	156	40	3.9	196	8–10	12.33	1.39	10.99	1.44	70.16	3.69	1.58	12.53	1.63	80.05	4.21	14.00	1.36	10.77	1.40	68.85	3.62
63	183	23	8.0	206	14–20	11.88	1.13	9.73	1.37	72.09	3.80	1.28	11.05	1.55	81.81	4.31	14.00	1.10	9.50	1.33	70.36	3.71
64	192	35	5.5	227	14–20	12.63	1.40	8.84	1.30	73.08	2.75	1.60	10.11	1.48	83.66	3.15	14.00	1.37	8.69	1.28	71.95	2.71
65	199	34	5.9	233	8	11.31	1.10	10.60	.83	71.49	4.67	1.24	11.95	.93	80.63	5.25	14.00	1.06	10.28	.80	69.35	4.51
66	278	39	7.1	317	12–16	14.48	1.23	8.79	.95	70.27	4.28	1.43	10.27	1.12	82.17	5.01	14.00	1.23	8.84	.96	70.67	4.30
67	192	47	4.1	239	10	12.67	1.20	9.22	1.39	72.42	3.10	1.37	10.56	1.60	82.92	3.55	14.00	1.17	9.08	1.37	71.33	3.05
68	223	50	4.5	273	8	14.38	1.28	10.02	.72	69.63	3.97	1.50	11.70	.84	81.32	4.64	14.00	1.29	10.06	.72	69.94	3.99
69	175	45	3.9	220	8	11.33	1.34	10.17	.94	71.85	4.37	1.50	11.46	1.06	81.05	4.93	14.00	1.29	9.85	.92	69.70	4.24
70	164	38	4.3	202	8	11.64	1.16	10.99	.92	70.06	5.23	1.30	12.43	1.16	79.26	5.85	14.00	1.11	10.69	1.00	68.17	5.03
71	158	29	5.4	187	8	16.66	1.11	7.82	1.15	68.76	4.50	1.33	9.38	1.37	82.52	5.40	14.00	1.13	8.07	1.17	70.99	4.64
72	161	35	4.6	196	8	14.66	1.13	9.88	1.03	68.98	4.32	1.32	11.59	1.20	80.83	5.06	14.00	1.12	9.97	1.03	69.57	4.35
73	204	31	6.6	235	8	13.52	1.15	11.49	1.15	68.19	4.50	1.32	13.29	1.32	78.87	5.20	14.00	1.12	11.43	1.12	67.86	4.47
74	189	33	5.7	222	12	12.12	1.07	10.76	.80	70.00	5.25	1.22	12.24	.91	79.66	5.97	14.00	1.06	10.52	.78	68.51	5.13
75	178	36	4.9	214	10–12	12.50	1.10	10.35	1.00	70.91	4.14	1.26	11.83	1.14	81.04	4.73	14.00	1.10	10.17	.99	69.67	4.07
76	92	15	6.1	107	8	12.42	1.05	8.10	1.32	72.54	4.57	1.20	9.25	1.51	82.82	5.22	14.00	1.04	7.96	1.30	71.21	4.49
77	206	31	6.6	237	12	12.46	.89	7.28	1.37	73.83	4.17	.98	8.33	1.56	84.37	4.76	14.00	.84	7.16	1.35	72.56	4.09
78	128	27	4.7	155	12	12.43	.80	10.00	1.02	70.67	5.08	.91	11.41	1.17	80.71	5.80	14.00	.78	9.80	1.02	69.41	4.99
79	222	45	5.0	267	8–10	12.97	.90	7.69	1.25	72.78	4.41	1.04	8.82	1.44	83.63	5.07	14.00	.90	7.59	1.25	71.90	4.36
80	168	29	5.8	197	8	12.57	.93	10.00	.80	71.54	4.16	1.06	11.44	.91	81.83	4.76	14.00	.92	9.83	.78	70.38	4.09
81	127	18	7.0	145	8	12.18	1.12	11.43	.85	70.19	4.23	1.28	13.02	.97	79.91	4.82	14.00	1.10	11.19	.83	68.74	4.14
82	247	46	5.4	293	8	12.60	1.07	10.25	.97	70.24	4.87	1.22	11.72	1.11	80.38	5.57	14.00	1.06	10.08	.96	69.11	4.79
83	125	32	3.9	157	8	12.69	.97	11.02	1.02	69.30	5.00	1.11	12.62	1.17	79.37	5.73	14.00	.96	10.86	1.01	68.24	4.93
84	110	23	4.8	133	8	12.72	.95	9.84	1.17	70.86	4.46	1.09	11.32	1.34	81.14	5.11	14.00	.94	9.74	1.16	69.76	4.40
85	152	29	5.2	181	8	12.34	.94	11.53	.90	69.67	4.62	1.07	13.14	1.03	79.49	5.27	14.00	.92	11.30	.89	68.36	4.53
86	133	22	6.0	155	8	12.51	1.26	10.66	.85	69.57	5.15	1.44	12.19	.97	79.51	5.81	14.00	1.25	10.49	.83	68.37	5.06
87	169	48	3.5	217	12	12.77	1.02	9.12	.95	71.14	5.00	1.16	10.46	1.05	81.61	5.72	14.00	1.01	9.00	.91	70.16	4.92
88	159	23	6.9	181	8–10	12.78	1.00	7.69	.82	72.97	4.74	1.15	8.79	.91	83.72	5.43	14.00	1.00	7.56	.78	71.98	4.68
89	136	25	5.4	161	8	12.34	.95	11.69	1.00	70.12	3.90	1.08	13.33	1.14	80.01	4.44	14.00	.93	11.47	.99	68.79	3.82
90	111	17	6.5	128	8	12.27	.88	11.28	.91	70.50	4.16	1.00	12.86	1.05	80.35	4.74	14.00	.86	11.06	.91	69.10	4.07

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