STATE OF CONNECTICUT.

ANNUAL REPORT

OF

The Connecticut Agricultural

EXPERIMENT STATION

For 1890.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
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1891.

OFFICERS AND STAFF FOR 1890.

STATE BOARD OF CONTROL.

Ex-officio.

HIS EXC. MORGAN G. BULKELEY, *President*.

	Term expires
Appointed by Connecticut State Agricultural Society:	
HON. E. H. HYDE, Stafford, *Vice-President*.	July 1, 1891.
Appointed by Board of Trustees of Wesleyan University:	
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Appointed by Governor and Senate:	
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H. L. DUDLEY, New London.	1893.

EXECUTIVE COMMITTEE.

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T. S. GOLD, West Cornwall.	1892.
Appointed by Governing Board of Sheffield Scientific School:	
W. H. BREWER, New Haven, *Secretary and Treas.*	1893.
Ex-officio.	
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Chemists.

E. H. JENKINS, PH.D., *Vice-Director*.
A. L. WINTON, JR., PH.B.
T. B. OSBORNE, PH.D.
R. S. CURTISS, PH.B.*
A. W. OGDEN, PH.B.†

Mycologist.

ROLAND THAXTER, PH.D.

Stenographer and Clerk.

MISS F. M. BIGELOW.

In charge of Buildings and Grounds.

CHARLES J. RICE.

Laboratory Helper.

HUGO LANGE.

* Till Oct. 1st. † From Oct. 1st.

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, useful or injurious insects, moulds, blights, mildews, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

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 use of individuals will be charged for at moderate rates. The Station will undertake 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 general interest will be published in Bulletins, of which copies are sent to each Post Office in this State, and to every citizen of the State who applies for them. These results will be 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*, and all communications should be directed, *not to any individual officer*, but 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 the Whitney ave. Horse 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.

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REPORT OF THE BOARD OF CONTROL.

To His Excellency, Morgan G. Bulkeley, Governor of Connecticut:—

The Board of Control of the CONNECTICUT AGRICULTURAL EXPERIMENT STATION respectfully submits its Annual Report for the year ending November first, 1890:

As required by the act concerning Commercial Fertilizers the Station has made and published one or more analyses of all brands offered for sale in the State so far as it has been able to obtain them. The Station employed special deputies during April and May last who visited 84 towns and a considerably larger number of villages in all parts of the State and drew from stock in the hands of dealers 468 samples of fertilizers. One hundred and forty-six distinct brands of fertilizers are known to be on sale but the analyses of manures and manurial waste products, etc., has increased the total number of fertilizer-analyses to 310.

The examinations of suspected butter, molasses and vinegar desired by the Dairy Commissioner, while not obligatory on the Station have yet been made gratuitously whenever called for and expert testimony has been furnished in court whenever required. Thirty-one samples of molasses, 12 of maple syrup, 33 of vinegar and 15 of butter or oleomargarin have thus been examined within the year.

Thirteen other samples of butter and 106 samples of milk have also been examined, chiefly for dairy farmers or for creameries, to test the milk of herds or to discover suspected watering or skimming.

Some 45 or 50 samples of feeding stuffs have been analyzed or are now being analyzed, a part of them at the request of stock-feeders who are using bought feed, and a part in connection with the field experiments of the Station.

As usual a very considerable amount of time has been spent in the testing of analytical methods, particularly those for the determination of phosphoric acid in fertilizers and for the rapid estimation of fat in milk.

The nature and composition of the albuminoids or proteids of oats have been the subject of extended study by Dr. Osborne, who has also worked upon the proteids of maize, under the advice of Professor R. H. Chittenden, in the Sheffield biological laboratory of Yale University.

The following field experiments have been carried out this year under the superintendence of Dr. Jenkins, Vice-Director.

1. An experiment coöperative with a number of other Stations "to study the composition of corn grown in different localities and to determine the influence of climatic conditions on varieties of corn native to one latitude when moved to a higher or lower latitude."

2. An experiment on the relative yield and chemical composition of corn planted in hills and in drills.

3. An experiment on the continuous growth of corn year after year on the same land, fertilized *a.*) with farm manure, *b.*) with commercial fertilizers.

4. A continuous experiment to test the relative yearly yield of potatoes from seed of different size, when the selection of seed is practiced for a course of years.

5. A special nitrogen experiment with potatoes.

6. An experiment on the relative value of certain raw phosphates and superphosphate.

In connection with investigations regarding grasses, 18 samples of orchard grass seed collected in the markets of the State, as well as in New York and Boston, have been tested with regard to their purity and vitality.

Mr. J. B. Olcott has had charge of the Forage Garden on the Station Grounds and also, in coöperation with the Station, has established on his farm in South Manchester a more extensive plantation of valuable or promising grasses for the purpose of obtaining pure seed and especially of observing for a series of years the characters of varieties of common species which he has gathered and intends gathering from various localities in this and other States, territories and countries.

During the past year Dr. Thaxter, Mycologist to the Station, has continued the study of fungus diseases of plants, with field experiments for the prevention of certain of them affecting the onion, quince, grape, etc. The special subject of the season has been the disease known as potato scab. By means of artificial cultivation and inoculations, the cause of this disease as it occurs in Connecticut has been shown to be a peculiar fungus. The subject is still undergoing investigation.

Four bulletins containing 45 octavo pages have been issued during the year and mailed to each newspaper, postmaster, and secretary of a farmer's organization and to more than 6500 citizens of the State.

Ten weekly statements have likewise been issued to bring the results of laboratory work more promptly before farmers. These are sent to leading agricultural papers and to each secretary of a farmers' organization.

For a detailed account of the work of the Station reference must be had to the Report of the Director now in preparation.

The accompanying Report of the Treasurer exhibits the financial affairs of the Station for the fiscal year which ended June 30, 1890.

All of which is respectfully submitted.

WILLIAM H. BREWER, *Secretary.*

New Haven, Conn., October 31, 1890.

REPORT OF THE TREASURER.

Wm. H. Brewer, *in account with the Connecticut Agricultural Experiment Station for the fiscal year ending June 30th, 1890.*

Receipts.

From the State Comptroller	$8,000.00	
From the U. S. Treasurer	7,500.00	
Analysis Fees due from previous fiscal year, collected this year	260.00	
Analysis Fees of the fiscal year	3,961.50	
Miscellaneous Receipts	47.03	
		$19,768.53

Expenditures.

	State Account.	United States Account.	Total.
Salaries	$5,130.00	$6,465.00	$11,595.00
General Laboratory expenses	1,126.83		1,126.83
Mycological expenses		122.77	122.77
Grass and Forage Investigation	580.06		580.06
Field Experiments		441.56	441.56
Gas	254.55		254.55
Water	147.00		147.00
Coal	547.00		547.00
The Establishment, Repairs, Grounds, etc.	565.74		565.74
Improvements, other than ordinary Repairs	2,093.88		2,093.88
Finishing Mycological Laboratory		284.13	284.13
Telephone	96.83		96.83
Printing	636.74	186.54	823.28
Postage	92.46		92.46
Stationery	179.47		179.47
Library	260.65		260.65
Traveling expenses of the Board of Control	20.36		20.36
Collecting Fertilizers	319.74		319.74
Unclassified Sundries	217.22		217.22
	$12,268.53	$7,500.00	$19,768.53

Memorandum.

The year's accounts were audited September 19, 1890, by the Auditors of the State Public Accounts.

The Analysis Fees of certain fertilizers believed to have been on sale in the State since May 1st and subject to the law concerning the sale of fertilizers, if hereafter collected will go to the new account.

WILLIAM H. BREWER, *Treasurer.*

REPORT OF THE DIRECTOR.

On the following pages is a full report of the work done by this Station during the year in the analysis of fertilizers, with a review of the market quotations of fertilizer chemicals and manurial waste products for the year.

The investigations in the botanical laboratory and the field observations and experiments of the mycologist are reported by Dr. Thaxter.

A paper by Dr. Osborne gives in full the method and results of his work on the proteids of the oat kernel.

Most of the analyses of feeding stuffs made during the year are discussed and also the results of a field experiment on the effects of growing maize in hills and drills.

These papers cover more than 200 pages, the limit prescribed by State law, and the expense for the additional printing is borne by the Station. There still remains a considerable amount of material which cannot be printed for lack of space. This includes the report of the examinations of seeds, analyses of potatoes, work done for the Dairy Commissioner and a coöperative experiment on the composition of corn grown in different localities.

The discussion of the experiments with potatoes it is deemed best to defer till further results have been obtained.

THE CONNECTICUT FERTILIZER LAW.

The General Assembly at its session in 1882 passed a Fertilizer Law which went into effect September 1, 1882, and which repealed and took the place of all previous legislation on this subject. The law is still in force without any amendment.

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

1. In case of fertilizers that retail at ten dollars or more per 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 1 and 3.

The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, viz: Nitrogen, Phosphoric acid and Potash. The analysis-fees in case of any fertilizer will therefore 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 case of any fertilizer selling at ten dollars or more per ton, 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.

A statement of the per cents. 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 4.

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 9 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 9, 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.

OBSERVANCE OF THE FERTILIZER LAW.

MANUFACTURERS who have paid the Analysis Fees as required by the Law, and Fertilizers for which fees have been thus paid for the year ending May, 1891.

Firm.	*Brand of Fertilizer.*
Apothecaries Hall Co., Waterbury, Conn.	Victor Phosphate.
Baker, H. J. & Bro., 215 Pearl St., N. Y.	Pure Ground Bone. A. A. Ammoniated Superphosphate. Potato Fertilizer. Corn Fertilizer. Castor Pomace.
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Kainit. Pure Dry Fish. Stockbridge Tobacco Manure. " Corn and Grain Manure. " Forage Crop Manure. " Vegetable manure. " Fruit Manure. Bowker's Hill and Drill Phosphate. " Fish and Potash. " Ammoniated Dissolved Bone. " Fresh Ground Bone.
Bradley Fertilizer Co., 27 Kilby Street, Boston, Mass.	Bradley's Superphosphate. " Potato Manure. " Complete Manure for Potatoes and Vegetables. " for Top Dressing Grass and Grain. " for Corn and Grass. " Pure Fine Ground Bone. " Circle Brand Ground Bone with 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.
Church, Joseph & Co., Tiverton, R. I.	Fish and Potash. Dry Ground Fish.
Coe, E. Frank, 16 Burling Slip, N. Y.	High Grade Ammoniated Bone Superphosphate. Red Brand Excelsior Guano. Gold Brand Excelsior Guano. Potato Fertilizer. Alkaline Bone. Ground Bone. Fish and Potash.

Firm.	Brand of Fertilizer.
Coe, Russell, Meriden, Conn.	Superphosphate.
Collier White Lead and Oil Co., St. Louis, by F. Ellsworth, Hartford.	Collier Castor Pomace.
Cooper's, Peter, Glue Factory, 17 Burling Slip, N. Y.	Pure Bone Dust.
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	New Rival Ammoniated Superphosphate. Buffalo Superphosphate No. 2. Special Potato Manure. Pure Ground Bone. Ammoniated Bone Superphosphate. Potato, Hop and Tobacco Phosphate. Queen City Phosphate. Vegetable Bone Superphosphate. Ammoniated Wheat and Corn Phosphate.
Cumberland Bone Co., Portland, Maine.	Cumberland Superphosphate. Seeding Down Fertilizer.
Darling, L. B. Fertilizer Co., Pawtucket, R. I.	Animal Fertilizer. Extra Bone Phosphate. Pure Ground Bone.
Davidge Fertilizer Co., 121 Front St., N. Y.	Davidge's Special Favorite. " Potato Manure. " Vegetator.
Downs & Griffin, Birmingham, Conn.	Ground Bone.
Fall, E. B., Middletown, Conn.	Ground Bone.
Farmers' Fertilizer Co., 230 W. Water St., Syracuse, N. Y.	Standard Special Formula. Fish and Potash.
Great Eastern Fertilizer Co., Rutland, Vt.	Great Eastern General Phosphate for Oats, Buckwheat and Seeding Down. Great Eastern General Fertilizer for Grass and Grain. Great Eastern Vegetable, Vine and Tobacco Fertilizer.
Kelsey, E. R., Branford, Conn.	Fish and Potash.
Lister's Agricultural Chemical Works, Newark, N. J.	Standard Superphosphate of Lime. Ammoniated Dissolved Bone. Celebrated Ground Bone.
Ludlam Frederick, 140 Maiden Lane, N. Y.	Ludlam's Cereal Fertilizer. " Cecrops Fertilizer.
Mapes Formula & Peruvian Guano Co., 158 Front St., N. Y.	Potato Manure. Complete Manure for Light Soils. " " for General Use. " " "A" Brand. Tobacco Manure, Connecticut Brand. " " Wrapper Brand. Fruit and Vine Manure.

Firm.	Brand of Fertilizer.
Mapes Formula & Peruvian Guano Co., 158 Front St., N. Y.	Peruvian Guano. Corn Manure. Fine Dissolved Bone. Seeding Down Manure. Grass and Grain Spring Top Dressing.
Miller, G. W., Middlefield, Conn.	Flour of Bone Phosphate. Pure Ground Bone.
Miller, H. S. & Co., Newark, N. J.	Harvest Queen Phosphate. Bone Meal. Special Potato Manure. Standard Superphosphate. Corn Fertilizer. Ammoniated Dissolved Bone.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's Complete Fertilizer. " Ammoniated Bone Phosphate. " Fish and Potash. " Ground Bone.
Olds & Whipple, Hartford, Conn.	Olds & Whipple's Special Phosphate.
Peck Brothers, Northfield, Conn.	Pure Ground Bone.
Plumb & Winton, Bridgeport, Conn.	Bone Fertilizer.
Quinnipiac Co., 83 Fulton St., N. Y.	Quinnipiac Phosphate. " Pine Island Phosphate. " Potato Manure. Market Garden Manure. Fish and Potash, Crossed Fishes Brand. Fish and Potash, Plain Brand. Dry Ground Fish. Bone Meal.
Read Fertilizer Co., Box 3121, New York City.	Farmers' Friend Fertilizer. Lion Brand Fertilizer. High Grade Farmers' Friend. Bone, Fish and Potash.
Red Seal Castor Oil Co., St. Louis, Mo., by Olds & Whipple, Hartford.	Red Seal Castor Pomace.
Reese, J. S. & Co., New Bedford, Mass.	Bay State Fertilizer. Great Planet "A" Fertilizer. Reese's Concentrated Potato and Corn Manure. Reese's Concentrated Tobacco and Cabbage Manure. Reese's New England Favorite. Pilgrim Fertilizer. King Philip Alkaline Bone Superphosphate.
Rogers & Hubbard Co., Middletown, Conn.	Pure Raw Knuckle Bone Flour. Pure Ground AX Bone. Soluble Potato Manure. Fairchild's Corn Formula. " Seeding Down Formula.

Firm.	*Brand of Fertilizer.*
Sanderson, L., Long Wharf, New Haven, Conn.	Formula A. Sulphate of Ammonia. Dried Blood. Nitrate of Soda. Blood, Bone and Meat. Dissolved Bone Black. Muriate of Potash. Sulphate of Potash. Fine Ground Bone.
Shoemaker & Co., M. L., Philadelphia, by F. Ellsworth, Hartford.	Swift-Sure Superphosphate. Swift-Sure Bone Meal.
Stearns Fertilizer Co., 133 Water St., N. Y.	Ammoniated Bone Superphosphate. Potato Grower.
Stewart, W. D. & Co., 8 Congress St., Boston, Mass.	Soluble Pacific Guano. Pacific Fish and Potash.
Wilcox, Leander, Mystic Bridge, Conn.	Wilcox's Acidulated Fish Guano. " Dry Ground Fish Guano.
Wilkinson & Co., 54 Williams St., N. Y.	Economical Bone Fertilizer.
Williams & Clark Fertilizer Co., 81 Fulton St., N. Y.	Americus High Grade Special for Tobacco, &c. Potato Phosphate. Americus Ammoniated Bone Phosphate. Americus Pure Bone Meal. Royal Bone Phosphate.

ANALYSES OF FERTILIZERS.*

During 1890, 314 samples of fertilizers have been analyzed. Of these, a small number were examined for private parties and for testing methods in connection with other Experiment Stations, and the remainder for the general use of the citizens of the State.

During April and May last Messrs. F. R. Curtiss of Stratford and Dennis Fenn of Milford, agents of this Station, collected samples of Commercial Fertilizers in all parts of Connecticut.

Eighty-four towns and a considerable number of villages have been visited, distributed as follows:

Hartford Co.	17
Tolland Co.	7
Windham Co.	15
New London Co.	5
Middlesex Co.	11
New Haven Co.	10
Fairfield Co.	12
Litchfield Co.	7
	84

These gentlemen drew about 468 samples, using the method of sampling which is described on page 91 of the Report of this Station for 1884.

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.

* The matter of this and several subsequent pages, explanatory of the sampling and valuation of fertilizers, is copied, with a few alterations, from the Report for 1887. This repetition appears to be necessary for the use of readers who have not seen former Reports.

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 fertilizing element.

Free Nitrogen is indeed universally abundant in the common air, but in this form its effects in nourishing vegetation are as yet obscure.

Organic Nitrogen is the nitrogen of animal and 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 "super-phosphates," 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.

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. "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 envelops 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 freely taken up by crops.

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

THE TRADE-VALUES FOR 1890 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	14½
Organic nitrogen in dry and fine ground fish, meat and blood	17
in cotton seed meal and castor pomace	15
in fine bone and tankage	16½
in fine medium bone and tankage	13
in medium bone and tankage	10½
in coarser bone and tankage	8½
in hair, horn shavings and coarse fish scrap	8
Phosphoric acid, soluble in water	8
in ammonium citrate*	7½
in dry ground fish, fine bone and tankage	7
in fine medium bone and tankage	6
in medium bone and tankage	5
in coarser bone and tankage	4
in fine ground rock phosphate	2
Potash as high-grade Sulphate and in forms free from Muriate (or Chlorides)	6
as kainit	4½
as muriate	4½

These Trade-values were agreed upon by the Experiment stations of Massachusetts, New Jersey, and Connecticut, for use in their respective States during 1890. 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 Superhosphate,
Azotin,	Dry Ground Fish,
Ammonite,	Bone and Tankage,

Ground So. Carolina Rock.

* 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.

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 3 cents, unless found to be from rock phosphate. In this latter form Insoluble Phosphoric Acid costs but 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, then this excess of Potash is reckoned at 6 cents per pound.

In most cases the valuation of the Ingredients in Superhosphates 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. These 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 1890 the average selling price of Ammoniated Superphosphates, and Guanos was $33.80, the average valuation was $28.57, and the difference $5.23—an advance of 18.3 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 $39.18, the average valuation $32.90, and the difference $6.28, or 19.0 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 at the beginning of a year should be adhered to as nearly as possibly 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 benefit 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.

The fertilizers and manurial waste products analyzed at the Station laboratory from November 1st, 1889, to November 1st, 1890, were as follows:

RAW MATERIALS COMMONLY USED IN MIXED FERTILIZERS.

1. *Containing Nitrogen as the Chief Valuable Ingredient.*

Nitrate of Soda	2
Sulphate of Ammonia	1
Dried Blood	1
Cotton Seed Meal	7
Castor Pomace	5
Hoof Meal	1

2. *Containing Phosphoric Acid as the Chief Valuable Ingredient.*

Thomas-Slag	1
Precipitated Phosphate	1
Dissolved Bone Black	1
Rock Phosphate	13

3. *Containing Potash as the Chief Valuable Ingredient.*

Double Sulphate of Potash and Magnesia	2
Muriate of Potash	1
Kainit	1

4. *Containing Nitrogen and Phosphoric Acid.*

Bone Manures	28
Bone and Potash	1
Tankage	8

MIXED FERTILIZERS.

Nitrogenous Superphosphates and Guanos	105
Special Manures	45
Home-mixed Fertilizers	9

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes	26
Unleached Wood Ashes	10
Lime-kiln Ashes	1
Limestone	2
Wool Waste	1
Tank Water and Settlings	3
Plaster	2
Yard Manure	2
Rockweed and Sponge	5
Total	314

These analyses are discussed in the order above given on the following pages.—In all cases where the contrary is not stated, the samples were drawn by agents of the Station. The regular retail prices are in all cases given. By special terms with the dealer in many cases the actual cash prices paid have been less than those here stated.

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.

2690. Sold by L. Sanderson, New Haven.

ANALYSIS.

Water	1.86
Salt	.54
Sulphate of Soda	.22
Matters insoluble in water	.08
* Pure nitrate of soda	97.30
	100.00
* Containing nitrogen	16.06
Cost per ton	$50.00
Nitrogen costs per pound in cents	**15.6**

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.

2691. Sold by L. Sanderson, New Haven.

ANALYSIS.

Nitrogen	20.86
Equivalent ammonia	25.3
Cost per ton	$75.00
Nitrogen costs per pound in cents	18.

DRIED BLOOD.

2721. A single sample of this material drawn from stock of L. Sanderson by a Station agent contained 12.90 per cent. of nitrogen. The price charged was $40.00 per ton.

Nitrogen costs per pound 15.5 cents.

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.

2658. "Off Color," unfit for cattle food. Stock of Olds & Whipple. Not sampled by Station agent.

2723. From stock of L. Sanderson, New Haven.

2758. "Off Color," from stock of C. L. Spencer, Suffield. Not sampled by Station agent.

2864. From stock bought by F. Culver, West Suffield. Sampled by F. C. Root.

2973. From stock bought and sampled by W. C. Newton, Durham, from Coles & Weeks, Middletown.

2980. From stock bought and sampled by Meech & Stoddard, Middletown. From Butler, Breed & Co. of Boston. This sample is undecorticated, which explains the low per cent. of nitrogen. It will be referred to more particularly in the discussion of feeding stuffs.

ANALYSES.

	2658	2723	2758	2864	2973	2980
Nitrogen	6.44	6.89	6.74	7.42	5.63	3.67
Phosphoric Acid	3.34	3.12	3.22	3.10	3.27	1.60
Potash	1.96	2.22	2.16	1.62	1.80	1.45
Cost per ton	$22.00	$26.00	$23.00	$25.00	$27.00	....
Nitrogen costs per pound in cents,*	11.7	13.8	11.9	12.6	18.0	- --

* Allowing 7c. and 6c. per pound respectively for phosphoric acid and potash.

Special attention is called to the last two analyses.

2973 is adulterated with rice meal which is harmless but reduces the value of the meal, either as a feed or fertilizer, by four or five dollars a ton. The color of the meal is rather lighter than pure meal, but the adulteration is not likely to be detected without microscopic or chemical examination.

Messrs. Coles & Weeks, from whom it was bought, state that they purchased it through a New York agent, and as a long time elapsed between the purchase and the sending to the Station for analysis the manufacturer of the fraud could not be traced. Messrs. Coles & Weeks expressed surprise at the result, as they had always ordered the best, and offered to make good the loss to the purchaser. Samples which are to be sent to the Station for analysis should be sent *at once.*

Cotton seed meal, of good quality, such as is used for cattle food, is one of the cheapest sources of available nitrogen in our fertilizer market, and that which is "off color" supplies nitrogen at even lower prices; in Nos. **2658** and **2758** for less than 12 cents per pound.

CASTOR POMACE.

The ground residue of castor beans from which castor oil has been extracted.

2714. Made by Occidental Oil Co., N. Y. Sold by L. Sanderson, New Haven. Sampled by E. F. Thompson, Warehouse Point.

2655. Made by Occidental Oil Co., N. Y. Sold by L. Sanderson, New Haven. Sampled by John Mason at Warehouse Point.

2656. Made by Collier Lead & Oil Co., St. Louis. Sold by F. Ellsworth, Hartford.

2932. Made by H. J. Baker & Bro., N. Y. Sold by W. F. Andross, East Hartford.

2933. Made by Red Seal Castor Oil Co., St. Louis, Mo. Sold by Olds & Whipple, Hartford.

ANALYSES.

	2714	2655	2656	2932	2933
Nitrogen	4.70	4.93	5.65	5.08	5.47
Phosphoric acid	1.55	1.62	2.11	1.83	2.41
Potash	1.24	1.11	1.05	1.11	1.16
Cost per ton	$19.00	$19.00	$23.00	$21.00	$23.00
Nitrogen costs per pound in cents,*	16.3	15.6	16.6	16.8	16.7

*Allowing 7c. and 6c. per pound respectively for phosphoric acid and potash.

The Castor Pomace furnished by the Occidental Oil Co. is exceptionally low in nitrogen [4.70–4.93 per cent.], but at $19.00 per ton, nitrogen costs no more than in the other brands sold at $23.00 per ton.

HOOF MEAL.

2805. A sample of this material, purchased in Chicago for field experiments, contained 13.90 per cent. of nitrogen.

II. RAW MATERIALS OF HIGH GRADE CONTAINING PHOSPHORIC ACID.

THOMAS-SLAG.

2730. Purchased by Lawrence Doyle, Harwinton, from P. Weidinger, 76 Pine St., N. Y., for $16.00 per ton, f. o. b. N. Y. Sampled by Mr. Doyle. The Slag contained 19.76 per cent. of phosphoric acid.

The phosphoric acid therefore costs 4 cents per pound.

DISSOLVED BONE BLACK.

A superphosphate prepared by treating bone black with oil of vitriol which renders nearly all of the phosphoric acid soluble in water.

2688. A single sample from stock of L. Sanderson, New Haven, had the following composition :—

ANALYSIS.

Soluble phosphoric acid	16.99
Reverted "	.13
Insoluble "	None
Cost per ton	$26.00
Available phosphoric acid costs per pound in cents	7.6

PRECIPITATED PHOSPHATE.

2669. Made by the Cartaret Chemical Co., 115 Broadway, N. Y. Sampled and sent by the manufacturers.

ANALYSIS.

Soluble phosphoric acid	2.32
Reverted	28.52
Insoluble	6.53
Cost per ton	$33.63*
Available phosphoric acid costs per pound in cents	5.4

* Wholesale.

This waste product from the glue manufacture is a white powder, fine and dry, and contains a large per cent. of phosphoric acid which has been precipitated from solution by the addition of lime. It is sold on analysis, wholesale, at "90 cents per unit of phosphoric acid." A "unit" in the trade is 1 per cent. or 20 pounds per ton. As the sample contains 37.37 per cent. or "units" of phosphoric acid, the ton price would be 37.37×.90= $33.63 at Newark, N. J., f. o. b.

Precipitated phosphate of lime is readily assimilable by vegetation and in many cases has proved quite as efficient as water-soluble phosphates and is considerably cheaper.

III. RAW MATERIALS OF HIGH GRADE CONTAINING POTASH.

DOUBLE SULPHATE OF POTASH AND MAGNESIA AND MURIATE OF POTASH.

The first named material is usually sold as "sulphate of potash" or "manure salt," on a guarantee of "48–50 per cent. sulphate," which is equivalent to 25.9–27 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.

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.

2687. Sulphate of Potash. **2689.** Muriate of Potash; both from stock of L. Sanderson, sampled by Station agent.

Analyses.

	2687	2689
Potash	25.76	51.12
Cost per ton	$30.00	$42.50
Potash costs per pound in cents	5.8	4.2

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 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 in order 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 nitrogen 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 pages 29 to 31 will be found tabulated analyses belonging to this class. Excluding **2934** and **2931,** which are mixtures of bone and potash, and **2928,** which is a mixture of bone and salt cake, the average cost of the other 19 samples of bone has been $33.00 and the average valuation $37.77. The values used by the Station in the valuation of bone this year have been, therefore, too high by about 10 per cent.

Bone Manures.—Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost per ton.
2720	Pure Ground Bone.	----------	L. Sanderson, New Haven.	$33.00
2924	Pure Bone Meal.	Peter Cooper's Glue Factory, N. Y.	Wilson & Burr, Middletown.	28.00
2811	Bone Fertilizer.	Plumb & Winton, Bridgeport, Conn.	Manufacturers.	30.00
2934	Self-Recommending Fertilizer.	F. Nuhn, Waterbury, Conn.	City Coal & Wood Co., New Britain.	33.00
2962	Pure Ground Bone.	Peck Bros., Northfield, Conn.	Manufacturers.	28.00
3004	Swift Sure Bone Meal.	M. L. Shoemaker & Co., Philadelphia, Pa.	F. Ellsworth, Hartford.	40.00
			J. P. Barstow & Co., Norwich.	38.00
			F. S. Bidwell, Windsor Locks.	32.00
2681	Pure Ground AX Bone.	Rogers & Hubbard Co., Middletown.	Manufacturer.	32.00
2683	Raw Knuckle Bone Flour.	Rogers & Hubbard Co., Middletown.	Manufacturer.	37.00
2918	Ground Bone.	Quinnipiac Co., New London.	J. F. Ellwood, Southport.	31.00
			G. M. Williams, New London.	35.00
			A. P. Wakeman, Fairfield.	----
2682	Strictly Pure Fine Bone.	Rogers & Hubbard Co., Middletown.	Manufacturer.	34.00
2926	Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	Olds & Whipple, Hartford.	35.00
			J. A. Lewis, Willimantic.	34.00
			J. P. Barstow & Co., Norwich.	34.00
2921	Fine Ground Bone.	H. J. Baker & Bro., 215 Pearl St, N. Y.	C. O. Jelliff & Co., Southport.	31.00
2927	Ground Bone.	Downs & Griffin, Birmingham.	Manufacturer.	30.00
2917	Chittenden's Ground Bone.	National Fertilizer Co., Bridgeport.	D. H. Leonard, Leonard's Bridge.	----
			T. E. Eldridge, Norwich.	33.00
			E. P. Matherson, Pomfret.	33.00
			J. H. French, Cheshire.	34.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost per ton.
2923	Pure Fine Ground Bone.	Bradley Fertilizer Co., 27 Kilby St, Boston, Mass.	Waterbury & June, Greenwich.	----
			W. B. Martin, Rockville.	$35.00
			R. A. Parker, Warehouse Point.	36.00
			Burtis & Mead, New Canaan.	37.00
2923	Pure Ground Bone.	G. W. Miller, Middlefield, Conn.	G. Dickinson, Haddam.	35.00
2920	Ground Bone.	H. S. Miller & Co., Newark, N. J.	W. H. Cheney's Sons, So. Manchester.	35.00
			Manufacturer.	30.00
			Southington Lumber & Feed Co., Southington.	30.00
			J. P. Bolan, Waterbury.	34.00
2930	Pure Ground Bone.	Williams & Clark Fertilizer Co., N. Y.	Staples & Raymond, Westport.	35.00
			H. K. Brainard, Thompsonville.	28.00
2931	Ground Bone.	E. Frank Coe., 16 Burling Slip, N. Y.	Daniel Morgan, Poquonock.	35.00
			W. E. Payne, Rockville.	35.00
2925	Pure Ground Bone.	Crocker Fertilizer Co., Buffalo, N. Y.	Arnold Rudd, New London.	30.00
2922	Fresh Ground Bone.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Simon Banks, Southport.	28.00
			J. S. Wells, Hebron.	38.00
			Hull & Sweet, South Coventry.	35.00
2928	Lister's Celebrated Ground Bone.	Lister's Agricultural Chemical Works, Newark, N. J.	H. F. Porter, Hebron.	34.00
			J. A. Lewis, Willimantic.	34.00
			A. N. Clark, Milford.	28.00

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.
				Finer than				Coarser than 1/6 inch.			
		Nitrogen.	Phos. Acid.	1/50 inch.	1/25 inch.	1/12 inch.	1/6 inch.				Valuation exc'ds cost.
2720	Sanderson's Pure Ground Bone	3.61	25.38	74	23	3	--	--	$33.00	$45.26	27.1
2924	Peter Cooper's Bone Dust	2.01	28.07	41	15	22	22	--	28.00	37.47	25.3
2811	Plumb & Winton's Bone Fertilizer	4.37	20.61	53	22	17	8	--	30.00	37.86	20.8
2934	Nuhn's Self-Recommending Fertilizer	3.99	*22.09	65	20	9	6	--	32.50	40.76	20.2
2962	Peck Bros.' Pure Ground Bone	4.13	21.15	30	27	28	15	--	28.00	34.67	19.2
3004	Shoemaker's Swift Sure Bone Meal	6.00	21.95	63	28	9	--	--	40.00	49.33	18.9
2681	Rogers & Hubbard Co's Pure Ground AX Bone	4.08	22.52	45	24	28	3	--	32.00	38.73	17.4
2683	Rogers & Hubbard Co's Raw Knuckle Bone Flour	3.85	25.45	72	28	--	--	--	37.00	44.60	17.0
2918	Quinnipiac Ground Bone	3.16	24.51	53	22	20	5	--	33.00	39.47	16.4
2682	Rogers & Hubbard Co's Strictly Pure Fine Bone	4.00	22.93	52	29	19	--	--	34.00	40.51	16.0
2926	Darling's Ground Bone	2.69	24.26	71	19	10	--	--	34.00	40.27	15.5
2921	Baker's Fine Ground Bone	3.81	24.27	48	34	18	--	--	31.00	36.57	15.2
2927	Downs & Griffin's Ground Bone	4.51	23.05	17	20	44	19	--	30.00	35.15	14.6
2917	Chittenden's Ground Bone	3.08	25.13	44	20	20	16	--	33.00	37.96	13.1
2923	Bradley's Pure Fine Ground Bone	3.62	22.81	58	30	12	--	--	35.00	40.13	12.8
2929	G. W. Miller's Pure Ground Bone	4.07	22.53	18	16	27	39	--	30.00	32.24	6.9
2920	H. S. Miller's Ground Bone	2.29	22.73	49	18	22	11	--	32.00	33.77	5.2
2930	Williams & Clark's Pure Bone Meal	2.83	23.95	42	23	23	12	--	35.00	36.06	2.9
											Cost exc'ds valuation.
2931	E. Frank Coe's Ground Bone	2.08	†18.75	35	20	21	24	--	29.00	27.67	1.2
2925	Crocker's Pure Ground Bone	4.37	23.69	23	25	34	18	--	38.00	36.82	3.2
2922	Bowker's Fresh Ground Bone	3.02	20.12	31	26	32	11	--	34.00	30.95	9.8
2928	Lister's Ground Bone	2.90	14.34	43	20	19	18	--	28.00	24.53	14.1

* Also contains .64 per cent. of Potash and .90 per cent. of Chlorine.

† Also contains 1.33 per cent. of Potash.

2. *Manufacturers' Samples and Samples Sent by Purchasers.*

3002. Ground Bone, made by E. B. Fall, Middletown.

2642. Ground Bone, made by F. Nuhn, Waterbury. Sampled and sent by John Spear, Cheshire.

2741. Self-Recommending Fertilizer, made by F. Nuhn, Waterbury. Sampled and sent by E. Davis, Hamden.

3054. Bone Sawdust, made by Salisbury Cutlery Co. Sampled and sent by T. A. Stanley, New Britain. Cost $40.00 per ton f. o. b. in Springfield, Mass.

ANALYSES.

	3002.	2642.	2741.	3054.
Fine, smaller than $\frac{1}{50}$ inch	52	59	68	100
Fine medium, smaller than $\frac{1}{25}$ inch	25	20	14	0
Medium, smaller than $\frac{1}{12}$ inch	20	16	10	0
Coarse, larger than $\frac{1}{12}$ inch	3	5	8	0
	100	100	100	100
Nitrogen	1.85	3.96	3.77	3.96
Phosphoric Acid	28.53	21.26	19.84	26.29
Potash	---	---	3.93	---
Valuation per ton	$40.97	$38.33	$40.14	$49.88

2675. Bone and Potash, home mixed. Sampled and sent by C. Buckingham, Southport.

2751. Bone ground at a grist mill and sent for analysis by E. M. Spalding, Suffield.

3055. Fish Scrap and Potash Salts, made by G. W. Miles, Milford. Sampled and sent by W. L. and S. T. Merwin, Milford.

	2675.	2751.	3055.
Nitrogen	3.23	3.31	4.32
Phosphoric Acid	13.19	17.45	3.64
Potash	6.86	----	2.53
Cost per ton	$35.00	$30.00	$20.00
Valuation	$34.34	$27.17	$22.06

84 per cent. of the mixture **2675** passed a $\frac{1}{25}$ inch sieve. Only 14 per cent. of **2751** passed a $\frac{1}{25}$ inch sieve and a half of it was larger than $\frac{1}{12}$ inch.

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

2686. Pulverized Tankage [Bone and Meat]; **2722,** Tankage; **2749,** Blood, Bone and Meat. All from stock of L. Sanderson, New Haven.

2750. Blood, Bone and Meat, made by F. S. Andrew & Co., New Haven. Sampled and sent by M. Wooding, Highwood.

2972. Tankage, made by Strong, Barnes, Hart & Co., New Haven. Sampled and sent by W. C. Newton, Durham.

MECHANICAL ANALYSES.

	2686	2722	2749	2750	2972
Fine, smaller than $\frac{1}{50}$ inch	96	42	51	19	47
Fine medium, smaller than $\frac{1}{25}$ inch	4	22	18	17	21
Medium, smaller than $\frac{1}{12}$ inch	--	25	19	26	14
Coarse, larger than $\frac{1}{12}$ inch	--	11	12	38	18
	100	100	100	100	100

CHEMICAL ANALYSES.

	2686	2722	2749	2750	2972
Nitrogen	5.03	8.26	7.35	4.00	6.96
Phosphoric Acid	19.32	8.75	12.69	17.09	9.94
Cost per ton	$35.00	$35.00	$35.00	$20.00	$22.00*
Valuation per ton	43.36	32.46	35.67	24.87	32.03

* In 5 ton lots f. o. b., New Haven.

Mixed Fertilizers.

I. 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. Fish scrap is here included as it is sometimes acidulated with oil of vitriol to preserve it, thus making it a nitrogenous superphosphate.

1. *Samples drawn by Station Agents.*

In the tables on pages 37 to 47 are given sixty-five analyses of this kind.

After the name of a brand the names of a number of dealers are frequently given. This indicates that a sample of this brand was drawn by our agent from each dealer named and that the corresponding analysis was made on a mixture of equal parts of all these samples.

The Station assumes full responsibility for accuracy of sampling and analysis only on such samples as are drawn by its own agents. On samples drawn by other persons the Station holds itself responsible only for the accuracy of analysis, but requires before making an analysis a formal statement that the person who drew the sample did it in accordance with the Station directions. A blank form of this statement is furnished on application.

The prices quoted are dealers' *cash ton* prices.

These prices quoted by different dealers for the same fertilizers differ in some cases considerably, partly on account of difference in freight-rates, presence or absence of competition, etc. Some manufacturers claim that their goods are sold at a uniform price at all points in the state, but usually the price charged is fixed by the dealer.

The last column of the table of analyses is "Percentage Difference between Cost and Valuation." Its significance and the method of calculating it may be seen by noticing the first analysis in the table on page 45, No. **2795**. Here the cost is $36, the valuation is $32.02, and the difference between them is $3.98. By multiplying this difference, $3.98, by 100, and dividing it by the valuation, $32.02, we get 12.4. the percentage advance of selling price over valuation, which advance should represent on the average the costs and profits of the manufacturer in converting the raw materials into a mixed fertilizer, selling it and collecting on his sales.

DIFFERENCE BETWEEN COST AND VALUATION.

In five cases the valuation exceeded the cost.

Leaving out of account the last three analyses in the tables in which the cost exceeded valuation by considerably more than 50 per cent. the average cost of 62 Nitrogenous Superphosphates was $33.80 and the average valuation $28.57. The difference is $5.23, and the percentage difference 18.3.

That is, the same quantities of nitrogen, phosphoric acid and potash, which were contained in an average ton of Nitrogenous Superphosphate could have been bought in raw materials of standard quality in ton lots in this State for $28.57 cash, in the average Superphosphate they cost $33.80, and hence the manufacturers' and dealers' expenses and profits on a ton of fertilizer averaged $5.23, or 18.3 per cent. of the cost of the materials.

Guarantees.—The analyses of 23 superphosphates out of the 65 show that their composition is below the maker's minimum guarantee in one or more particulars. Twenty-two, or more than one-third of the whole number, are deficient in one ingredient, and two others in two ingredients.

It is required, under the law, that the quantity of *actual* potash shall be expressly stated. "Potash, Sulphate, 4 per cent." means four per cent of *actual potash* in the form of sulphate, and not 2.16 per cent. of potash, but the expression is often used by manufacturers, when only the smaller quantity of actual potash is present in the fertilizer. Such use is deceptive.

Fish and Potash.—The analyses of material bearing this designation, though included among nitrogenous superphosphates are also tabulated by themselves on the next page. Most of the brands are not simple mixtures of fish scrap and potash salts, as the name would imply, but contain in some cases considerable quantities of added phosphates.

Fish and Potash—Sampled by the Station.

	Kelsey's.	Bowker's.	Chittenden's.	Quinnipiac Plain Brand.	Bradley's Anchor Brand.	Read's.	Church's.	Quinnipiac Crossed Fishes Brand.	Bradley's Triangle A.	Farmer's.	E. F. Coe's.
	2828	**2839**	**2793**	**2876**	**2852**	**2892**	**2907**	**2875**	**2851**	**2831**	**2856**
Nitrogen as Ammonia	.78	----	.96	.56	----	----	.30	.78	.62	----	----
Nitrogen, Organic	3.24	2.54	2.92	2.25	3.76	2.78	2.96	3.02	2.00	1.69	2.21
Soluble Phosphoric Acid	2.56	5.95	1.31	1.60	4.76	3.52	1.55	1.12	3.25	4.26	.51
Reverted Phosphoric Acid	3.16	1.99	4.37	3.31	1.84	2.46	2.71	3.79	1.60	2.33	3.75
Insoluble Phosphoric Acid	.68	4.42	3.10	3.00	1.36	1.73	.88	3.57	1.35	1.25	4.60
Potash	3.51	4.15	5.05	5.22	2.67	4.96	3.89	4.41	3.99	7.42	3.10
Cost	$27.00	32.50	33.00	28.00	32.00	30.00	28 00	34.00	30.00	34.00	29.50
Valuation	$26.65	28.68	28.26	23.59	26.39	24.28	21.67	26.51	20.91	23.50	19.56

Nitrogenous Superphospates and Guanos Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2909	Dry Ground Fish Guano.	Leander Wilcox, Mystic Bridge.	C. M. Smith, E. Hartford.	------
2879	Acidulated Fish Guano.	Leander Wilcox, Mystic Bridge.	C. M. Smith, E. Hartford.	$22.00
2919	Dry Ground Fish.	Quinnipiac Co., New London.	Olds & Whipple, Hartford.	36.00
2908	Pure Dry Fish.	Joseph Church & Co., Tiverton, R. I.	H. K. Brainard, Thompsonville.	36.00
2748	Sanderson's Formula, A. A.	L. Sanderson, New Haven.	J. J. Merwin, Orange.	36.00
2891	Flour of Bone Phosphate.	G. W. Miller, Middlefield.	Manufacturer.	35.00
2828	Fish and Potash.	E. R. Kelsey, Branford.	Wilson & Burr, Middletown.	28.00
			Miles Payne, Cheshire.	25.00
		M. L. Shoemaker & Co., Phila., Pa.	J. P. Barstow & Co., Norwich.	37.00
2880	Swift Sure Superphosphate.		F. Ellsworth, Hartford.	38.00
		Russell Coe, Tremley, N. J.	City Coal and Wood Co., New Britain.	30.00
			Wilson & Burr, Middletown.	30.00
2857	Ammoniated Bone Superphosphate.		S. J. Hall, Meriden.	32.00
		H. S. Miller & Co., Newark, N. J.	J. O. Fox, Putnam.	25.00
			H. K. Brainard, Thompsonville.	28.00
2904	Harvest Queen Phosphate.	Quinnipiac Co., New London.	E. B. Clark, Milford.	39.00
			J. F. Elwood, Southport.	41.00
2874	Market Garden Manure.	Lister's Agricultural Chemical Works,	J. A. Lewis, Willimantic.	28.00
		Newark, N. J.	A. N. Clark, Milford.	25.00
2802	Standard or Success Fertilizer.		J. H. Fish, Newington.	30.00
		Lister's Agricultural Chemical Works,	Edw. Carroll, E. Hartford.	37.00
		Newark, N. J.	A. N. Clark, Milford.	28.00
2823	Ammoniated Bone Phosphate.		G. T. Fowler, Branford.	28.00
		Cumberland Bone Co., Portland, Me.	Haley & Cheseboro, Stonington.	35.00
			H. H. Davenport, Putnam.	34.00
2873	Cumberland Superphosphate.	Quinnipiac Co., New London.	J. E. Leonard, Jewett City.	32.00
			John Taylor, Old Mystic.	37.00
2761	Pine Island Phosphate.		Olds & Whipple, Hartford.	35 00
			B. E. Johnson, Higganum.	32.00
			E. B. Clark, Milford.	30.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2795	Complete Manure, A Brand.	Mapes' Formula and Peruvian Guano Co., N. Y.	Mapes' Branch, Hartford.	$36.00
			Wilson & Burr, Middletown.	36.00
			J. P. Barstow & Co., Norwich.	36.00
2839	Fish and Potash.	Bowker Fertilizer Co., 43 Chatham Street, Boston, Mass.	F. Hallock & Co., Birmingham.	35.00
2765	A. A. Ammoniated Bone Superphosphate.	H. J. Baker & Bro., 215 Pearl St., N. Y.	W. W. Cooper, Suffield.	37.50
			A. L. Winton, Bridgeport.	37.50
			M. F. Gregory & Co., Milford.	38.00
			W. F. Andross, E. Hartford.	37.50
2797	Complete Manure for General Use.	Mapes' Formula and Peruvian Guano Co., N. Y.	Mapes' Branch, Hartford.	39.00
			W. H. Childs, Manchester.	39.00
			Dean & Horton, Stamford.	40.00
2766	Ammoniated Bone Phosphate.	National Fertilizer Co., Bridgeport.	N. C. Barker, Lebanon.	33.00
			G. H. & H. B. Williams, E. Hartford.	32.00
			T. E. Eldridge, Norwich.	------
			S. W. Currier, Bridgeport.	35.00
			E. B. Clark, Milford.	30.00
2822	Farmers' New Method Fertilizer.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Warren, Clark & Taylor, Sandy Hook.	32.00
			J. E. Leonard, Jewett City.	32.00
			Prentiss & Young, Norwich.	32.00
			D. N. Clark & Sons, Milford.	30.00
			W. J. Starr, Groton.	34.00
			G. R. Fowler, Central Village.	34.00
			F. S. Bidwell, Windsor Locks.	30.00
			Carter & Strong, Manchester.	34.00
			Wilson & Burr, Middletown.	34.00
			G. W. Carver, Putnam.	29.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2860	Darling's Animal Fertilizer.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	R. P. Hubbard, Middletown.	$36.00
			F. S. Bidwell, Windsor Locks.	35.00
			J. P. Barstow & Co., Norwich.	35.00
2798	Complete Manure for Light Soils.	Mapes' Formula and Peruvian Guano Co., N. Y.	Mapes' Branch, Hartford.	44.00
			G. K. Nason, Willimantic.	45.00
			Wilson & Burr, Middletown.	44.00
2762	Ammoniated Bone Superphosphate, Americus Brand.	Williams & Clark Fertilizer Co., 81 Fulton St., N. Y.	Dix & Wells, Wethersfield.	35.00
			Daniel Morgan, Poquonock.	35.00
			J. E. Roode, Jewett City.	36.00
			C. L. Backus, Andover.	----
			Charles Stagg, Stratford.	35.00
			L. N. Dimmock, New London.	35.00
			Abbott & Co., Birmingham.	40.00
			F. S. Bidwell, Windsor Locks.	34.00
			H. K. Brainard, Thompsonville.	35.00
			J. P. Little, Columbia.	36.00
			G. H. & H. B. Williams, E. Hartford.	32.00
2793	Chittenden's Fish and Potash.	National Fertilizer Co., Bridgeport.	N. C. Barker, Lebanon.	33.00
			T. E. Eldridge, Norwich.	34.00
			A. J. Martin, Wallingford.	28.00
2876	Fish and Potash, Plain Brand.	Quinnipiac Co., New London.	B. E. Johnson, Higganum.	31.00
			J. P. Little, Columbia.	36.00
2760	Quinnipiac Phosphate.	Quinnipiac Co., New London.	G. M. Williams, New London.	37.00
			D. C. Wood, Stratford.	37.00
			J. S. Worthington, Portland.	36.00
			Olds & Whipple, Hartford.	38.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2815	Ammoniated Bone Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. E. Leonard, Jewett City.	$32.00
			N. E. Smith, Woodmont.	30.00
			E. B. Clark, Milford.	30.00
			W. B. Martin, Rockville.	34.00
2976	Standard Bone Superphosphate.	H. S. Miller & Co., Newark, N. J.	Staples & Raymond, Westport.	35.00
			Southington L. & F. Co., Southington.	34.00
			A. Williams, Collinsville.	35.00
2841	Sea Fowl Guano.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	W. W. Cooper, Suffield.	36.00
			F. S. Bidwell, Windsor Locks.	32.00
2882	Royal Bone Phosphate.	Williams & Clark Fertilizer Co., 81 Fulton St., N. Y.	Hale, Day & Co., South Manchester.	28.00
			F. S. Bidwell, Windsor Locks.	30.00
2852	Fish and Potash, Anchor Brand.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	H. J. Morse, Cheshire,	32.00
			R. A. Parker, Warehouse Point.	32.00
2820	Bradley's Patent Superphosphate of Lime.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	N. C. Barker, Lebanon.	36.00
			W. J. Starr, Groton.	37.00
			D. Beers, Danbury.	38.00
			J. E. Leonard, Jewett City.	36.00
			Burtis & Mead, New Canaan.	38.00
			D. N. Clark & Sons, Milford.	34.00
			E. B. Clark, Woodmont.	37.00
			Warren, Clark & Taylor, Sandy Hook.	36.00
			E. E. Scofield, Stamford.	34.00
			J. E. Holmes, Stratford.	37.00
			Wheeler & Howe, Bridgeport.	37.00
			Raymond Bros., South Norwalk.	36.00
			Prentiss & Young, Norwich.	36.00
			G. A. Dickinson, Haddam.	36.00
			G. R. Fowler, Central Village.	----
			Carter & Strong, Manchester.	38.00
			Dix & Wells, Wethersfield.	35.00
			Wilson & Burr, Middletown.	35.00
			J. P. Little, Columbia.	36.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2820	Bradley's Patent Superphosphate of Lime.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	J. A. Lewis, Willimantic.	$38.00
			R. A. Parker, Warehouse Point.	34.00
			Quinnebaug Store, Danielsonville.	36.00
			W. B. Martin, Rockville.	36.00
			W. H. Cheney's Sons, S. Manchester.	38.00
			W. F. Andross, East Hartford.	36.00
			A. C. Sternberg, Hartford.	35.00
			G. W. Carver, Putnam.	35.00
			H. D. Lanphear, Chaplin.	36.00
			F. S. Bidwell, Windsor Locks.	34.00
2768	High Grade Phosphate.	E. Frank Coe, 16 Burling Slip, N. Y.	N. C. Barker, Lebanon.	34.00
			I. W. Denison & Co., Mystic.	33.00
			Wheeler & Howe, Bridgeport.	35.00
			Backus Bros., South Windham.	34.00
			F. P. Burr & Co., Middletown.	35.00
			Arnold Rudd, New London.	33.00
			J. P. Barstow & Co., Norwich.	32.00
			J. A. Amidon, Wethersfield.	33.00
2800	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport.	G. H. & H. B. Williams, E. Hartford.	42.00
			D. Fitzgerald, Stratford.	42.00
			D. G. Penfield, Danbury.	42.50
2833	Reese's New England Favorite.	J. S. Reese & Co., New Bedford, Mass.	Ansell Arnold & Co., Willimantic.	29.00
2813	Clark's Cove Bay State Fertilizer, G. G.	J. S. Reese & Co., Licensee, New Bedford, Mass.	Ansell Arnold & Co., Willimantic.	28.50
			H. H. Davenport, Pomfret.	32.00
			W. Tillinghast, Plainfield.	37.50
2889	Victor Phosphate.	Apothecaries Hall Co., Waterbury.	Manufacturer.	30.00
2892	Bone, Fish and Potash.	Read Fertilizer Co., N. Y.	W. F. Andross, East Hartford.	30.00
			H. E. Ives, Cheshire.	30.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2803	Hill and Drill Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Hull & Sweet, South Coventry.	$38.00
			C. H. Bell, Portland.	38.00
			J. H. Ives, Danbury.	38.00
			C. T. Leonard, Norwalk.	38.00
			B. Curtis & Son, Stepney.	40.00
			W. B. Martin, Rockville.	37.00
			J. H. Fish, Newington.	36.00
2905	Olds & Whipple's Special Phosphate.	Made for Dealer.	Olds & Whipple, Hartford.	35.00
2910	IXL Phosphate.	G. W. Miles, Milford.	A. H. Hinckley, Old Mystic.	30.00
2843	Original Coe's Superphosphate.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	F. S. Bidwell, Windsor Locks.	33.00
2835	Soluble Pacific Guano.	W. D. Stewart & Co., Boston, Mass.	P. J. Bolan, Waterbury.	34.00
			W. F. Andross, East Hartford.	36.00
			City Coal and Wood Co., New Britain.	36.00
2974	Dissolved Bone Phosphate.	H. S. Miller & Co., Newark, N J.	Staples & Raymond, Westport.	32.00
2907	Fish and Potash.	Joseph Church & Co., Tiverton, R. I.	A. Williams, Collinsville.	32.00
			H. K. Brainard, Thompsonville.	28.00
2875	Fish and Potash, Crossed Fishes Brand.	Quinnipiac Co., New London.	Olds & Whipple, Hartford.	37.00
			B. E. Johnson, Higganum.	34.00
			J. F. Silliman, New Canaan.	38.00
			A. L. Martin, Wallingford.	34.00
			J. P. Little, Columbia.	35.00
2807	Pilgrim Fertilizer.	J. S. Reese & Co., New Bedford, Mass.	Ansell Arnold & Co., Willimantic.	24.00
2854	Clark's Cove Company's King Philip Alkaline Guano.	J. S. Reese & Co., Licensees, New Bedford, Mass.	Ansell Arnold & Co., Willimantic.	24.65
2829	Cecrops Fertilizer.	F. Ludlam, 140 Maiden Lane, N. Y.	H. H. Davenport, Pomfret.	30.00
2830	Farmers' Friend Fertilizer.	Read Fertilizer Co., N. Y.	Ahlquist & Allison, Portland.	38.00
			C. H. Cleveland, Brooklyn.	42.00
			W. F. Andross, East Hartford.	35.00
			R. P. Hubbard, Middletown.	34.00
			H. E. Ives, Cheshire.	35.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2827	Cereal Fertilizer.	F. Ludlam, 140 Maiden Lane, N. Y.	W. J. Starr, Groton.	$32.00
			W. Tillinghast, Plainfield.	32.00
			Ahlquist & Allison, Portland.	32.00
			C. A. Young, Danielsonville.	31.00
			C. H. Cleveland, Brooklyn.	32.00
2799	Ammoniated Bone Superphosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	L. Browning, New London.	37.00
			Dix & Wells, Wethersfield.	35.00
			L. L. Herman, Noroton.	35.00
			J. E. Leonard, Jewett City.	36.00
			Haley & Cheeseboro, Stonington.	45.00
2825	Lion Brand Fertilizer.	Read Fertilizer Co., N. Y.	R. P. Hubbard, Middletown.	30.00
			W. Tillinghast, Plainfield.	33.00
			H. E. Ives, Cheshire.	32.00
			W. F. Andross, East Hartford.	32.00
2796	New Rival Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	L. L. Herman, Noroton.	32.00
			L. Browning, New London.	35.00
			J. A. Lewis, Willimantic.	30.00
2890	Peruvian Guano. Cargo C. R. Lewis.	Mapes' Formula and Peruvian Guano Co., 158 Front St., N. Y., Importers.	Mapes' Branch, Hartford.	62.00
2855	Alkaline Bone Phosphate.	E. Frank Coe, 16 Burling Slip, N. Y.	Backus Bros., South Windham.	34.00
			H. S. Hall, (2d) Wallingford.	35.00
851	Triangle A, Fish and Potash.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Burtis & Mead, New Canaan.	33.00
			Raymond Bros., South Norwalk.	30.00
2831	Fish and Potash.	Farmers' Fertilizer Co., Syracuse, N. Y.	A. C. Sternberg, Hartford.	34.00
2856	High Grade Fish and Potash.	E. Frank Coe, 16 Burling Slip, N. Y.	W. T. Andrews, Orange.	29.00
			F. P. Burr & Co., Middletown.	30.00
2895	Davidge Vegetator.	Davidge Fertilizer Co., 121 Front St., N. Y.	J. M. Burke, South Manchester.	35.00
2894	Ammoniated Bone Superphosphate.	Stearns Fertilizer Co., 181 Front St., N. Y.	R. P. Hubbard, Middletown.	34.00
2832	Standard Special Formula.	Farmers' Fertilizer Co., Syracuse, N. Y.	W. H. Childs, Manchester.	32.00
2872	Economical Bone Fertilizer.	Wilkinson & Co., 54 William St., N. Y.	R. H. Coley, Southport.	32.00

Analyses of Nitrogenous Superphosphates Sampled by the Station.

Station No.	Name or Brand.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
2909	Wilcox's Dry Ground Fish Guano	----	---	8.61	8.61	*8.0*	.93	4.20	1.93	7.06	----	5.13	*4.0*	----	----	---	$32.00	$38.23	16.3*
2879	Wilcox's Acidulated Fish Guano	----	.97	4.59	5.56	*5.5*	1.76	2.72	.47	4.95	----	4.48	*4.0*	----	----	----	22.00	26.09	15.7*
2919	Quinnipiac Dry Ground Fish	----	----	9.26	9.26	*7.5*	81	3.60	2.43	6.84	----	4.41	*40*	----	----	----	36.00	39.64	9.2*
																	47.50	47.60	3.4*
2908	Church & Co.'s Pure Dry Fish	----	----	8.84	8.84	*8.2*	.72	4.26	2.71	7.69	----	4.98	*6.8*	----	----	----	36.00	39.23	8.2*
2748	Sanderson's Formula, A. A.	2.33	----	2.14	4.47	*3.3*	4.40	2.64	.74	7.78	*10.0*	7.04	*6.0*	8.64	*6.0*	2.26	35.00	34.96	0.1
																			5.1
2891	G. W. Miller's Flour of Bone Phosphate	1.12	.21	3.33	4.66	*4.0*	----	----	----	12.60†	*9.0*	----	----	4.92	*4.1*	3.98	35.00	34.63	1.0
2828	Kelsey's Fish and Potash	----	.78	3.24	4.02	*3.3*	2.56	3.16	.68	6.40	*4.0*	5.72	----	3.51	*3.0*	1.21	27.00	26.65	1.0
2880	Shoemaker's Swift Sure Superphosphate	.57	----	2.57	3.14	*2.5*	8.03	3.86	3.54	15.43	----	11.89	*9.0*	4.87	*4.0*	.32	37.50	36.87	1.7
2857	Russell Coe's Ammoniated Bone Phosphate	----	----	2.82	2.82	*1.7*	6.08	2.70	1.07	9.85	*10.0*	8.78	*8.0*	4.58	*2.0*	4.67	30.00	28.13	6.6
2904	H. S. Miller's Harvest Queen Phosphate	----	----	1.71	1.71	*.8*	6.14	2.69	1.11	9.94	----	8.83	*10.0*	2.61	*1.5*	.30	25.00	23.36	7.0
2874	Quinnipiac Market Garden Manure	.59	1.18	1.80	3.57	*3.3*	4.70	5.66	.86	11.22	----	10.36	*8.0*	7.05	*7.0*	.42	40.00	36.66	9.1
2802	Lister's Standard or Success Fertilizer	----	----	2.03	2.03	*1.0*	7.36	2.79	2.17	12.32	----	10.15	*10.0*	1.37	*1.3*	.52	28.00	25.61	9.3
2823	Lister's Ammoniated Bone Phosphate	----	----	2.05	2.05	*1.8*	7.05	2.51	2.47	12.03	----	9.56	*9.0*	1.56	*1.5*	.18	28.00	25.31	10.6
2873	Cumberland Superphosphate	.31	----	2.13	2.44	*2.0*	6.24	6.48	2.12	14.84	*12.0*	12.72	----	1.96	*2.0*	.78	34.50	31.17	10.7
7261	Quinnipiac Pine Island Phosphate	----	----	2.48	2.48	*2.0*	4.95	7.08	1.34	13.37	----	12.03	*9.0*	1.07	*1.0*	1.24	32.00	28.73	11.4

* Valuation exceeds cost.

† A mixture of fertilizer chemicals and ground bone, 89 per cent. of which passes holes 1/50 inch in diameter.

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

Station No.	Name or Brand.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
2795	Mapes' Complete Manure, A Brand	.35	.72	1.90	2.97	*2.5*	7.39	4.28	1.83	13.50	*12.0*	11.67	*10.0*	3.05	*2.5*	3.61	$36.00	$32.02	12.4
2839	Bowker's Fish and Potash	----	----	2.54	2.54	*2.3*	5.95	1.99	4.42	12.36	*8.0*	7.94	----	4.15	*4.0*	.27	32.50	28.68	13.3
2765	Baker's A.A. Ammoniated Bone Superphosphate	----	1.98	.86	2.84	*2.5*	11.14	1.65	.36	13.15	----	12.79	*10.0*	3.00	*2.0*	2.72	37.50	32.87	14.1
2797	Mapes' Complete Manure for General Use	.92	.64	2.17	3.73	*3.3*	7.16	3.68	2.02	12.86	----	10.84	*10.0*	4.17	*4.0*	3.51	39.00	34.17	14.1
2766	National Fertilizer Co.'s Ammoniated Bone Phosphate	----	----	2.63	2.63	*1.7*	7.26	3.00	.78	11.04	*9.0*	10.26	*7.0*	2.57	*2.0*	1.18	32.50	28.14	15.5
2822	Bradley's Farmers' New Method Fertilizer	----	----	2.31	2.31	*1.6*	7.74	2.72	1.30	11.76	*10.0*	10.46	*8.0*	2.88	*3.0*	2.79	32.00	27.70	15.5
2860	Darling's Animal Fertilizer	----	.41	2.80	3.21	*3.3*	3.90	4.21	3.40	11.51	*10.0*	8.11	----	5.29	*4.0*	4.09	35.00	20.28	15.6
2798	Mapes' Complete Manure for Light Soil	1.54	1.44	2.37	5.35	*4.9*	4.96	3.31	2.03	10.30	*8.0*	8.27	*7.0*	7.05	*6.0*	6.70	44.00	37.91	16.1
2762	Williams & Clark's Ammoniated Bone Superphosphate, Americus Brand	.16	.68	1.94	2.78	*2.0*	7.47	4.34	.62	12.43	*11.0*	11.81	*10.0*	1.99	*2.0*	2.00	35.00	29.99	16.7
2793	Chittenden's Fish and Potash	----	.96	2.92	3.88	*3.3*	1.31	4.37	3.10	8.78	*6.0*	5.68	----	5.05	*5.0*	4.95	33.00	28.26	16.8
2876	Quinnipiac Fish and Potash, Plain Brand	----	.56	2.25	2.81	*2.0*	1.60	3.31	3.00	7.91	*6.0*	4.91	*4.0*	5.22	*4.0*	4.97	28.00	23.59	18.7
2760	Quinnipiac Phosphate	.29	.51	1.93	2.73	*2.5*	4.46	7.50	1.42	13.38	----	11.96	*9.0*	1.90	*2.0*	2.40	36.00	30.08	19.7
2815	Bowker's Ammoniated Bone Phosphate	.43	----	1.81	2.24	*2.0*	6.29	3.25	3.33	12.87	*10.0*	9.54	*8.0*	2.19	*2.0*	2.74	31.50	26.32	19.7
2976	Miller's Standard Superphosphate	----	.15	2.56	2.71	*2.4*	9.76	.69	.26	10.71	----	10.45	*10.0*	2.75	*1.5*	.30	35.00	29.22	19.7
2841	Bradley's Sea Fowl Guano	.20	.29	2.12	2.61	*2.5*	8.69	2.05	1.16	11.90	*11.0*	10.74	*9.0*	2.13	*2.0*	2.31	34.00	28.39	19.8
2882	Williams & Clark Co.'s Royal Bone Phosphate	----	----	1.66	1.66	*.8*	5.78	2.62	2.29	10.69	----	8.40	*7.0*	2.70	*2.0*	.36	29.00	23.30	20.4

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

Station No.	Name or Brand.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
2852	Bradley's Anchor Brand Fish and Potash	----	----	3.76	3.76	3.3	4.76	1.84	1 36	7.96	5.0	6.60	3.0	2.67	3.0	4.64	$32.00	$26.39	21.3
2820	Bradley's Patent Superphosphate of Lime	.20	.14	2.37	2.71	2.3	8.53	2.42	1.10	12.05	----	10.95	9.0	1.98	1.5	2.00	35.00	28.84	21.4
2768	E. F. Coe's High Grade Phosphate	----	----	2.24	2.24	2.0	8.67	1.75	1.54	11.96	11.0	10.42	9.0	2.53	2.0	.33	34.00	27.95	21.6
2800	Chittenden's Complete Fertilizer	.81	----	3.03	3.84	3.3	3 34	5.60	3.79	12.73	8.0	8.94	6.0	5.49	6.0	1.84	42.00	34.52	21.7
2833	Reese's New England Favorite	----	----	2.51	2 51	2.3	6.86	3.31	2.84	13 01	10.5	10.17	9.0	1.81	2.0	2.05	34.00	27.83	22.1
2813	Clark's Cove Bay State Fertilizer, G.G.	----	.28	2.06	2.34	1.9	7.26	1.35	3.58	12 19	10.5	8.61	8.5	2.70	2.3	2.21	32 00	26.19	22.2
2889	Apothecaries Hall Co.'s Victor Phosphate	----	----	2.33	2.33	2.5	7.68	1.36	.04	9.08	8.5	9.04	----	2 24	2 0	1.97	30.00	24.30	22.6
2892	Read's Fish and Potash	----	----	2.78	2.78	2.5	3.52	2.46	1.73	7.71	6.0	5.98	4.0	4.96	4 0	5.05	30.00	24.28	23.5
2803	Bowker's Hill and Drill Phosphate	.81	----	2.05	2.86	2.5	7.52	2.21	2 64	12.37	11.0	9.73	10.0	2.40	2.0	.25	36 00	29.03	24.0
2905	Olds & Whipple's Special Phosphate	.87	----	2.07	2.94	----	8.61	1.07	.78	10.46	----	9.68	----	2.18	----	.42	35.00	27.88	25.5
2910	G. W. Miles' IXL Phosphate	----	.31	1.47	1.78	2.0	7.71	1.81	.74	10.26	----	9.52	9.0	2.26	1.5	1.86	30.00	23.60	27.1
2843	Original Coe's Superphosphate	.47	----	1.66	2.13	2.1	8.45	2.40	1.24	12.09	10.0	10.85	8.0	.99	1.0	1.13	33.00	25.77	28.1
2835	Soluble Pacific Guano	1.85	----	.70	2.55	2.3	8.10	2.68	1.36	12.14	10.5	10.78	8.5	1.97	2.0	1.92	35.00	27.33	28.1
2974	H.S. Miller's Dissolved Bone	----	.10	1.73	1.83	1.6	7.82	1.55	.65	10.02	9.5	9.37	8 0	2.94	1.5	.25	32.00	24.88	28.6
2907	Church & Co.'s Fish and Potash	----	.30	2.96	3.26	3.3	1.55	2.71	.88	5.14	5.0	4.26	----	3.89	8.0	6.90	28.00	21.67	29.2
2875	Quinnipiac Fish and Potash, Crossed Fishes Brand	----	.78	3.02	3.80	3.3	1.12	3.79	3.57	8.48	5.0	4.91	3.0	4.41	3.0	4.06	34.00	26.51	32.0

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

Station No.	Name or Brand.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
2807	Reese's Pilgrim Fertilizer	----	.28	1.42	1.70	1.0	5.70	1.00	2.22	8.92	7.5	6.70	6.5	2.99	2.5	2.57	$27.00	$20.42	32.2
2854	Clark's Cove King Philip Alkaline Guano	----	----	1.73	1.73	1.2	6.35	1.37	2.31	10.03	7.5	7.72	6.5	3.29	3.0	2.33	30.00	22.51	33.3
2829	Ludlam's Cecrops Fertilizer	.64	----	1.85	2.49	3.3	8.05	1.39	1.18	10.62	----	9.44	7.0	6.80	7.0	5.89	40.00	29.95	33.6
2830	Read's Farmers' Friend Fertilizer	---	----	1.95	1.95	2.0	7.37	2.92	1.62	11.91	11.0	10.29	9.0	2.25	2.0	2.23	34.50	25.80	33.7
2827	Ludlam's Cereal Fertilizer	.59	----	.87	1.46	1.2	8.64	1.26	2.11	12.01	11.0	9.90	8.0	2.34	4.0	4.01	32.00	23.78	34.6
2799	Crocker's Ammoniated Bone Superphosphate	----	----	2.97	2.97	2.9	6.77	2.09	1.60	10.46	----	8.86	10.0	1.49	1.0	1.25	36.00	26.37	36.5
2825	Read's Lion Brand Fertilizer	----	----	1.20	1.20	.8	6.64	2.74	1.33	10.71	10.0	9.38	8.0	4.19	4.0	4.80	32.00	23.39	36.7
2796	Crocker's New Rival Phosphate	----	----	1.48	1.48	1.2	6.51	2.76	2.59	11.86	----	9.27	10.0	2.14	1.6	2.13	32.00	23.07	38.7
2890	Mapes' Peruvian Guano	----	5.15	1 35	6.50	6.7	7.44	3.99	3.27	14.70	14.7	11.43	----	2.99	3.0	4.28	62.00	44.65	38.8
2855	E. F. Coe's Alkaline Bone Phosphate	----	----	1.42	1.42	1.0	6.96	2.70	3.47	13.13	11.0	9.66	9.0	2.07	2.0	.52	34.00	24.38	39.5
2851	Bradley's Triangle A, Fish and Potash	----	.62	2.00	2.62	2.0	3.25	1.60	1.35	6.20	6.0	4.85	4.0	3.99	4.0	6.12	30.00	20.91	43.5
2831	Farmers' Fertilizer Co.'s Fish and Potash	----	----	1.69	1.69	1.6	4.26	2.33	1.25	7.84	7.0	6.59	6.5	7.42	13.0	7.49	34.00	23.50	44.7
2856	E. F. Coe's High Grade Fish and Potash	----	----	2.21	2.21	3.0	.51	3.75	4.66	8.92	6.0	4.26	4.0	3.10	2.0	7.04	29.50	19.56	50.8
2895	Davidge's Vegetator	----	----	3.03	3.03	2.9	4.67	.82	.07	5.56	----	5.49	5.0	3.85	4.0	7.99	35.00	22.51	55.4
2894	Stearn's Ammoniated Bone Superphosphate	trace	.37	1.29	1.66	1.6	2.82	4.41	2.79	10.02	8.5	7.23	----	2.88	2.5	1.38	34.00	21.36	59.2
2832	Farmers' Fertilizer Co.'s Standard Special Formula.	.09	----	.65	.74	.8	7.30	2.09	.63	10.02	10.0	9.39	8.0	1.88	4.0	8.85	32.00	19.36	65.3
2872	Wilkinson's Economical Bone Fertilizer	----	----	1.02	1.02	1.2	.24	4.17	5.52	9.93	6.0	4.41	----	3.11	3.0	.44	32.00	17.00	88.2

Notes on Particular Analyses.

An analysis of READ'S HIGH GRADE FARMERS' FRIEND FERTILIZER was made on a mixture of two dealers' samples, one from W. Tillinghast, Plainfield, the other from W. F. Andross, East Hartford. This analysis is given below, No. **2877.** The manufacturers claim that this does not represent the average quality of the brand. As no other lots of this article were sampled by our agents, further analyses could not be made. Nitrogen, phosphoric acid and potash were, however, determined separately in each of the two samples from which the mixture had been made, Nos. **2936** and **2937,** and also in the sample deposited here at the beginning of the season by the manufacturer, No. **2938.** The results follow :

READ'S HIGH GRADE FARMER'S FRIEND FERTILIZER.

	2877	2936	2937	2938
Nitrogen	3.04	3.20	3.20	3.71
Nitrogen guaranteed	**3.3**	----	--	----
Soluble Phosphoric Acid	4.13	----	----	2.96
Reverted " "	2.07	----	----	3.13
Insoluble " "	1.36	----	----	2.62
Total Phosphoric Acid	7.56	7.60	7.25	8.71
Phosphoric Acid, guaranteed	**6.0**	----	----	----
Potash	9.64	9.49	9.52	7.87
Potash, guaranteed	**10.0**	----	----	----
Chlorine	9.15	----	----	----
Cost per ton	$38.50	----	----	----
Valuation	$29.56	----	----	30.70

The results show that the two samples were practically alike in composition, but contained half a per cent. less nitrogen and 1.7 per cent. more potash than the manufacturers' standard sample.

An analysis of E. F. COE'S "GOLD BRAND EXCELSIOR GUANO" was made on a mixture of two samples, one from stock of Arnold Rudd, New London, the other from D. N. Clark, Shelton. This analysis is given below, No. **2808.** The manufacturer states that this cannot possibly represent the Gold Brand ; that it has never run lower than 6 per cent. of potash and 2¾ per cent. of ammonia, while the phosphoric acid could not run over 9 per cent.

The great and unusual discrepancy between guarantee and actual composition creates a suspicion that the goods were not of this brand. Our sampling agent, however, distinctly remembers that the samples were drawn from bags bearing the Gold Brand mark. The determinations of nitrogen, phosphoric acid and potash in the separate samples are given below for comparison. We do not feel at liberty to suppress the analysis, while we accept the manufacturers' statement, that it does not represent the goods, and for that reason it has not been tabulated with other analyses of superphosphates.

E. F. COE'S GOLD BRAND EXCELSIOR GUANO.

	2808	2939	2940
Nitrogen, as Ammonia	.74	-- -	----
Organic Nitrogen	1 04	----	----
Total Nitrogen	1.78	1.53	2.11
Nitrogen, guaranteed	2.5	----	----
Soluble Phosphoric Acid	7.71	----	----
Reverted " "	2.14	----	----
Insoluble " "	1.79	----	----
Total Phosphoric Acid	11.64	12.56	11.12
Phosphoric Acid, guaranteed	**8.0**	----	----
Potash	4.27	3.47	4.74
Potash, guaranteed	**6.0**	----	----
Chlorine	.46	----	----
Valuation per ton	$27.63	----	----

Of "Bradley's Superphosphate," 29 samples were drawn by our agents, about half of them in the northern and half of them in the southern counties of the State. A mixture was prepared of equal parts of all of them, and on this mixture was made analysis No. **2820,** given on page 46, and reprinted below for comparison.

To test the accuracy of the work of sampling both by the agents and in the laboratory, a mixture was prepared of all samples drawn in the northern counties, No. **2885,** and another of all samples drawn in the southern counties, No. **2886,** and these were separately analyzed with the results below given, which show satisfactory agreement, and demonstrate the ability of the manufacturer to turn out a thoroughly uniform product, and the ability of the Station to put before consumers an accurate knowledge of the fertilizers they are using.

	2820	2885	2886
Nitrogen as nitrates	.20	.20	.20
Nitrogen as ammonia	.14	.16	.16
Organic Nitrogen	2.37	2.26	2.38
Total Nitrogen	2.71	2.62	2.74
Soluble Phosphoric Acid	8.53	8.54	8.35
Reverted " "	2.42	2.35	2.45
Insoluble " "	1.10	1.16	1.19
Total " "	12.05	12.05	11.99
Potash	1.98	1.74	1.89
Chlorine	2.00	1 98	1.66
Valuation	$28.84	28.28	28.68

Similarly agreeing results were also obtained in the case of another brand, which it is not necessary to present in detail.

2. Manufacturers' Samples.

The fertilizers named below, with the exception of Nos. **2913** and **2915**, were not found by the Station agents in any stock which they inspected, and accordingly the analyses were made on samples deposited at the Station by manufacturers.

2899. Bone and Potash, Circle Brand, made by Bradley Fertilizer Co., Boston, Mass.

2810. Dry Ground Fish, made by Joseph Church & Co., Tiverton, R. I.

2809. Fish and Potash, made by Joseph Church & Co., Tiverton, R. I.

2916. Red Brand Excelsior Guano, made by E. Frank Coe, New York.

2900. Buffalo Superphosphate, No. 2, made by Crocker Fertilizer Co., Buffalo, N. Y.

2902. Queen City Phosphate, made by Crocker Fertilizer Co., Buffalo, N. Y.

2903. Vegetable Bone Superphosphate, made by Crocker Fertilizer Co., Buffalo, N. Y.

2911. Extra Bone Phosphate, made by L. B. Darling, Pawtucket, R. I.

2966. Davidge's Special Favorite, made by Davidge Fertilizer Co., New York.

2913. Clark's Cove Co.'s Great Planet A, made by J. S. Reese & Co., licensees, New Bedford, Mass.

2915. Pacific Fish and Potash, made by W. D. Stewart & Co., Boston, Mass.

2679. Wilcox's Dry Ground Fish Guano, and **2680,** Wilcox's Acidulated Fish Guano, both made by Leander Wilcox, Mystic Bridge.

MANUFACTURER'S SAMPLES—ANALYSES AND VALUATIONS.

	2899	2810	2809	2916	2900	2902	2903	2911	2966	2913	2915	2679	2680
Nitrogen as nitrates	----	----	----	.23	----	----	----	.41	----	.99	----	----	----
Nitrogen as ammonia	.20	----	.36	1.44	----	----	----	.25	.45	----	----	.21	1.19
Nitrogen, organic	1.51	7.10	3.22	2.30	----	1.71	4.07	3.10	1.03	2.42	3.33	8.16	4.84
Total Nitrogen found	1.71	7.10	3.58	3.97	----	1.71	4.07	3.76	1.48	3.41	3.33	8.37	6.03
Nitrogen guaranteed	**1.8**	**8.2**	**3.3**	**3.3**	----	**1.7**	**5.0**	----	**1.2**	**3.3**	**3.0**	----	----
Soluble phosphoric acid	trace	----	1.63	7.61	11.47	7.31	6.38	4.75	8.32	4.08	4.14	.89	1.28
Reverted phosphoric acid	8.23	----	2.74	.87	2.04	2.17	1.59	4.22	2.99	4.88	2.02	3.73	3.00
Insoluble phosphoric acid	5.73	----	.72	1.15	.92	1.82	.55	2.19	1.75	2.81	.74	2.35	.95
Total phosphoric acid found	13.96	8.05	5.09	9.63	14.43	11.30	8.52	11.16	13.06	11.77	6.90	6.97	5 23
Phosphoric acid guaranteed	**8.0**	----	**5.0**	----	**12.0**	**9.0**	**7.0**	----	----	**8.3**	**6.0**	----	----
Available phosphoric acid found	8.23	----	4.37	8.48	13.51	9.48	7.97	8.97	11.31	8.96	6.16	4.62	4.28
Available phosphoric acid guaranteed	----	----	----	**10.0**	**11.0**	**8.0**	**6.0**	----	**10.0**	**7.3**	**4.0**	----	----
Potash	4.45	----	4.19	4.00	1.91	2.16	7.42	3.68	2.11	9.50	2.53	----	----
Potash guaranteed	**2.0**	----	**3.0**	**4.8**	**1.0**	**1.0**	**6.0**	----	**1.5**	**9.5**	**4.0**	----	----
Chlorine	10.76	----	7.27	.12	1.96	2.16	6.70	1.12	2.17	9.22	3.39	----	----
Valuation per ton	$25.61	----	29.03	32.32	23.68	23.81	33.45	31.80	25.78	35.19	23.70	36.88	27.63

3. *Samples drawn by Private Individuals.*

2859. Sanderson's Formula A. Made by L. Sanderson, New Haven. Sampled from stock bought by J. H. Webb, Hamden. See also analysis No. **2748,** page 44.

Analysis.	2859
Nitrogen as nitrates	.47
Nitrogen as ammonia	1.27
Organic nitrogen	2.89
Soluble phosphoric acid	4.11
Reverted phosphoric acid	2.88
Insoluble phosphoric acid	1.71
Potash	7.96
Chlorine	3.32
Cost per ton	$35.00
Valuation per ton	35.67

II. Special Manures.

1. *Sampled by Station Agents.*

For Analyses and Valuations see pages 55–61.

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

Guarantees.—Of the thirty-three samples analyzed ten are below the maker's minimum guarantee as regards one ingredient and two are below guarantee on two ingredients.

COST AND VALUATION.—In one case the valuation exceeded the cost.

The average cost of 33 special manures has been $39.18 and the average valuation $32.90. The difference between cost and valuation has been $6.28 and the Percentage Difference 19.0. The corresponding difference in case of the superphosphates (see page 35) was 18.3 per cent.

This year the Special Manures as a class have been higher-priced and more concentrated than the other nitrogenous superphosphates, but not as heretofore more economical to purchase.

Manufacturers' Samples of Special Manures.

The fertilizers named below were not found by the Station agents in any stock which they inspected, and accordingly the analyses were made on samples deposited at the Station by manufacturers.

2898. Complete manure for Grass and Grain, made by Bradley Fertilizer Co., Boston, Mass. Sent in April.

2961. Bradley's Complete Manure for Grass and Grain. Sent in July.

2901. Special Potato Manure, made by Crocker Fertilizer Co., Buffalo, N. Y.

2912. Great Eastern General Fertilizer for Oats, Buckwheat, and Seeding Down. Made by Great Eastern Fertilizer Co., Rutland, Vt.

2914. Concentrated Manure for Tobacco and Cabbage, made by J. S. Reese & Co., New Bedford, Mass.

The analysis of **2898,** it was claimed by the manfacturer, did not represent the average quality of the goods, though sent to us from the factory. A second sample was accordingly sent from the factory in July and was also analyzed, (No. **2961.**)

Analyses and Valuations.

	2898	2961	2901	2912	2914
Nitrogen as Nitrates	4.54	4.84	1.44	----	.41
Nitrogen as Ammonia	----	----	----	----	.27
Organic Nitrogen	.08	.09	2.35	1.02	3.28
Total Nitrogen found	4.62	4.93	3.79	1.02	3.96
Nitrogen, guaranteed	*4.94*	*4.9*	*3.7*	*.8*	*4.1*
Soluble Phosphoric Acid	3.28	6.19	6.69	6.83	4.69
Reverted Phosphoric Acid	2.30	1.97	1.84	1.80	2.03
Insoluble Phosphoric Acid	.94	1.01	1.77	1.03	2.43
Total Phosphoric Acid found	6.52	9.17	10.30	9.66	9.15
Phosphoric Acid, guaranteed	*7.0*	*7.0*	*9.0*	*9.0*	*6.0*
Available Phosphoric Acid found	5.58	8.16	8.53	8.63	6.72
Available Phosphoric Acid, guaranteed	----	----	*8.0*	*8.0*	*5.0*
Potash	2.63	3.39	6.74	3.85	5.97
Potash, guaranteed	*2.5*	*2.5*	*5.5*	*4.0*	*5.0*
Chlorine	.45	.40	6.32	4.69	4.82
Valuation per ton	$25.69	$31.73	$32.77	$21.19	$30.65

Notes on Particular Analyses.

Analyses Nos. **2837** and **2838** given below are objected to by the manufacturer as not representing the average composition of the goods, Stockbridge Top Dressing. No other samples of this brand were found by our agents, and no other analyses could be made. On account of the manufacturer's protest, these analyses are not tabulated with the others. It sometimes happens that goods are re-bagged by the dealer when the original bags are torn or rotted, and in such cases there is chance that the new bags may bear the wrong brand. Wrong tags may also occasionally be attached to unstenciled bags at the factory.

Stockbridge Top Dressing.

	2837	2838
Nitrogen as nitrates	1.75	1.96
Organic Nitrogen	2.83	2.41
Total Nitrogen	4.58	4.37
Soluble Phosphoric Acid	3.10	1.09
Reverted "	1.38	3.49
Insoluble "	5.96	6.59
Total Phosphoric Acid	10.44	11.17
Potash	4.46	5.24
Chlorine	4.49	4.79
Valuation per ton	$29.33	29.56

In the table below, **2794**, is an analysis made on a mixture of four samples of H. S. Miller & Co.'s Special Potato Manure. The manufacturer stated that the per cent. of phosphoric acid found was less than the brand should contain. Phosphoric acid was accordingly determined in each of the four samples, and the following per cents. were found: 5.41, 7.91, 7.82, 7.84. Evidently the first sample was unlike all the rest. It was, therefore, rejected, and a mixture of the other three gave the analysis, No. 2950, as follows:

H. S. Miller & Co.'s Special Potato Manure.

	2794	2950
Nitrogen as nitrates	.52	---
Nitrogen as ammonia	2.31	3.07
Organic Nitrogen	1.10	.78
Soluble Phosphoric Acid	4.53	3.89
Reverted "	1.95	3.08
Insoluble "	.47	.92
Potash	7.76	7.88
Chlorine	.42	.37
Valuation per ton	$32.70	33.79

Special Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2684	Fairchild's Formula for Seeding Down.	Rogers & Hubbard Co., Middletown.	Manufacturers.	$40.00
2710	Soluble Potato Manure.	Rogers & Hubbard Co., Middletown.	Manufacturers.	37.00
2685	Fairchild's Formula for Corn and General Crops.	Rogers & Hubbard Co., Middletown.	Manufacturers.	46.00
2951	Mapes' Seeding Down Manure.	Mapes' F. & P. G. Co., New York.	Mapes' Branch, Hartford.	37.50
2871	Fruit and Vine Manure.	Mapes' Formula and Peruvian Guano Co., New York.	Mapes' Branch, Hartford.	38.00
2819	Complete Manure, for Potatoes and Vegetables.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	D. N. Clark & Sons, Milford.	39.00
			Geo. Dickinson, Haddam.	40.00
			Wilson & Burr, Middletown.	38.00
			J. E. Holmes, Stratford.	38.00
			Carter & Strong, Manchester.	42.00
			F. S. Bidwell, Windsor Locks.	38.00
2801	Corn Manure.	Mapes' Formula and Peruvian Guano Co., New York.	Mapes' Branch, Hartford.	41.00
			W. W. Cooper, Suffield.	41.00
			G. K. Nason, Willimantic.	42.60
			J. P. Barstow & Co., Norwich.	41.00
			Dean & Horton, Stamford.	42.00
2858	Tobacco Manure, Connecticut Brand.	Mapes' Formula and Peruvian Guano Co., New York.	Mapes' Branch, Hartford.	45.00
			W. W. Cooper, Suffield.	45.00
2893	Americus High Grade Special for Tobacco.	Williams & Clark Fertilizer Co., 81 Fulton St., New York.	Hale, Day & Co., South Manchester.	40.00
			John Bransfield, Portland.	40.00
2824	Grass and Grain Spring Top Dressing.	Mapes' Formula and Peruvian Guano Co., New York.	G. K. Nason, Willimantic.	42.60
			W. W. Cooper, Suffield.	41.00
			Mapes' Branch, Hartford.	41.00
2804	Complete Potato Manure.	H. J. Baker & Bro., 215 Pearl St., N. Y.	M. T. Gregory & Co., Milford.	42.00
			Allen Betts, Norwalk.	42.00
			W. W. Cooper, Suffield.	42.50
			E. F. Hawley, Newtown.	42.50
2975	Corn Fertilizer.	H. S. Miller & Co., Newark, N. J.	G. T. Fowler, Branford.	32.00

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2952	Stockbridge Seeding Down Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Southington Lumber & Feed Co., Southington.	$40.00
2836	Complete Corn Manure.	H. J. Baker & Bro., 215 Pearl St., N. Y.	Strong & Tanner, Winsted.	40.00
			S. J. Hall, Meriden.	42.00
			W. W. Cooper, Suffield.	42.50
			I. J. Scoville, Bristol.	40.00
2950	Special Potato Manure.	H. S. Miller & Co., Newark, N. J.	Staples & Raymond, Westport.	42.00
			H. P. Treat, Orange.	40.00
2759	Potato Manure.	Mapes' Formula and Peruvian Guano Co., N. Y.	G. K. Nason, Willimantic.	44.50
			Mapes' Branch, Hartford.	43.00
			J. P. Barstow & Co., Norwich.	44.00
			Wilson & Burr, Middletown.	43.00
			Wheeler & Howe, Bridgeport.	46.00
2861	Tobacco Manure, Wrapper Brand.	Mapes' Formula and Peruvian Guano Co., N. Y.	W. W. Cooper, Suffield.	52.00
			Mapes' Branch, Hartford.	50.00
2818	Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	J. A. Lewis, Willimantic.	35.00
			Dix & Wells, Wethersfield.	33.00
			C. A. Young, Danielsonville.	33.00
2840	Bowker's Tobacco Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	W. B. Martin, Rockville.	44.00
2767	Potato Manure.	Williams & Clark Fertilizer Co., 81 Fulton St., N. Y.	Charles Stagg, Stratford.	35.00
			Joseph Roode, Jewett City.	36.00
			Daniel Morgan, Poquonock.	35.00
			H. K. Brainard, Thompsonville.	36.00
			C. L. Backus, Andover.	----
			F. S. Bidwell, Windsor Locks.	*36.00*
			Abbott & Co., Birmingham.	*40.00*

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2821	Potato Manure.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	A. C. Sternberg, Hartford.	$37.00
			F. S. Bidwell, Windsor Locks.	35.00
			D. N. Clark & Sons, Milford.	35.00
			Wilson & Burr, Middletown.	35.00
			N. C. Barker, Lebanon.	37.00
			D. Beers, Danbury.	38.00
			City Coal and Wood Co., New Britain.	40.00
			W. H. Cheney's Sons, South Manchester.	39.00
			Waterbury & June, Greenwich.	----
			Raymond Bros., South Manchester.	37.00
			W. B. Martin, Rockville.	37.00
			G. R. Fowler, Central Village.	----
			G. W. Carver, Putnam.	36.00
			Carter & Strong, Manchester.	39.00
			J. E. Leonard, Jewett City.	38.00
			G. A. Dickinson, Haddam.	38.00
			F. C. Root, Suffield.	38.00
			W. F. Andross, East Hartford.	36.00
			W. W. Cooper, Suffield.	36.00
			J. S. Wells, Hebron.	36.00
			E. B. Clark, Woodmont.	37.00
2763	Stockbridge Vegetable Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	E. B. Clark, Milford.	38.00
			L. Browning, New London.	42.50
			E. B. Clark, Woodmont.	40.00
			J. A. Lewis, Willimantic.	40.00

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2842	Complete Manure for Corn and Grain.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	J. E. Holmes, Stratford.	$42.00
2764	Potato Manure.	Quinnipiac Co., New London.	D. N. Clark & Sons, Milford.	39.00
			Carter & Strong, Manchester.	42.00
			B. E. Johnson, Higganum.	34.00
			John Taylor, Old Mystic.	38.00
			J. S. Worthington, Portland.	40.00
			J. F. Silliman, New Canaan.	38.00
			D. C. Wood, Stratford.	38.00
			G. M. Williams, New London.	35.00
			Olds & Whipple, Hartford.	40.00
2816	Potato Manure.	E. Frank Coe, 16 Burling Slip, N. Y.	J. A. Amidon, Wethersfield.	40.00
			N. C. Barker, Lebanon.	36.00
2826	Great Eastern Vegetable, Vine and Tobacco Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	H. S. Hall, (2d) Wallingford.	40.00
			D. E. Stone, Cheshire.	33.00
			L. L. Herman, Noroton.	35.00
			F. Woodford, Farmington.	37.00
			Andrew Bonfoey, Higganum.	35.00
			W. A. Snow, Columbia.	35.00
2834	Reese's Concentrated Potato and Corn Manure.	J. S. Reese & Co., New Bedford, Mass.	W. Tillinghast, Plainfield.	39.00
2897	Stockbridge Fruit Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. A. Paine, Danielsonville.	42.50
2814	Stockbridge Corn Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. A. Lewis, Willimantic.	40.00
			E. S. Lincoln, Chaplin.	38.00
			S. R. Jones, Deep River.	40.00
			J. A. Lewis, Willimantic.	40.00
			City Coal and Wood Co., New Britain.	41.00
			W. B. Martin, Rockville.	41.00

SPECIAL MANURES SAMPLED BY THE STATION—*Concluded.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2814	Stockbridge Corn Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. A. Paine, Danielsonville.	$42.50
			J. M. Williams, Manchester.	39.00
			W. H. Anderson, Putnam.	42.00
2817	Potato, Hop and Tobacco Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	Dix & Wells, Wethersfield.	35.00
			C. A. Young, Danielsonville.	36.00
			W. Tillinghast, Plainfield.	36.00
			L. L. Herman, Noroton.	35.00
			J. E. Leonard, Jewett City.	36.00
			L. Browning, New London.	37.00
			J. H. Fish, Newington.	38.00
			W. C. Russell, Orange.	35.00
			E. Hill, Moosup.	36.00
2853	General Fertilizer for Grain and Grass.	Great Eastern Fertilizer Co., Rutland, Vt.	W. A. Snow, Columbia.	35.00
2878	Potato Manure.	Davidge Fertilizer Co., 121 Front St., N. Y.	Henry Dackett, Andover.	40.00
2881	Stearns' Potato Grower.	Stearns Fertilizer Co., 181 Front St., N. Y.	R. P. Hubbard, Middletown.	34.00

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. Nitrogen Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total Found.	Phosphoric Acid. Total Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
2684	Fairchild's Formula for Seeding Down†	.25	----	2.81	3.06	2.5	----	----	----	16.61†	18.0	----	----	14.67	12.5	13.92	$40.00	$44.73	11.0*
2710	Rogers & Hubbard's Soluble Potato Manure	1.36	.72	3.24	5.32	5.0	1.08	6.20	3.61	10.89	10.0	7.28	----	5.33	5.0	.22	37.00	36.91	0.2
2685	Fairchild's Formula for Corn and General Crops‡	3.40	----	1.92	5.32	5.5	----	----	----	13.30‡	12.0	----	----	12.53	13.0	12.06	45.00	44.67	0.7
2951	Mapes' Seeding Down Manure	.83	.15	2.41	3.39	2.5	----	----	----	15.24§	15.0	----	----	11.71	10.0	11.56	37.50	34.29	9.3
2871	Mapes' Fruit and Vine Manure	.23	.35	1.42	2.00	1.7	8.77	.49	.14	9.40	----	9.26	7.0	11.16	10.0	.52	38.00	34.74	9.4
2819	Bradley's Comp. Manure for Potatoes and Vegetables	.38	1.39	1.99	3.76	3.7	7.06	2.64	.96	10.66	9.0	9.70	8.0	6.49	6.0	6.60	38.00	34.28	10.9
2801	Mapes' Corn Manure	.75	1.06	2.03	3.84	3.7	6.30	3.83	1.97	12.10	----	10.13	10.0	6.76	6.0	6.41	41.00	35.79	14.6
2858	Mapes' Tobacco Manure, Conn. Brand	.83	1.52	2.23	4.58	4.7	6.08	2.50	1.04	9.62	----	8.58	7.8	8.46	7.8	.59	45.00	39.19	14.8
2893	Williams & Clark's Americus High Grade Special for Tobacco	.72	1.17	1.60	3.49	3.7	4.32	4.85	1.88	11.05	8.0	9.17	7.0	6.70	7.0	.20	40.00	34.80	14.9
2824	Mapes' Grass and Grain Spring Top Dressing	1.54	1.44	1.89	4.87	4.1	5.74	2.80	1.69	10.23	7.0	8.54	7.0	5.93	5.0	5.51	41.00	35.55	15.3
2804	Baker's Comp. Potato Manure	----	3.43	.77	4.20	3.3	5.98	1.40	.30	7.68	----	7.38	5.0	9.98	10.0	5.02	42.00	36.11	16.3
2952	Stockbridge Seeding Down Manure	1.56	.15	1.93	3.64	2.5	7.36	2.25	2.25	11.86	12.0	9.61	6.0	4.88	3.0	.34	40.00	33.83	18.2
2975	Miller's Corn Fertilizer	---	----	2.04	2.04	1.4	5.15	4.06	1.06	10.27	7.5	9.21	6.5	4.14	3.0	.34	32.00	26.74	19.6
2836	Baker's Comp. Corn Manure	----	3.49	.73	4.22	4.9	5.97	1.26	.18	7.41	----	7.23	6.3	9.17	7.0	7.02	41.00	34.15	20.1
2950	Miller's Special Potato Manure	----	3.07	.78	3.85	3.7	3.89	3.08	.92	7.89	----	6.97	8.5	7.88	7.0	.37	41.00	33.79	21.3
2759	Mapes' Potato Manure	1.46	.85	1.60	3.91	3.7	3.90	4.32	2.54	10.76	8.0	8.22	8.0	7.32	6.0	.57	43.00	35.36	21.6

* Valuation exceeds cost. † Mixture of chemicals and ground bone, 93 per cent. of which passes holes $\frac{1}{25}$ inch in diameter. ‡ Mixture of chemicals and ground bone, 100 per cent. of which passes holes $\frac{1}{25}$ inch in diameter. § Mixture of chemicals and bone, 30 per cent. of which passes holes $\frac{1}{25}$ inch in diameter.

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

Station No.	Name or Brand.	Nitrogen. Nitrogen as Nitrates.	Nitrogen. Nitrogen as Ammonia.	Nitrogen. Nitrogen, Organic.	Nitrogen. Total Nitrogen Found.	Nitrogen. Nitrogen Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total Found.	Phosphoric Acid. Total Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
2861	Mapes' Tobacco Manure, Wrapper Brand	1.17	3.53	1.42	6.12	6.2	1.18	3.05	1.82	6.05	----	4.23	4.5	11.43	10.5	1.06	$50.00	$41.08	$21.7
2818	Crocker's Ammoniated Wheat and Corn Phosphate	----	.16	2.22	2.38	2.0	7.81	2.14	2.08	12.03	---	9.95	10.0	1.95	1.8	1.92	33.00	26.81	23.1
2840	Bowker's Tobacco Manure	----	1.60	1.87	3.47	3.3	7.13	2.13	3.16	12.42	8.0	9.26	7.0	5.08	5.0	.48	42.50	34.22	24.2
2767	Williams & Clark's Potato Manure	.29	----	2.55	2.84	2.0	5.41	2.96	1.12	9.49	----	8.37	8.0	5.75	6.0	3.09	36.00	28.96	24.3
2821	Bradley's Potato Manure	.29	----	2.34	2.63	2.5	6.43	2.43	1.50	10.36	8.0	8.86	6.0	5.87	5.0	5.79	36.00	28.91	24.5
2763	Stockbridge Vegetable Manure	1.32	.47	1.62	3.41	3.3	6.88	1.83	1.47	10.18	8.0	8.71	7.0	6.73	5.0	4.20	40.00	31.98	25.1
2842	Bradley's Complete Manure for Corn and Grain	.31	1.00	1.98	3.29	3.3	7.47	2.38	1.31	11.16	10.0	9.85	8.0	5.02	4.5	5.27	40.00	31.86	25.5
2764	Quinnipiac Potato Manure	.35	----	2.75	3.10	2.5	4.00	3.82	1.24	9.06	5.0	7.82	5.0	5.40	5.0	.96	37.00	29.35	26.0
2816	E. Frank Coe's Potato Manure	----	.66	1.64	2.30	2.0	7.49	1.69	1.40	10.58	8.0	9.18	8.0	5.69	6.0	.34	38.00	29.89	27.1
2826	Great Eastern Vegetable, Vine and Tobacco Fertilizer	----	----	2.14	2.14	2.1	7.04	1.92	1.20	10.16	----	8.96	8.0	5.97	6.0	5.69	35.00	27.52	27.2
2834	Reese's Concentrated Potato and Corn Manure	.37	----	2.62	2.99	2.7	3.36	4.73	3.14	11.23	7.0	8.09	6.0	6.95	7.5	7.06	39.00	30.61	27.4
2897	Stockbridge Fruit Manure	.64	----	1.79	2.43	2.5	7.31	2.46	2.77	12.54	7.0	9.77	6.0	5.38	4.0	.62	40.00	31.21	28.2
2814	Stockbridge Corn and Grain Manure	.81	----	2.46	3.27	3.2	6.50	2.66	3.07	12.23	10.0	9.16	8.0	4.17	4.0	3.06	40.00	30.73	30.2
2817	Crocker's Potato, Hop and Tobacco Phosphate	----	----	2.07	2.07	2.0	8.40	1.73	1.29	11.42	8.0	10.13	8.0	4.19	3.5	3.70	36.00	27.63	30.3
2853	Great Eastern General Fertilizer for Grass and Grain.	----	----	2.80	2.80	2.9	7.06	1.69	1.27	10.02	----	8.75	8.0	2.43	2.0	2.86	35.00	26.31	33.0
2878	Davidge Potato Manure	1.11	----	1.81	2.92	2.9	6.75	3.16	1.28	11.19	----	9.91	9.0	4.23	4.0	4.48	40.00	29.50	35.6
2881	Stearns' Potato Grower	----	.65	1.36	2.01	2.5	4.14	2.06	2.46	8.66	5.0	6.20	---	5.34	5.0	.62	34.00	24.20	40.5

Home-Mixed Fertilizers.

Following are analyses of all the samples of Home-Mixed Fertilizers which have been sent to the Station this year, with such facts as could be obtained regarding their cost, etc. The formulas by which the fertilizers were mixed are first given, followed by the table of analyses and valuations, with some explanations and further remarks.

2703. Phosphate made by Lawrence Doyle, Harwinton. This was mixed last year, but the formula by which it was prepared was mislaid and cannot be given.

2742. Mixture for corn, made by Dennis Fenn, Milford.

FORMULA.

500 pounds	Ground Bone, costing	$8.25
200 "	Muriate of Potash, "	4.25
100 "	Sulphate of Potash, "	1.50
500 "	Dissolved Bone Black, "	6.50
350 "	Tankage, "	6.13
500 "	Nitrate of Soda, "	12.50
2150		$39.13

Cost of Materials, $36.40 per ton.

2744. Mixture for Potatoes. Made by Dennis Fenn, Milford.

FORMULA.

200 pounds	Muriate of Potash, costing	$ 4.26
300 "	Sulphate of Potash, "	4.50
750 "	Tankage, "	13.12
350 "	Nitrate of Soda, "	8.75
500 "	Dissolved Bone Black, "	6.50
2100		$37.13

Cost of Materials, $35.36 per ton delivered at Milford.

2745. Mixture for Corn, etc. Made by W. L. & S. T. Merwin, Milford.

FORMULA.

1668 pounds	Dissolved Bone Black, costing	$21.68
1334 "	Tankage, "	23.34
334 "	Muriate of Potash, "	7.09
668 "	Sulphate of Potash, "	10.02
333 "	Sulphate of Ammonia, "	12.48
500 "	Fine Ground Bone, "	8.25
4837		$82.86

Cost of materials $34.26 per ton delivered at Milford.

2746. Mixture for Potatoes, etc. Made by W. L. & S. T. Merwin, Milford.

FORMULA.

1668 pounds	Dissolved Bone Black, costing	$21.68
1534 "	Tankage, "	26.84
334 "	Muriate of Potash, "	7.09
668 "	Sulphate of Potash, "	10.02
333 "	Sulphate of Ammonia, "	12.48
4537		$78.11

Cost of materials $34.43 per ton delivered at Milford.

2737. Mixture for Turnips and Grass. Made by W. L. & S. T. Merwin, Milford.

FORMULA.

800 pounds	Dissolved Bone Black, costing	$10.40
400 "	Tankage, "	7.00
600 "	Sulphate of Potash, "	9.00
150 "	Sulphate of Ammonia, "	5.62
300 "	Nitrate of Soda, "	7.50
250 "	Fine Ground Bone, "	4.12
2500		$43.64

Cost of materials $34.92 per ton delivered at Milford.

2743. Mixture for Potatoes. Made by G. F. Platt, Milford.

FORMULA.

800 pounds	Blood, Bone and Meat, costing	$14.00
400 "	Bone, "	6.60
550 "	Dissolved Bone Black, "	7.15
50 "	Sulphate of Ammonia, "	1.87
50 "	Nitrate of Soda, "	1.25
100 "	Sulphate of Potash, "	1.50
50 "	Muriate of Potash, "	1.06
2000		$33.43

Cost of materials $33.43 per ton delivered at Milford.

2738. Mixture made by N. D. Platt, Milford.

FORMULA.

1333 pounds	Tankage,	costing	$23.32
1333 "	Bone Black,	"	17.33
333 "	Ground Bone,	"	5.50
333 "	Sulphate of Ammonia,	"	12.50
333 "	Muriate of Potash,	"	7.08
333 "	Sulphate of Potash,	"	5.00
3998			$70.73

Cost of materials $35.36 per ton delivered at Milford.

2747. Mixture for General Use. Made by R. M. Treat, Woodmont.

FORMULA.

450 pounds	Tankage,	costing	$ 7.88
170 "	Sulphate of Ammonia,	"	6.38
1000 "	Dissolved Bone Black,	"	13.00
280 "	Muriate of Potash,	"	5.95
100 "	Bone,	"	1.65
2000			$34.86

Cost of materials $34.86 per ton delivered at Milford.

Nos. **2703** and **2737** were sampled by private individuals, all the others by a Station agent.

The raw materials from which these mixtures were prepared were analyzed, and knowing their composition and the quantity of each which was used, the composition of the mixtures can be calculated, assuming that all weights were correctly taken, that the materials had not lost or gained moisture and that both mixing and sampling had been thorough. These calculated analyses are given in the table to compare with the actual composition of the mixtures. The agreement of the calculated with the actual composition is not as close as it would have been had the mixing been thorough and the weights correct. In all cases the valuation is lower than if the formula had been exactly followed.

The mechanical condition of these mixtures is good and their chemical composition corresponds with that of the high grade "special fertilizers" and ammoniated superphosphates.

The cost above given is in every case based on the regular cash ton prices of the trade. The *actual* cost in many, if not all, of these cases has been very considerably reduced by special rates

which are given where a number of farmers give a cash order for a car lot or more.

The average cost of materials in these home mixed fertilizers has been $34.23 per ton delivered at the purchaser's freight station. Two dollars will fully cover the cost of screening and mixing. [From a dollar to a dollar and a half is the estimate of those who have done the work.] *At the highest estimate*, therefore, the average cost of these home-mixed fertilizers has been $36.23 per ton. The average valuation has been $34.85 per ton. On the basis of these figures the average difference between cost and valuation has been less than 6 per cent. In factory-mixed goods it has averaged in round numbers 18 per cent.

The attention of those who plan to try home-mixing is called to the following particulars:

1. Nitrogen has come highest this season in ammonia salts, about 18 cents per pound; in nitrates it has cost from 15 1-2 to 16 1-2 cents per pound. Nitrogen in Castor Pomace has cost about the same. Cotton seed meal remains the cheapest source of quickly available nitrogen which it has furnished at 12 to 14 cents per pound. In one case adulterated Cotton seed meal has been found in the Conn. market. See page 25.

2. At present the superphosphate used in home-mixtures is dissolved bone-black, but soluble phosphoric acid can be bought considerably cheaper in dissolved South Carolina rock.

Besides superphosphates there are other sources of phosphoric acid which should be considered. On some soils, Thomas-Slag has given as good results as superphosphates, and there are other native phosphates in which the ratio between cost and agricultural value may be for some soils and crops as favorable as in superphosphates. Fine ground bone too, which contains from 24–30 per cent. of phosphoric acid and from 1.5–4.0 per cent. of nitrogen can be got for from $26–32 per ton; while bone-black superphosphate, containing 17 per cent. of phosphoric acid and a small fraction of 1 per cent. of nitrogen costs $26. Attention is also called to the precipitated phosphate mentioned on page 27. Its mechanical condition is excellent and it supplies readily available phosphoric acid at a low price.

3. Potash in sulphates costs about 6 cents per pound, in muriate from 4 to 4 1-2 cents. Kainit contains large quantities of chlorine and should be regarded as an impure muriate rather than as a sulphate. Potash in kainit costs at retail more than in muriate, about 4.8 cents per pound. As may be seen on page 68, potash as a carbonate and perhaps phosphate, has averaged 5.4 cents per pound in cotton-hull ashes. At the lower figure they are an excellent source of potash. The only objection to their use is the great variation in quality. As a result of this the buyer can have no certainty regarding them without a chemical analysis.

Home Mixed Fertilizers.—Analyses and Valuations.

Station No.	Name.	Nitrogen.					Phosphoric Acid.					Potash.		Chlorine.	Valuation per Ton.	Cost per Ton.
		As Nitrates.	As Ammonia.	Organic.	Total.		Soluble.	Reverted.	Insoluble.	Total.		Found.	Calculated			
					Found.	Calculated				Found.	Calculated.					
2703	Lawrence Doyle, Home Mixture	....	....	3.27	3.27	....	5.15	1.53	.24	6.92	....	7.92	....	....	$31.30	$32.00
2742	Dennis Fenn, Mixture for Corn	3.44	....	1.79	5.23	*5.4*	5.57	4.88	1.38	11.83	*13.0*	4.00	*5.9*	2.17	37.06	36.40
2744	Dennis Fenn, Mixture for Potatoes	2.49	....	1.87	4.36	*4.5*	4.32	3.32	.70	8.34	*11.1*	6.71	*8.7*	2.77	32.84	35.36
2745	W. L. & C. T. Merwin, Mixture for Corn	....	1.51	2.47	3.98	*4.0*	6.05	3.00	.81	9.86	*10.9*	7.42	*7.0*	3.89	35.55	34.26
2746	W. L. & C. T. Merwin, Mixture for Potatoes	....	1.35	1.75	3.10	*4.3*	6.35	3.73	1.50	11.58	*9.3*	6.75	*7.5*	3.61	33.86	34.43
2737	W. L. & C. T. Merwin, Mixture for Turnips and Grass	1.78	1.29	1.49	4.56	*4.8*	6.38	2.11	1.83	10.32	*9.4*	5.64	*6.2*	....	35.63	34.92
2743	G. F. Platt, Mixture for Potatoes	.37	.58	3.56	4.51	*4.9*	4.97	6.07	3.03	14.07	*13.3*	2.30	*2.5*	1.33	36.25	33.43
2738	N. D. Platt, Home Mixture	....	1.75	2.79	4.54	*3.7*	5.37	3.36	2.46	11.19	*14.3*	5.54	*6.4*	3.34	35.87	35.36
2747	R. M. Treat, Mixture for General Use	....	1.80	1.66	3.46	*3.1*	9.25	1.55	.36	11.16	*14.2*	8.19	*7.2*	6.87	35.28	34.86

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.
2643	R. E. Pinney, Suffield	C. H. Wells, Suffield	.46	6.84	.99	19.36	$33.00	$34.62	*5.6*
2652	C. L. Spencer, Suffield	F. C. Root, Suffield	.40	6.68	1.24	22.79	35.00	38.51	*5.2*
2657	R. A. Parker, Warehouse Point	John Mason, Warehouse Point	.64	5.14	1.17	20.00	35.00	33.20	*6.4*
2660	R. A. Parker, Warehouse Point	A. Z. Fowler, Warehouse Point	2.08	7.58	1.09	22.81	35.00	42.50	*4.4*
2661	F. W. Mack, Windsor	H. S. Frye, Poquonock	2.94	7.74	1.95	25.69	30.00	47.91	*2.5*
2671	C. L. Spencer, Suffield	W. H. Prout, Suffield	.54	8.07	1.33	19.07	35.00	36.37	*5.6*
2713	R. A. Parker, Warehouse Point	E. F. Thompson, Warehouse Point	1.23	6.28	2.40	25.28	35.00	42.68	*4.5*
2718	Allen Wilson, Suffield	Arthur Sikes, Suffield	1.10	4.80	4.81	21.10	34.00	36.20	*5.5*
2717	C. L. Spencer, Suffield	Allen Wilson, Suffield	.70	5.09	2.77	17.81	35.00	31.23	*7.0*
2731	Olds & Whipple, Hartford	Olin Wheeler, Buckland	1.62	7.24	1.89	30.24	35.00	50.50	*3.4*
2740	Olds & Whipple, Hartford	E. P. Brewer, Silver Lane	.72	6.16	.28	29.86	35.00	46.33	*4.1*
2757	H. A. Sheldon, West Suffield	F. C. Root, Suffield	.16	4.85	1.55	15.57	35.00	26.83	*8.6*
2862	Sold by H. K. Brainard, Thompsonville	Station Agent	2.22	5.87	2.40	23.37	33.00	41.37	*3.5*
2863	Frank Culver, West Suffield	F. C. Root, Suffield	.17	4.61	2.13	14.16	35.00	25.03	*9.5*
2865	C. L. Spencer, Suffield	F. C. Root, Suffield	.80	3.02	7.58	23.39	35.00	36.91	*5.6*
2866	C. L. Spencer, Suffield	J. E. Hastings, West Suffield	.70	7.49	2.30	22.62	35.00	40.43	*4.8*
2867	C. L. Spencer, Suffield	A. J. Easton, Suffield	.22	4.89	1.72	22.24	35.00	35.07	*6.0*
2868	Allen Wilson, Suffield	Arthur Sikes, Suffield	1.71	7.63	1.70	17.56	35.00	35.94	*5.7*
2869	Allen Wilson, Suffield	Arthur Sikes, Suffield	1.01	4.83	3.42	22.16	35.00	36.83	*5.6*
2870	H. N. Loomis, West Suffield	F. C. Root, Suffield	.26	5.66	2.06	19.96	35.00	33.69	*6.3*
2888	C. L. Spencer, Suffield	J. H. Ford, Suffield	.21	7.27	1.77	25.73	35.00	43.18	*4.4*
2906	Olds & Whipple, Hartford	Station Agent	1.44	6.30	.54	33.49	35.00	52.16	*3.5*
2867	James Van Gelder, Suffield	F. C. Root, Suffield	trace	5.37	1.83	15.04	35.00	26.83	*8.7*
2969	Dudley Webster, West Suffield	F. C. Root, Suffield	.64	8.61	.56	23.22	35.00	42.03	*4.5*
3058	J. E. Soper & Co., Boston, Mass.	H. S. Frye, Poquonock	trace	7 69	.43	25.24	30.00	42.00	*3.6*

Miscellaneous Fertilizers and Manures.

Cotton-Hull Ashes.

In the table on the preceding page, are tabulated 25 analyses of Cotton-Hull Ashes analyzed during the present year. It will be seen that the highest percentage of potash in these samples is 33.49, the lowest 14.16, and the average 22.3 per cent. The actual cost of potash per pound (valuing the water-soluble and and citrate-soluble phosphoric acid at 8 and 7½ cents per pound respectively, and insoluble phosphoric acid at 2 cents) has ranged from 9½ cents to 2½ cents, or 5.4 cents per pound on the average, or about half a cent per pound less than it costs in sulphate of potash.

Only potash soluble in water is determined in the analyses. That insoluble in water has little immediate value.

A complete analysis of Cotton-Hull Ashes is here given, which shows the state of the different ingredients as regards solubility.

Cotton-Hull Ashes.—*Complete Analysis.*

	Soluble in water.	Insoluble in water.	Total.
Potash (K_2O)	25.20	2.65	27.85
Soda (Na_2O)	.50	.80	1.30
Lime (CaO)	none	5.23	5.23
Magnesia (MgO)	.20	11.04	11.24
Oxide of iron and alumina	none	1.64	1.64
Phosphoric acid (P_2O_5)	1.52	8.29	9.81
Sulphuric acid (SO_3)	2.32	0.09	2.41
Carbonic acid (CO_2)	8.28	3.31	11.59
Chlorine	.21	none	.21
Silica and sand	.16	9.34	9.50
		water and charcoal	19.27
	38.39	42.39	100.05
Deduct chlorine equivalent to oxygen			.05
			100.00

Wood Ashes.

2692. Ashes from hard wood. Sampled and sent by D. Fenn, Milford.

2736. Canada Ashes. Sampled and sent by W. H. Burr, Westport, from a lot bought by him of J. B. Nash, Westport, for $11.50 per ton.

2850. Screened Canada Ashes. Sampled by Station Agent from stock of C. S. Gillette, Cheshire. Price $11.00 per ton.

2935. Ashes from stock bought by T. R. Dawley, Griswold, of Ezra Chazy, Baltic, for 20 cents per bushel. Sampled and sent by Station Agent.

2715. Damp Wood Ashes from the Coe Brass Mfg. Co., Torrington. Sampled and sent by C. H. Eno, Simsbury. They contain 15.3 per cent. of water.

3010. Screened Wood Ashes from James Hartness Soap Co., Detroit, Mich. Sampled and sent by N. S. Platt, Cheshire, from stock purchased by him. Guaranteed to contain 5 per cent. of potash.

Analyses.

	2692	2736	2850	2935	2715	3010
Potash, soluble in water	4.50	3.69	3.71	4.30	1.96	4.40*
Phosphoric acid	2.70	1.61	1.45	2.32	2.09	1.63

* Total potash 5.27.

The unleached ashes which are in market now are of considerably poorer quality than they were in former years.

Lime Kiln Ashes.

2076. Sampled and sent by D. E. Peck, Whigville.

Water	19.54
Carbonate of lime	49.00
Lime chiefly as hydrate	4.11
Phosphoric acid	.49
Potash	.48
Coal and other matters by difference	26.38
	100.00

Limestone.

2970. White with crystalline structure, **2971** gray, from Canaan.

Analyses.	2970	2971
Insoluble in acids	.15	.48
Oxide of iron and alumina	----	.20
Lime	56.02	31.31
Magnesia	----	21.03
Carbonic acid by difference	43.83	46.98
	100.00	100.00

2970 is practically pure carbonate of lime, the mineral calcite. **2971** is a mixture of carbonate of lime and carbonate of magnesia, the mineral dolomite.

Land Plaster.

2806. Nova Scotia Plaster, sent by Robt. Aitkin, Shaker Station.

2887. Cayuga Plaster sent by E. P. Halley & Co., Coscob.

Analyses.	2806	2887
Pure hydrated sulphate of lime	96.99	65.40
Carbonate of lime	2.27	27.27
Other matters by difference	.74	7.33
	100.00	100.00

Tank Water and Settlings.

2712. Water in which bones have been boiled to remove grease. Sent by C. A. Sanderson, Moodus.

2704. Waste Scouring Solution from wool scouring works.

2705. Sediment from Tanks in which wool is scoured. Both sent by J. A. Bill, Lyme.

Analyses.	2712	2704	2705
Water	----	----	32.33
Sand	----	----	50.78
Organic matter	----	.55	6.72
Nitrogen	1.14	.02	.14
Phosphoric acid	----	trace	.15
Potash	----	.16	.69

Wool Waste.

2968. A sample of Wool Waste sent to the Station by some one in the State, whose name and address have been mislaid, thus making a report to him impossible when the analysis was completed, contained

Nitrogen as ammonia	.38
Nitrogen, organic	6.75
Total nitrogen	7.13
Phosphoric acid	.14
Potash	.14

Some forms of wool waste have proved to be valuable as nitrogenous manures and others are quite inert. This material was damp and seemed to be already rotting, so that it may be presumed that the nitrogen in it was becoming available.

Farm Manure.

2754. Cow Manure. From milk cows fed on hay and stover,—one feed of each per day—corn meal, wheat bran and a moderate quantity of brewers' grains. The manure was kept closely packed in a manure house having a cement floor.

2755. Hog manure from swine fed on garbage and corn meal. Manure exposed to the weather in the sties. The extraordinary quantity of phosphoric acid in the manure comes from the bone contained in the garbage.

Samples of both these manures were drawn by an officer of the Station with all possible care. The manure was from a lot used in field experiments at the farm of J. H. Webb, Esq., Hamden, and will be again referred to in the discussion of field experiments.

Analyses.	Cow Manure. 2754	Hog Manure. 2755
Water	82.42	65.23
Organic and volatile matters	15.33	25.73
Ash	2.27	9.04
	100.00	100.00
Contained in the Ash:		
Potash	.300	.102
Soda	.114	.111
Lime	.280	1.476
Magnesia	.121	.119
Oxide of iron and alumina	.063	.488
Phosphoric acid	.204	.808
Sulphuric acid	.075	.171
Chlorine	.123	.054
Sand and silica	.990	5.711
	2.270	9.040
Contained in the organic and volatile matters:		
Nitrogen as ammonia	.10	.02
Organic nitrogen	.32	.56
Total nitrogen	.42	.58

Rockweed and Sponge.

Some species of marine plants are more or less used on the coast as fertilizers, and are thought much of for corn land; particularly the "round-stalked rockweed" and "flat-stalked rockweed," for which farmers sometimes pay 5 cents per bushel in its green state as it is cut from the rocks at low tide. It is plowed under green, and is popularly believed to lose much of its value if allowed to dry before turning under.

Analyses of several species have been made, the samples being supplied by Mr. Walter Merwin, of Milford, March 24.

2724. Round Stalked Rock-Weed. *Ascophyllum nodosum.*

2725. Flat Stalked Rock-Weed. *Fucus vesiculosus.*

2726. A coarse Sponge. Species not determined.

2727. A finely branching Sea Weed. Species not determined.

2728. "Irish Moss." *Chondrus crispus.*

ANALYSES.

	Rockweed round-stalked. 2724	Rockweed flat-stalked. 2725	Sponge. 2726	Sea Weed. 2727	Iceland Moss. 2728
Water	82.71	84.34	86.13	81.39	80.84
Organic and volatile matters	13.52	12.09	5.46	12.72	14.43
Pure ash	3.97	3.57	8.41	5.89	4.73
	100.00	100.00	100.00	100.00	100.00
The organic matter contains nitrogen,	.53	.48	.58	.73	.77
The ash consists of—					
Potash	.61	.54	.16	1.30	1.00
Soda	.90	.85	.72	.58	
Lime	.30	.27	.08	.23	
Magnesia	.24	.23	.14	.18	
Oxide of iron and alumina	.01	.02	.23	.12	
Phosphoric acid	.10	.09	.14	.18	.17
Sulphuric acid	.82	.67	.17	.84	
Chlorine	.80	.82	.77	.96	
Sand and silica	.12	.16	6.17	1.72	.54
Other matters by difference	.05	.10	----	----	
	3.95	3.75	8.58	6.11	
Deduct oxygen equivalent to chlorine,	.18	.18	.17	.22	
	3.77	3.57	8.41	5.89	

The analyses show as large a percentage of nitrogen in all the samples as is contained in good stable manure, but less phosphoric acid. The "rock weeds" have as much potash, and the fine sea-weed and Irish moss a good deal more than ordinary stable manure. In the opinion of those who use rock-weed, fresh, it is as quick in its action as stable manure. Some maintain that Rock-weed gathered in the fall is best. Others prefer the spring-crop.

No attempt was made to determine the small quantity of iodine which the samples probably contain. With the volatile matter is included a portion of the sulphur which the seaweeds contain in considerable quantity.

Direct determinations of total sulphur made in samples Nos. **2724** and **2725** gave .43 and .34 per cent. respectively of sulphur in the fresh substance.

PIGEON MANURE.

2649. A dry sample, containing very little foreign matter, feathers, straw, etc. Sampled and sent by A. D. Cooke, Hartford.

ANALYSIS.

Water	9.55
Organic and volatile matters*	62.38
Potash	1.07
Soda	.65
Lime	2.12
Magnesia	.79
Oxide of iron and alumina	1.08
Phosphoric acid	1.83
Sulphuric acid	.57
Chlorine	.47
Sand and silica	18.12
Carbonic acid and undetermined	1.37
	100.00
*Containing nitrogen as ammonia	.47
Organic nitrogen	3.43
Total nitrogen	3.90

This material contains as much or more nitrogen than most commercial fertilizers, besides 1 per cent. of potash and 1.8 per cent. of phosphoric acid. The "dung" of fowls contains not only the undigested food, but also, in solid form, the excretions of the kidneys, which in cattle are voided as urine, and are apt to be lost, both by drainage and by rapid fermentation. This, the richer food, and the fact that the dung of fowls is comparatively dry, explain the higher percentage of nitrogen, phosphoric acid and potash in it.

REVIEW OF THE FERTILIZER MARKET.

FOR THE TWELVE MONTHS ENDING DEC. 31, 1890.

NITROGEN.

Nitric Nitrogen.

The *wholesale* quotation of nitrogen in nitrate of soda has fallen very decidedly during the year. The average price during the first five months of 1889 was 16.1 cents per pound, for the same period in 1890 the average price was 11.9 cents. In December, 1890, it was quoted at 11.2 cents per pound. See monthly quotations on page 79.

The *retail* price of nitrogen in nitrate of soda in this State during the last season has been about 16 cents per pound.

Ammonic Nitrogen.

The *wholesale* price of nitrogen in sulphate of ammonia was about a cent lower per pound during the first five months of 1890 than during the same period in 1889. But from July on, the wholesale price in 1890 has ruled about a cent higher in 1890 than in 1889. This has been caused in part by the unusual demand for ammonia for ice-machines during the last summer. The wholesale price of nitrogen in this form in December, 1890, was 16½ cents per pound. See monthly quotations on page 79.

The *retail* price of nitrogen in sulphate of ammonia in this State the past year has been about 18 cents per pound.

Organic Nitrogen.

The wholesale price of nitrogen in Dried Blood has also been decidedly lower in 1890 than in the previous year. Thus for the first five months of 1889 the average *wholesale* price of nitrogen in blood was 16.1 cents per pound; for the same months in 1890, 11.9 cents per pound. It was quoted in December last as 11.2 cents. The monthly quotations are given on page 79. Very little dried blood has been retailed in Connecticut the past year.

The wholesale quotations of nitrogen in Azotin have followed the same changes as in Blood, always being a fraction of a cent higher.

Dried Fish Scrap, which is considerably used in mixed fertilizers, was quoted in January, 1889, at $22.50 per ton, but has steadily fallen to $19.25.

As has been already noticed in this report, nitrogen has retailed in this State the past year at 15.5 cents per pound in Blood, from 15.6 to 16.8 cents in Castor Pomace and from 11.7 to 13.8 cents per pound in Cotton Seed Meal. Cotton Seed Meal still remains the cheapest source of available organic nitrogen.

PHOSPHATIC MATERIALS.

Refuse Bone Black, quoted at the beginning of the year at $19.45 per ton wholesale fell to $18.50 in September at which price it is still quoted.

Rough and Ground Bone have been quoted at $21.50 and $26.50 per ton wholesale through the whole year.

Ground Charleston Rock, quoted at wholesale in January at $11.25 per ton fell to $10.65 in July, $9.75 in August and has been quoted at the same figure ever since.

Acid Phosphate, containing 14 per cent. available phosphoric acid, was quoted at 81¼ cents per unit, equivalent to 4.06 cents per pound for available phosphoric acid, in January. It fell in July to 73¾, equivalent to 3.7 cents per pound for available phosphoric acid, and is still quoted at that price.

POTASH.

MURIATE OF POTASH.

The wholesale quotations of this article show smaller fluctuations than those of any other commonly used fertilizer. They have varied between 3.55 cents per pound for actual potash in December last and 3.64 cents per pound, the quotation during all the earlier part of the year.

Actual potash in the form of muriate has been retailed in Connecticut at about 4.2 to 4.4 cents per pound.

Double Sulphate of Potash and Magnesia.

The wholesale quotation remained steady at 4.42–4.44 cents per pound for actual potash till November, when it fell to 4.27 and in December rose to 4.53.

The retail price in Connecticut this year has been a little less than 6 cents per pound.

High-Grade Sulphate of Potash.

This material contains about the same per cent. of potash as the muriate but is almost entirely free from chlorine. The wholesale quotation made actual potash cost 4.77 cents per pound from January to September. Under the new tariff law it is imported duty-free, and in consequence the price fell to 4.17 cents in October, and 4.06 cents in November. In December it rose again to 4.31. It has not been retailed in Connecticut during the past season.

Kainit.

The wholesale price of Kainit rose from $10.70 per ton in January to $11.00 in April, fell to $10.37½ in July, remained steady till December and then fell to $10.00.

In general nitrogen in blood, azotin, nitrate of soda and fish scrap has fallen decidedly in price during the year. The nitrogen of sulphate of ammonia has, on the other hand, risen considerably.

Charleston Rock is considerably lower, Bone Black somewhat lower, Bone has remained constant through the year.

Acid phosphate made from South Carolina rock is considerably lower than at the opening of the year.

Muriate of Potash, Double Manure Salt and Kainit are quoted about as they have been through the year, but high-grade sulphate is very considerably lower.

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 8½ units of ammonia, and if quoted at $2.25 per unit, a ton of it will cost 8½ × 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 the 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 lb.	Nitrogen	costs	19.5	cents per lb.
"	3⅞	"	"	"	18.9	"
"	3¾	"	"	"	18.3	"
"	3⅝	"	"	"	17.6	"
"	3½	"	"	"	17.0	"
"	3⅜	"	"	"	16.4	"
"	3¼	"	"	"	15.8	"
"	3⅛	"	"	"	15.2	"
"	3	"	"	"	14.6	"
"	2⅞	"	"	"	14.0	"
"	2¾	"	"	"	13.4	"

Commercial Nitrate of Soda averages 95 per cent. of the pure salt or 15.6 per cent. of nitrogen.

If quoted at 3 cents per lb.	Nitrogen costs 19.2 cents per lb.
" 2⅞ "	" " 18.3 "
" 2¾ "	" " 17.6 "
" 2⅝ "	" " 16.9 "
" 2½ "	" " 16.0 "
" 2⅜ "	" " 15.2 "
" 2¼ "	" " 14.4 "
" 2⅛ "	" " 13.6 "
" 2 "	" " 12.8 "
" 1⅞ "	" " 12.0 "
" 1¾ "	" " 11.2 "

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 July, 1887. The price given for each month is the average of the four weekly quotations in that month. Sulphate of ammonia is assumed to contain 20.5 per cent. and nitrate of soda 15.6 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			
		Blood. Cents per pound.	Azotin or Ammonite. 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 of Potash. Cents per pound.	Available Phosphoric Acid in Dissolved South Carolina Rock. Cents per pound.
1887.	July	13.1	14.0	12.0	14.5	3.41	---	---	---
	August	12.6	13.4	11.8	14.5	3.40	---	---	---
	September	12.1	12.5	12.2	14.7	3.36	---	---	---
	October	12.1	12.3	13.0	14.9	3.36	---	---	---
	November	11.8	12.2	12.7	14.7	3.41	---	---	---
	December	12.1	12.3	13.8	14.9	3.46	4.08	---	---
1888.	January	12.2	12.3	13.8	14.9	3.48	4.24	---	---
	February	12.6	12.6	13.3	14.9	3.48	4.49	---	---
	March	13.9	13.6	13.1	14.9	3.46	4.15	---	---
	April	13.9	13.6	12.9	14.9	3.46	4.11	---	---
	May	13.9	13.6	12.8	15.2	3.52	4.24	---	---
	June	14.0	13.6	13.1	14.9	3.50	3.86	---	---
	July	14.2	13.9	13.1	14.9	3.50	3.86	---	---
	August	14.5	14.2	13.2	14.9	3.50	3.86	---	---
	September	14.6	14.2	13.9	15.3	3.71	4.38	---	---
	October	15.0	15.0	14.1	15.8	3.71	4.47	---	---
	November	15.9	16.2	14.6	16.4	3.72	4.48	---	3.89
	December	16.0	16.5	15.2	16.4	3.71	4.53	---	3.89
1889.	January	16.3	16.6	15.1	16.6	3.66	4.63	5.00	4.30
	February	16.5	17.0	15.0	16.6	3.66	4.44	5.01	4.37
	March	16.5	17.1	15.2	16.6	3.66	4.48	4.88	4.20
	April	16.0	16.1	14.6	16.2	3.57	4.44	4.85	4.10
	May	15.1	15.2	13.8	15.7	3.64	4.49	4.65	4.06
	June	14.9	14.6	12.8	15.2	3.64	4.53	4.60	4.06
	July	14.6	14.2	12.5	15.1	3.64	4.53	4.56	4.06
	August	14.6	14.2	11.9	15.0	3.64	4.53	4.56	4.06
	September	13.9	14.2	12.1	15.0	3.64	4.44	4.66	4.06
	October	13.6	13.7	12.2	15.0	3.64	4.44	4.67	4.06
	November	13.2	13.6	12.3	15.4	3.64	4.44	4.75	4.06
	December	12.6	13.3	12 4	15.4	3.64	4.44	4.98	4.06
1890.	January	12.2	12.7	12.1	15.4	3.64	4.44	4.97	4.06
	February	12.1	12.5	12.0	15.4	3.64	4.44	4.97	4.06
	March	11.9	12.2	11.9	15.4	3.64	4.44	4.89	4.06
	April	11.5	12.2	11.2	15.4	3.64	4.42	4.77	4.06
	May	11.6	12.2	11.2	15.3	3.62	4.42	4.77	4.05
	June	11.6	12.1	11.2	15.8	3.62	4.42	4.77	4.00
	July	11.6	12.0	11.2	16.6	3.62	4.42	4.77	3.69
	August	11.3	11.5	11.0	16.6	3.62	4.42	4.77	3.69
	September	11.0	11.3	11.1	16.6	3.62	4.42	4.77	3.69
	October	11.1	11.7	11.6	16.5	3.62	4.42	4.17	3.69
	November	11.2	11.4	11.6	16.5	3.55	4.27	4.06	3.69
	December	11.2	11.4	11.6	16.5	3.62	4.53	4.31	3.69

REPORT OF THE MYCOLOGIST,

Dr. Roland Thaxter.

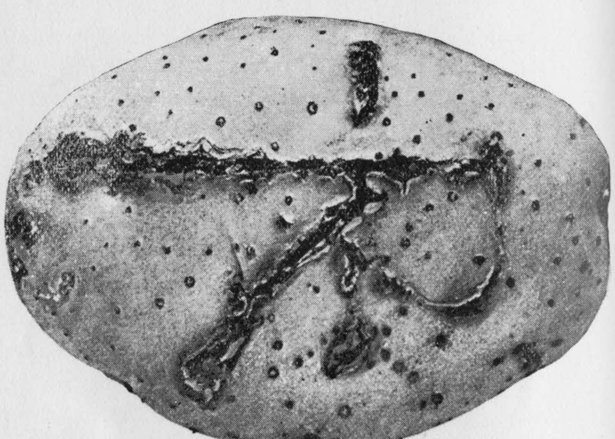
During the past season the injury from fungus diseases was much less than in the previous year owing to the absence of warm damp weather through the early summer, which was more than usually dry and therefore unfavorable for their development. For this reason several experiments which had been planned were necessarily abandoned for lack of material to work with, and the attention of the mycologist has been for the most part divided between further trials of fungicides for the treatment of certain fungus diseases, and an investigation of the "potato scab," which proved of such considerable interest and importance that it has been made the special subject of inquiry during the season. An elaborate experiment in regard to the effect of certain chemicals upon the "onion smut," in continuation of last year's work on the same subject, proved almost valueless owing to the failure of the seed; and further greenhouse experiments do not point to the conclusion that more favorable results, from the sulphur treatment, are to be looked for than were obtained during the season of 1889.

The success which has attended the use of fungicides by the Station has led the writer to give somewhat more specific directions for their preparation and use, as an extension of Bulletin 102 issued by the Station in March, 1890. The importance of the injuries due to fungi and known under such names as blight, rust, mildew, etc., and the fact that many of them are readily remedied does not receive sufficient recognition in the State, which should not be behind other farming communities both in this country and abroad in reaping the benefit of whatever information is obtainable on the subject. The present opportunity is therefore taken again to urge farmers to communicate with this department of the Station, and to furnish information where serious damage is being done to their crops through injuries of the nature just referred to. Attention is called to the photographic reproduction facing p. 99, which shows very well what may be

Fig. 1.

Specimen of ordinary "deep" Scab.

Fig. 2.



"Deep" Scab, induced by inoculation, in form of monogram R. T.

done at small expense to prevent premature defoliation of fruit trees by fungi; and also to the fact that treatment applied to grapes this year has resulted in a difference equivalent to that between a nearly full crop and an almost total failure. Such demonstrations, supported by similar results in various sections of the country, show that farmers can no longer afford to neglect the subject of fungus diseases and their treatment, and it is hoped that greater interest in it may be shown during the coming season and more frequent calls made for information from the Experiment Station.

THE POTATO "SCAB."*

It is a well-known fact that the theories and explanations which have been advanced to account for certain diseased conditions of the surface of potato tubers generally known as "Scab," are nearly as numerous as the experimenters who have studied the disease, but until quite recently no satisfactory demonstration of what the active agent really is which gives rise to the condition, has been advanced; although the subject has occupied scientific investigators from time to time for upwards of half a century.

The recent demonstration just referred to is that of Mr. H. L. Bolley, which was published in Agricultural Science, Vol. IV, p. 243, having been previously presented as a paper at the meeting of the American Association for the Advancement of Science, Aug. 26 of the present year. Mr. Bolley's work was so carefully done and his results appear to be so conclusive in bearing out his statement that the disease originates from the action of a specific bacterium, that the subject might seem exhausted and not open to further investigation. The observations of the writer, however, begun without any knowledge of Mr. Bolley's work, although they do not, as will be seen, disprove the accuracy of his investigations, have nevertheless led to quite different results which seem to show that the question "what is potato 'Scab'" is still a very pertinent one.

It is hardly necessary to remark that the investigation of the writer has been in a great measure preliminary, having been commenced about midsummer of the present year, and is based largely

*The substance of the present notice was presented in a paper by the writer read before the botanical section at the meeting of the Association of Agricultural Colleges and Experiment Stations at Champaign, Ill., Nov. 12, 1890.

on greenhouse cultures, which were necessarily made on a small scale; work upon the subject out of doors not being possible at the time when the organism producing scab had been isolated and obtained pure by artificial cultures in sufficient quantities for inoculations. Experiments of a practical nature, therefore, were not attempted and the main object in view has been to isolate, and if possible to demonstrate what is the active agent in causing the disease investigated. Having, in the writer's opinion at least, succeeded in doing this pretty conclusively, a rational basis is gained for practical experiments which will be undertaken at the Station during the coming year.

The theories which have been previously held concerning the origin or cause of "Scab" may here be briefly alluded to; although for further information on the subject the recent papers of Prof. Humphrey* and Mr. Bolley† should be consulted; the latter especially containing a very full bibliography of the subject.

Among the causes of an inorganic nature which have been said to produce the disease may be mentioned the following: *Excessive moisture* in the soil, supposed to affect the lenticels, which constitute the small rough dots scattered over the surface of normal tubers, producing an abnormal growth of corky tissue at such points, which may extend to the adjacent superficial tissue and be associated with more or less decay. *Mechanical irritation* induced through foreign substances in the soil which may act as a direct irritant to the surface of the tubers; the "Scab" being the result of an attempt to repair the injury through an abnormal corky growth at such points; also accompanied or followed by more or less decay. *Chemical action* due to the presence of certain substances in the soil, such as lime or oxide of iron, which through an irritant action might lead to similar results. *Fertilization* especially by stable manure which has been definitely observed to influence the prevalence of the disease; a fact which has been explained on the supposition that it may furnish conditions favorable for the action of one or more of the supposed causes already enumerated.

It is needless to examine these different theories in detail, since in all cases they lack the confirmation of crucial experiments and are involved and involve each other in a mass of contradictions, with a result of nothing definite in any case. The simple fact

* Report of the Mass. Agr. Exp. Station 1889, p. 131, and 1890, p. 214. † l. c.

that scab occurs very commonly on light dry land entirely free from extraneous material which could produce external irritation, and regardless of lime or other chemical substances in the soil; also that barn manure, not infrequently at least, yields a clean crop, is sufficient to show clearly that none of these supposed causes is in itself sufficient to account for the phenomenon. The best that can be said of them is, that in some cases they may involve conditions favoring the prevalence of the disease; but the question of its cause they leave untouched.

Turning to the theories which connect the "scab" with the action of some organism, vegetable or animal, the "insect" theory is one very commonly entertained, especially by farmers, "insects" including earth worms. This idea is based upon the fact that scab spots form an attractive feeding ground for a variety of insects, especially wire worms, myriapods and mites, the common occurrence of which, especially in the deeper scab spots, has led to the belief that the two were directly associated. That this is not the case has been shown by careful observation, the only connection between the two resting on the fact that the injury already existing from a quite different cause is often extended by them very considerably.

On the botanical side perhaps the earliest explanation of the cause of scab is that of Dr. Wallroth,* who in 1842 attributed it to the action of a fungus which he called *Erisybe subterranea.* This fungus, however, which is a conspicuous form and very readily recognized, is now known to have no connection with the ordinary forms of scab and has not even been found in this country. The disease which it produces, although having some resemblance to scab in its earlier stages, is yet quite distinct and peculiar, and is more properly known as "smut" of potatoes; the fungus developing in the diseased tubers beneath the skin, which finally cracks, liberating a powdery greenish mass of large, multicellular spores. The same thing appears to have been described and figured as "*Protomyces*" by Martius,† by Berkeley‡ as *Tubercinia scabies*, and distributed, according to Smith,§ by Rabenhorst as *Rhizosporium solani*. It was placed in the genus *Sorosporium* by Fischer de Waldheim‖ under the name *S. scabies*

* Linnæa, 1842, p. 332.
† De Aardappel-Epidemie etc. Genootsch. v. Landb. en Kruidk. t. Utrecht, 1843.
‡ Jour. Roy. Hort. Soc., vol. 1, 1846, p. 33, fig. 30–31 [Sec. Smith].
§ Diseases of Field and Garden Crops, p. 35.
‖ Aperçu System d. Ustilagineés, 1877, p. 33.

and is there retained by Saccardo,* although Dr. Wallroth's name would appear to be the oldest.

Beyond general allusions to a possible fungus origin this so-called smut is apparently the only true fungus which has been in any way suggested as a cause of any scab-like disease of potato tubers. Within a few years, however, Dr. Brunchorst† of Sweden, claims to have shown that a disease of potatoes occurring in that country, which he considers identical with the ordinary and destructive forms of scab, is due to one of the Mycetozoa or slime-fungi, allied to that producing the club root of cabbage. This organism, which he calls *Spongospora solani*, has not been found associated with any American form of the disease; and Prof. Humphrey is doubtless correct in his opinion, based partly on photographs of diseased tubers sent by Dr. Brunchorst, that the latter's "*skurv*" and our "scab" are quite different diseases.

The most recent contribution concerning the cause of scab from a botanical standpoint is that of Mr. Bolley, already referred to, which embodies the first experimental demonstration of a definite cause of scab that has yet been given. This author shows through careful experiments, by means of inoculations from pure cultures, that the specific agent in his disease is a species of Bacterium which he found always associated with it; and which when used as a medium for inoculations under proper conditions reproduced the disease in growing tubers. It is to this group of what may be called "vegetable" theories that the writer is constrained to add yet another as a result of his observation and experiments.

General Characteristics of the Disease.—The disease as it occurs in Southern Connecticut, where the writer has had an opportunity of examining it, first shows itself as a minute, reddish or brownish spot on the surface of the tuber, often making its appearance when the latter is very young, and sometimes not until it has reached a considerable size. This discoloration very commonly, though not invariably, has its origin in one of the roughened points, or lenticels, which are scattered over the surface of the potato, and after it has once appeared may extend quite rapidly to the adjacent tissue; becoming deeper in color and being associated with an abnormal corky development of the parts involved which often cover a considerable area. This area may

* Sylloge, vii, 513.

† Ueber eins uhr. verbr. Krankheit d. Kartoffelknollen. Bergens Museum Aarsberetnung, 1886: p. 217–226. Bergen, 1887.

constitute a more or less irregular scab-like crust over the surface or more frequently may become deeply cracked and furrowed, the depth and extent of the injury depending in a great measure upon the stage at which the tuber first became diseased; those which are attacked while very young showing, as might be expected, by far the most deep seated injury. The presence of bacterial decay together with the growth of various forms of saprophytic fungi, for which such diseased spots form a congenial substratum, serve to extend the injury very considerably, especially when the tubers are left in the ground for some time after maturity. Under such conditions also the work of injury is completed very frequently by various insects, more especially by wire worms, myriapods and mites, which feed upon the decaying portions of the tuber till the cavities may be scraped quite clean down to the sound tissues; so that the surface may present the appearance of a succession of rounded pockets. In severe cases where, however, there has been little extension of the injury by insects the potato presents the appearance figured on Plate I, fig. 1.

The description just given may seem superfluous, the described condition being so familiar; yet it has seemed best to give it in consideration of the uncertainties which are attached to the meaning of the term "scab," partly as a result of the numerous theories held concerning it, and partly on account of actual differences presented by the disease itself.

The attention of the writer was first specially attracted to this subject in July of the present year after examining a number of the tubers in various stages of the disease in question which were brought to the laboratory from the town of Hamden. It was then noticed that the majority of diseased spots on these tubers were associated with the presence of a peculiar grayish mould-like appearance, especially prominent about the edges of the younger spots and frequently discernible without the aid of a hand lens. An attempt was made at the time to transfer a portion of this gray substance to a slide, in order to gain some knowledge of its true character by examining it under the microscope; but the attempt was unsuccessful, the substance seeming to disappear when touched with a needle. Scrapings from the diseased surface, where this film was observed, when placed under the microscope showed nothing characteristic which could be identified as connected with the object sought for, and the same result attended the examination of sections cut from the scab spots. The subject was then laid aside for a time until, on visiting the field from which the potatoes in question had been brought, it was found that the diseased tubers, which constituted a large percentage of the crop, in almost every case showed the more or less distinct presence of the same grayish material previously observed. In fact it was invariably visible in the younger spots when due care was taken to uncover the potatoes so as to avoid unnecessary friction, and to examine them while still moist. When rubbed against the earth, or when the surface was allowed to become dry, the gray material was often found to have disappeared entirely. Having ascertained that the appearance described was not local in any part of the field, but was present wherever diseased potatoes were examined, a number of the latter on which it was most conspicuous, were placed, while still moist, in a tight tin box where they were left for twenty-four hours or more. At the end of this time the gray growth was found to have greatly increased; being visible to the naked eye on all the scab spots, and no difficulty was met with in taking enough of it on a needle to make sure of recognizing it under the microscope. It was then found to consist of bacteria-like bodies with a strong tendency to cohere in an amorphous-looking mass, very repellant of water and even to some extent of absolute alcohol. The bodies themselves were rod-like, of various lengths, and among them numerous spirally-coiled forms were peculiar and conspicuous. Pressure on the cover glass, applied to separate the mass, caused it to break up entirely into bacillus-like pieces exactly resembling a group of minute bacteria.

After examining a number of fields affected by the disease in different localities, and finding that this gray organism was its invariable accompaniment when once recognized and sought for, usually visible to the naked eye when due care was taken in removing the tubers from the ground, its isolation and cultivation were undertaken, and by a few transfers it was finally obtained quite pure. The nutrient media used for this purpose were gelatine and agar peptone broths and potato decoctions, sterilized slices of potato being also used for the same purpose. Drop cultures were made in Van Tieghem cells, in which decoctions of horse dung or of potato were used as the nutrient fluids. In all these substances, both fluid and solid, the organism was found to grow with vigor.

General Characters of the Scab fungus when cultivated.—The gross appearance of the cultures on solid media should be noted, since it is quite peculiar and varies considerably according to the substance used. In all cases the growth of the organism when it is in direct contact with the air is accompanied by a peculiar dark stain, although when a culture is made so that the growth takes place wholly within the nutrient medium, little or no discoloration is produced. This stain is very characteristic, and varies considerably in intensity according to the substances used for cultivation. On slices of potato as well as on potato agar or potato gelatine decoction it is very striking—smoky black, almost opaque, and diffuses itself to a considerable distance from the point of growth. On gelatine peptone broth the stain is dark rust brown, while on agar peptone broth it is comparatively pale. As the culture grows old the stain loses its intensity, diffusing evenly through the jelly, which becomes reddish brown and more or less translucent.

In all cases a neutral medium is the best for cultures. Slight alkalinity, and to a less degree slight acidity, appear to retard the growth. This is strikingly shown in liquid cultures made on a large scale, in which also the changes of color are very marked. The connection between the black discoloration and some alkaline product formed by the growth of the fungus seems evident, since both neutral and acid solutions are made alkaline by it after the black discoloration has begun. In the latter case the solution retains its natural yellowish color until its acidity is overcome. Alkaline salts readily impart a brownish color to potato decoction; but it is far less intense than that produced by the fungus, and a solution already thus stained is only slightly changed by the fungus, or changes very slowly.

The gross appearance of the organism itself is also quite peculiar and somewhat variable, being most characteristic on the potato bases. On potato slices it tends to become heaped up so as to form a blackish, viscid-looking, lobulated pustule, without spreading to any great extent over the surface on which it grows. On potato agar it produces a circular, lichenoid, livid brownish growth extending evenly over the surface in all directions, slightly convex, firm and viscous-looking, with scalloped margin and radial and concentric furrows. On agar peptone broth the growth is less convex and less characteristic; in some cases viscid and slightly lichenoid, but usually covered with a white, flocculent stratum which eventually turns grayish, and resembles exactly the grayish film originally found in connection with the scab spots, both in appearance and microscopic characters, and constitutes the "fructification" of the fungus. This fructification may make its appearance at points on any solid culture medium, especially when the latter has become somewhat dry; but potato agar cultures may grow for months without showing any sign of it, the growth remaining smooth and viscid-looking over its whole surface.

The life history of the Scab fungus, as shown by a microscopic examination of the drop cultures and those on solid media, is briefly this. One of the longer or shorter rods or spirals, or any portion, however small, torn from the ordinary vegetative filaments, when placed in a nutrient medium, produces directly an intricately branched mass of extremely fine filaments, from five to eight or nine ten-thousandths of a millimeter in diameter, which grow in all directions in short, irregular curves. In water no septation whatever is visible in the vegetating filaments; but on the application of iodine, divisions are seen at irregular intervals giving the appearance of septation, which may perhaps be only spurious. Under certain conditions these filaments may grow up into the air and become spirally coiled at their extremities, and subsequently rather closely septate, may break up into a mass of short pieces resembling bacteria, at the same time turning from white to gray in gross appearance. In addition to this form of fructification, certain bodies, apparently resting spores, are sometimes formed, especially in liquid media, when the fungus is subjected to unfavorable conditions. These bodies are produced in the continuity of the filaments, especially at their extremities, are roundish or oval, refractive and much like spores of bacteria in general appearance. Their germination, however, has not been observed, and it is possible that they may not be reproductive bodies.

Inoculations made with the Scab fungus.—These pure cultures were not obtained until after the opportunity for using them in making inoculations out of doors had passed; but in the meantime, as a matter of curiosity, infections were made by transferring as small a portion of the gray material as could be taken on the point of a sterilized needle, directly from the diseased potatoes, to a number of sound ones which were found to be still growing out of doors at the time. The tubers to be infected were carefully uncovered, washed with distilled water, and a cavity made around them so that they could be covered by a pane of glass, which was in turn covered with a few inches of soil. The tuber lying exposed in the cavity could thus be readily examined at any time by removing the earth and looking through or raising the glass. Some half dozen hills were thus treated, from one to three potatoes being exposed and infected in each hill. Within three days after the inoculation the point at which the tuber was touched by the needle began in every case to show the characteristic symptoms of the disease, and subsequently developed into scabs similar to those from which the infection material was obtained, and accompanied by the same gray organism. This experiment was of course valueless as a test inoculation, not only from the fact that the material used was not known to be pure, but because very many of the potatoes in the neighboring hills were subsequently found to be diseased in the same way, and it is merely mentioned as in a measure confirmatory of the results of subsequent inoculations made under more strict conditions.

There was fortunately available at this time a small lot of sprouting potatoes obtained from a greenhouse experiment of the previous winter. These tubers were planted at once in three small greenhouse borders affording about eighteen small hills for experiment, and by the first of October tubers were formed in them large enough for inoculation experiments. One or more of these tubers were then uncovered in each hill, and were treated as above described in connection with the inoculations made out of doors. They were then inoculated with pure material of the scab organism taken from the agar peptone broth cultures, the aerial "fructification" on these cultures being more convenient for the purpose than the tough, stroma-like crust on the remaining substrata. The inoculations were made in two ways; in the one case by using a stiff platinum wire as a needle in transferring the infection material, by which a slight injury was inflicted on the epidermis of the tuber at the point of contact, and in the other by using a piece of very thin platinum foil cut to a long slender point, by means of which the scab organism could be transferred without any such injury to the epidermis. In the majority of cases the infection material was placed upon the surface of the tuber at a single point; but in others, as a means of showing an unquestionable and direct connection between the process of infection and whatever results might arise from it, the material was applied at a definite series of points, forming circles, lines, curves or letters, as shown in fig. 2 of Plate I., where the monogram R. T. was employed for this purpose.

Two sets of infections were made at an interval of five days in order to compare the periods which might elapse between the infection and the first appearance of any effect which it might produce upon the surface of the tuber. As in the infections made out of doors, the effect of the inoculation became manifest within three or four days by the appearance of the characteristic brown stain in every potato infected; with one exception in the case of a nearly mature tuber in which none of the several points infected showed any diseased condition of the adjacent tissues. In the other cases the infection was apparent at every point of application, with few exceptions where the continuity of lines was interrupted by the failure of a point here and there. The infection was most certain where the epidermis was slightly injured at the point of contact or where this point was a lenticel; but in very young tubers three-quarters of an inch or less in length an entrance seemed to be effected at any point of the surface without reference to lenticels or any injury. In one case more particularly a potato of some white, smooth skinned variety, was infected in the form of a letter R when a little more than half an inch long, the material being placed on its surface so as to inflict no injury and the definite area of discoloration and corky growth which resulted was an unbroken reproduction of the letter. This particular specimen was kept uncovered under its glass plate until it had grown about a third larger than when infected, after which it was cut from the stem and put in alcohol. It was found, however, that the method of experiment employed was open to a serious objection in that the tubers, shortly after they were uncovered, ceased to grow, or grew only slightly, so that the diseased spots resulting from the infection, reached no considerable dimensions, although after about a week all showed the usual corky formation together with more or less cracking of the surface and were visibly accompanied by the gray organism as in the specimens obtained out of doors. For this reason several tubers, on which the infection was seen to have taken, were hilled over on the eighth day and left buried for a fortnight. At the end of this time they were again uncovered, and were found to have made considerable growth while the diseased spots had become much larger and more prominent, resembling in all respects the ordinary deep scab.

In these two sets of greenhouse infections, twenty-two potatoes were infected as above described, and the disease was reproduced in them all, with only one exception already mentioned in the case of a nearly full grown tuber which showed no signs of disease at the point of application, although the infection was accompanied by a slight injury to the epidermis. This failure was probably due to the age of the potato when infected, since a tolerably rapid growth appears necessary, as would be expected, in order to produce well-marked scabs; although it might be accounted for by variations in the susceptibility to the disease of different varieties of potatoes. It may be mentioned further that the infected potatoes, while uncovered, showed no spots of disease at other points than where the material was applied, and the same was true in the majority of those which were subsequently covered. The potato infected in the form of a monogram, for example, reproduced on Plate I., was absolutely without a flaw over its whole surface apart from the direct results of infection. In two or three cases, however, where the potatoes were covered, a spot of scab appeared here and there near the original point of infection. Such spots may, of course, have had an independent origin, but were probably due to the fact that a little of the scab organism was brushed from the original point of infection in covering the tuber.

Of the thirty-six uninfected tubers which were obtained when the hills were finally dug, five showed from one to several scab marks each. Of these, two were exposed in cavities where other tubers were infected and may have become diseased in this way, while the other three were undoubtedly independently affected. Since, however, the remaining thirty-one were quite clean, the presence of so small an amount of independent infection cannot be said in any way to vitiate the general results obtained.

Summary.—To summarize the writer's observations, then, it may be said, that whenever he has examined the disease out of doors it has invariably been found to be visibly accompanied by the growth of an undetermined fungus, at least in its earlier stages, and that this fungus when cultivated in an absolutely pure condition on nutrient substrata and thence transferred to growing tubers with the necessary precautions, reproduces in them the disease called scab, from which it was originally obtained, the observations and experiments made so far being convincing, to the writer at least, that the two are directly associated as cause and effect.

This may seem too positive a statement; based as it is on necessarily limited experiments which cover so short a period of time, not even including a single growing season, in the face of equally positive statements to the contrary by previous investigators. Prof. Sorauer* for example remarks that "one finds in and on the dead tissue divers kinds of fungi, but none which attack the sound tissue." Again, Prof. Arthur says in his report† upon the subject, "no particular kind of fungus or small animal, in truth no fungus or animal at all can be found invariably to accompany the injury at any particular stage of its development," and Prof. Humphrey who has recently conducted careful experiments on the subject in Massachusetts concludes‡ that "no organism of any sort was found constantly or even frequently present at any stage of its progress and there can be no doubt that it is not the result of the activity of the development of any living thing other than the potato plant."

That a particular kind of fungus *does* invariably accompany the injury studied by the writer, at least in its younger stages, he has satisfied himself by careful examination in the field, and in this respect he feels that his observations have been sufficiently extended to warrant a positive contradiction of the statement that such is not the case. That this fungus does attack the sound tissues is certainly indicated by the infection experiments above described, neither can it be said that the diseased condition is merely a result of the activity of the tuber, except in so far as this is true of any disease accompanied by abnormal growth in or near the tissues involved.

"Deep" and "Surface" Scab compared.—It will doubtless be asked how the results just described are to be reconciled with equally positive results obtained by Mr. Bolley which have been previously referred to, and what explanation can be given of the fact that the scab fungus, although so conspicuous and easily recognized by its accompanying stain, was not observed in any of the latter's cultures. This apparent contradiction arises, in the writer's opinion, from the fact that, although Mr. Bolley appears to have demonstrated the bacterial origin of the form of scab which he has investigated, he is in error in one important particular, namely, in assuming that the disease he has studied so

* Pflanzen-krankheiten, Band 1, p. 231.

† 6th Ann. Report of N. Y. Agr. Exp. Station, 1887, p. 344.

‡ 7th Ann. Rep. Mass. Agr. Exp. Station, 1889, p. 220.

ably includes all the diseased conditions commonly known in this country under the name of "scab." As a matter of fact, there appear to be two quite different diseases, very similar in general appearance, which have been distinguished by Prof. Humphrey as "deep" and "surface" scab, although still considered by this writer as merely variations of the same affection. In the "surface" form the corky modification of the diseased tissues is much more prominent than in the "deep" form; producing a slight elevation, in the beginning at least, on the surface of the tuber; and appears much less inclined to give rise to general decay resulting in the pockets characteristic of the deep form. This latter, even in its earlier stages, is apt, when the surface of the tuber has dried off, to produce a depression rather than an elevation, and the diseased area is rather scaly or scab-like than evenly corky, as in the earlier condition, at least, of the surface form. The deep form, again, is always accompanied by a more or less prominent discoloration, which becomes dark and pronounced as the disease progresses, and is undoubtedly owing to the staining action of the scab fungus already referred to. The fungus seems to be much more rapid and corrosive in its action than the bacterium, a fact which may account for the presence of a more abundant corky growth in connection with the latter, which its less rapid action would render possible. This is also indicated by the usually more deep-seated and serious character of the fungus injury, as well as by the fact that the bacterium, as Prof. Arthur informs me, is unable to produce any effect unless applied to the tuber while very young; whereas the fungus can be made to produce a marked effect upon good-sized growing tubers, as is shown in fig. 2, Plate I., the tuber represented having been two-thirds grown when inoculated.

It is necessary to state, however, in connection with what has just been said, that the writer's experience with "*surface*" scab has been very limited, and that he can speak with certainty from sufficient personal observation only concerning the so-called deep form. As a matter of fact, the surface form was not observed in any of the fields where the deep form was injurious, and only a few specimens of it were received among a quantity of tubers affected by the deep form which were sent to the Station from Guilford. These specimens together with a few others, for which the writer is indebted to the kindness of Messrs. Arthur, Bolley, and Humphrey, are all the material available upon which to base an opinion. Insufficient though it be, however, it shows a distinct variation in the type of the disease, and the assumption that such a difference really exists is apparently the only rational explanation which can be brought forward to account for successful inoculation experiments both with the fungus and with the bacterium.

The fact that the deep and surface forms often occur side by side on the same tuber, as in the specimens received from Prof. Humphrey, seems to be entirely explicable, and in no way calculated to throw doubt on the probable existence of the two distinct diseases above characterized. That the deep form if distinct should not occur in the west in company with the surface form is hardly to be believed, in view of the ease with which such a disease would naturally be disseminated through the yearly movements of the crop. It is therefore somewhat remarkable that the fungus should not have appeared in any of Mr. Bolley's cultures, unless it may be explained by his avoidance, in seeking material for cultivation, of such scabs as were "blackened or pitted,"* pitting and blackening being, as already mentioned, characteristics of the fungus disease.

Botanical Relations of the Scab Fungus.—In regard to the true position of the fungus of deep scab nothing definite can be said, and a more detailed account of it from a botanical point of view, together with figures of its microscopic and gross appearance, is reserved for another year, when more definite information concerning its botanical relations may be available. Except for its apparently true branching and aerial "fructification," it reminds one strongly of some of the polymorphic bacteria, for which it was taken when first observed. The two characters just mentioned seem, however, to exclude it from the bacteria; but where among the Hyphomycetous fungi it can be properly referred is a question concerning which no botanist to whom it has been referred has been able to give any information. Possibly it may be found in some such ill-defined genus as *Oospora*. That it or its prototype has not been already described seems very improbable, since a fungus resembling it closely in microscopic characters and general mode of growth is one of the commonest forms of mould among the many species which appear upon barnyard manure and dung and rubbish of all sorts. This common form, however, does not produce the black stain upon its

* Bolley, l. c., p. 277.

substratum so characteristic of the scab fungus, and further differs from it in the great abundance of its "fructification" on media upon which the scab form produces none at all. Otherwise, it resembles it so closely that the two can hardly be distinguished microscopically. In two cultures of this form on potato jelly a slight blackening was observed after several weeks, but it was comparatively faint and not comparable to the deep stain which appears in cultures of the scab form in a few days.

The writer will be glad to receive notes of observations on this subject, or specimens of the different varieties of scab from any one interested.*

MISCELLANEOUS NOTES.

Diseases of Tomatoes.—For some reason not readily explained Tomatoes in various localities have, during the latter portion of the last season, been greatly injured by the attack of various fungi, which in 1889 did no special damage to the crop. The most noticeable injury was done by the fungus of the Potato Rot (*Phytophthora infestans*) which not only attacked the leaves so as to do considerable damage, but appeared with virulence upon green and even partly ripe fruit, causing it to turn brown and black, and producing decay. The same fungus was also observed in Maine, destroying green tomatoes early in October, although the writer has not previously noticed that it attacked them. Should this taste for tomatoes be perpetuated, it will be necessary to resort to Bordeaux mixture or carbonate of copper in order to save the September crop. It is unlikely, however, that it will become permanently serious.

In addition to the *Phytophthora* considerable injury was done locally by the brown *Cladosporium fulvum* upon the leaves, which was much more virulent than in the previous year, in some instances killing the vines completely, towards the end of September.

The tomatoes themselves have also suffered to an unusual degree from several fungi which, like the fungus of potato rot, may attack them before or after they are ripe. Of these the two most injurious appear to be *Macrosporium Tomato*, Cke. and

* Since the above was in press a second set of infections with the scab fungus have been made successfully in the greenhouse. Infections with the similar organism obtained from horse dung have given no result. Concerning the latter. Prof. Saccardo writes that it may be doubtfully referred to his *Oospora perpusilla*.

Fusarium Lycopersici, Sacc., the former producing roundish decayed areas which become covered with an olive-brown or black velvety coating of the *Macrosporium*. The *Fusarium*, usually appears on the ripe fruit, especially where it has cracked, forming a thick coating of mould, at first white then reddish salmon colored. The injury of these fungi may be decreased by gathering and burying the tomatoes as soon as they show signs of disease. If left in the field they are sure to communicate the disease to the sound tomatoes.

Fungus Disease of Tomato worms.—Although numerous insects are known to be subject to the attack of parasitic fungi of various kinds, the smaller forms are usually the greatest sufferers and the writer was therefore surprised to find a destructive epidemic among the tomato worms (*Phlegethontius Carolina* and *P. Celeus*) infesting a field in the vicinity of New Haven. The same field had been largely stripped of its foliage by the worms in the previous year; but this season sustained comparatively slight injury owing to an epidemic caused by an *Empusa* similar in nature to the fly fungus so common in houses during the late summer and autumn. When this field was examined the epidemic was nearly at an end, very few larvæ remaining; but the owner stated that the dead tomato worms were hanging on the vines in large numbers a few weeks previous, as was attested by numerous blackened remains still adhering to the stems. A small lot of larvæ just killed by the disease was, however, obtained, from which the character of the affection could be ascertained. Just before death the larvæ become slightly milky, changing to greenish-yellow after death and collapsing to a greater or less extent. A few hours after death the fungus appears as a whitish coating on the skin and an enormous number of spores are discharged. The presence of a fungus in the case would hardly be noticed without a hand lens, as the hyphæ barely project beyond the integument and are very inconspicuous. As the spore discharge ceases the larvæ become rapidly soft and flaccid turning black and putrid. The fungus is the same (*Empusa Grylli* form *aulicæ*) which is common on hairy caterpillars and has also been found this year on a number of naked cut-worm larvæ (*Lithophane, Mamestra* and *Agrotis*). It was found easy to propagate it on young tomato worms, which died after the usual period of incubation (six to ten days,) with the characteristic symptoms. This is the first instance recorded of an *Empusa* upon larvæ of any of the Sphingidæ.

Fungus Disease of Grape leaf hopper and Cabbage worms.—During September the Grape leaf hoppers (*Tettigonia vitis*), which were abundant and causing no little injury to the grape leaves in Mr. Coe's vineyard at Meriden, were found to be attacked in great numbers by another species of *Empusa*, which eventually destroyed them entirely. At the same time a single specimen, rather old, of the Cabbage worm (*Pieris rapæ*) was found at New Haven infested by apparently the same fungus; a circumstance which suggested to the writer a repetition of an experiment performed several years before, by which a single cabbage worm had been successfully inoculated with the disease transferred from the apple leaf hopper (*Typhlocybe mali*). The matter was of some economic interest from the fact that the *Empusa* in question is destructive to numerous noxious insects and would be perhaps the most available species to employ should it be found practicable to use such fungi as a means of artificially spreading disease among injurious insects.

Twelve small *Pieris* larvæ were selected and confined for a day with several of the diseased leaf hoppers from which there was an abundant discharge of spores. The larvæ were then fed in a crystallizing dish and grew rapidly. The weather was very cool at the time so that the period of incubation was considerably lengthened; nevertheless, between the eighth and thirteenth day all of the larvæ had died and were found to be filled with the resting spores of the fungus, with the exception of one specimen which was killed by parasitic insects (*Pteromalus*) soon after infection. What appears to be the same *Empusa* has been kindly sent from New Jersey by Prof. Halsted, on *Pieris* larvæ, and the same fungus is reported to have killed vast numbers of the clover weevil in the same locality during the past season.

Peronospora on Cucumbers.—The occurrence of *Peronospora Cubensis*, B. C. on cucumbers may be noted as of interest in extending the range of this peculiar species, which was first found in Cuba, then in Japan, and quite recently in New Jersey and several other localites in this country. It produces yellow spots upon the leaves which resemble the injury of the melon aphis; but did not seem to be very injurious at South Manchester where it was first observed.

Mildew of Lima Beans.—This mildew (*Phytophthora Phaseoli*) described and figured in last year's report, has been again destructive this year and has made its appearance in a number of new localities in the neighborhood of New Haven. So far as ascertained it extends from New Haven to Hartford and west to South Norwalk, but has not yet been discovered outside of Connecticut. Its serious nature is indicated by the damage it has done during so unfavorable a season as that of 1890, and farmers are again strongly advised to use the precautions for keeping it in check mentioned in the Report of this Station for 1889, p. 171.

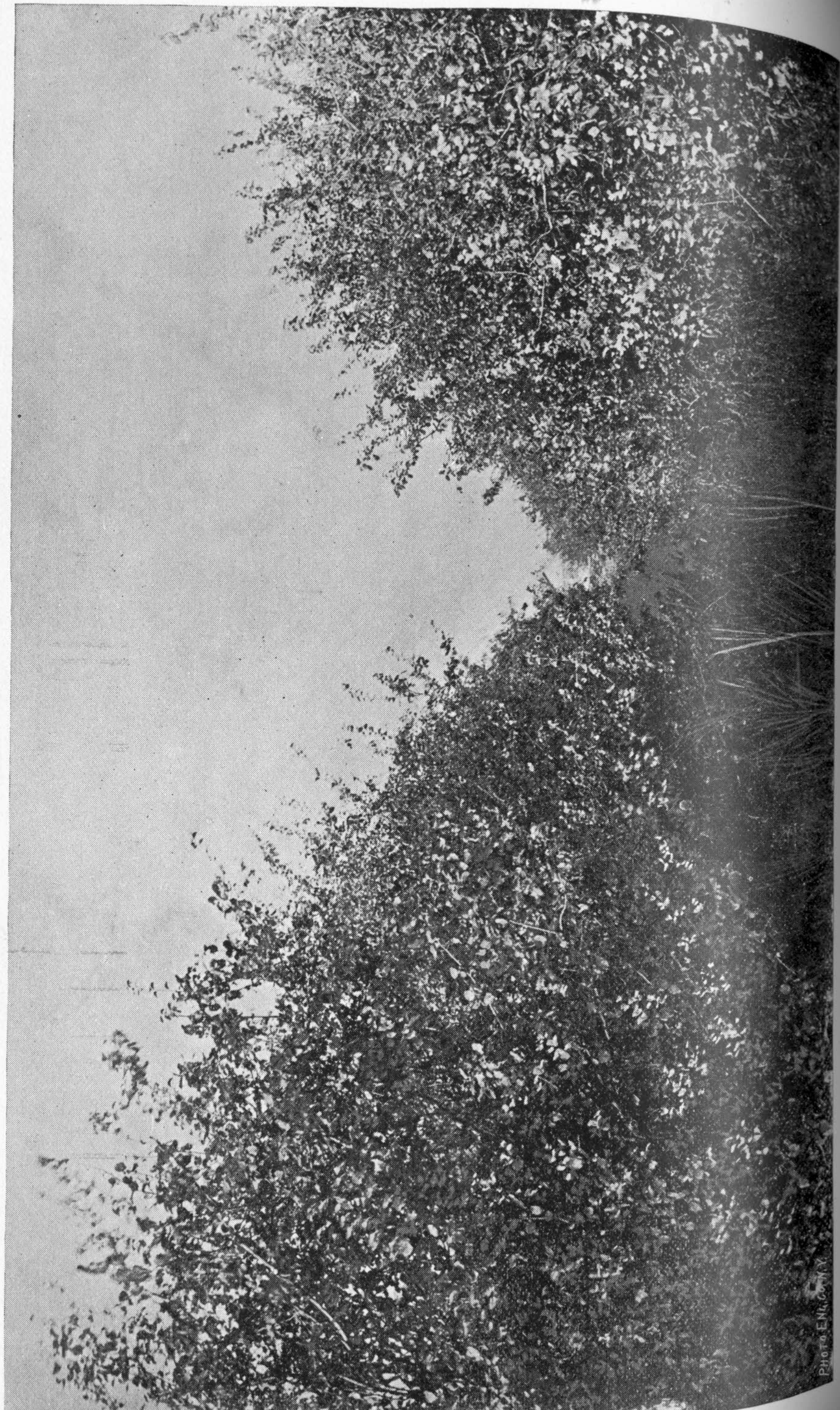
Rust of Pears.—The several varieties of pear of the Japanese strain (*Kefir*, etc.) have shown themselves very susceptible to injury by one of the rusts derived from the red cedar; the particular "cedar apple" which in this case has its third or Roestelia stage on pears, being what is known as *Gymnosporangium globosum*, a form which also produces rust in Connecticut on Hawthorn, Apple, Quince, etc., but does not attack the ordinary varieties of Pear. The fungus forms dull red orange spots on the pear leaves early in the season, the finger-like Roestelia stage developing from the under side of these spots during August and September. The presence of this fungus interferes with assimilation, and when severe produces premature defoliation. The trouble may be decreased by cutting down neighboring cedars as far as possible or by spraying with fungicides immediately after rains in May.

Mildew on Buckwheat.—A mildew which appears to be the form described by Peck as *Ramularia rufomaculans* on another member of the same family (*Polygonaceæ*) has been observed in several localities on Buckwheat. It does considerable injury, attacking the lower leaves first and spreading upwards, stunting the growth of the plant and impairing the quality as well as diminishing the quantity of the seed. Nothing can be recommended for its prevention beyond burning of all stubble and refuse, and rotation with some other crop.

Clover Rust.—This rust, which was incorrectly referred to in the last Report as caused by *Uromyces striatus*, proves to be *U. Trifolii* Wint. and has been very abundant this year. Its æcidial stage was not uncommon on white clover during June.

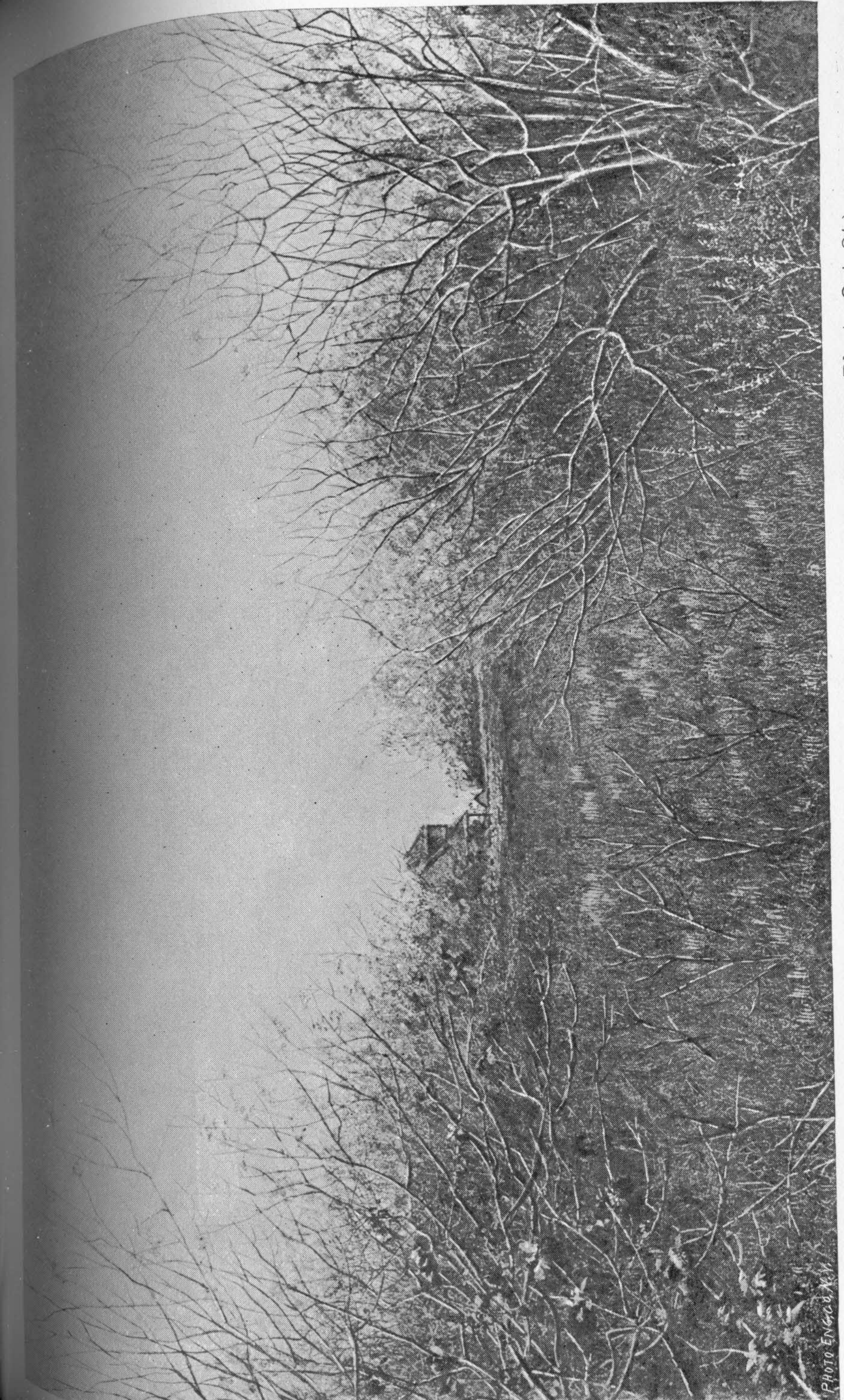
Rye rust and smut.—*Puccinia rubigo-vera*, D. C. has been unusually abundant on Rye this year, covering the leaves with its rust colored Uredo-form and doing considerable injury. The Rye smut also (*Urocystis occulta*, Rabh) has been very common, though not enough so to be very injurious.

PLATE II.



Quince Orchard, showing results of treatment with Bordeaux Mixture for the "Leaf spot." (Photo Oct. 31.)

PLATE III.



Adjacent rows in same orchard, showing results of no treatment, (Photo Oct. 31.)

SOME RESULTS FROM THE APPLICATION OF FUNGICIDES.

Leaf-spot of Quince (*Entomosporium maculatum*, Lév.)

The leaf-spot of quince has become a very serious trouble in Connecticut as well as elsewhere, and the writer knows of at least one large orchard which has been entirely abandoned from this cause. The Station has therefore made several tests of the efficacy of fungicides in this disease with results which may be seen by reference to Plates II. and III. of the present report, which show the effects of treatment and no treatment respectively, and represent exactly the condition of treated and untreated rows side by side in the same orchard as they were photographed by the writer on October 31.

The appearance and results of the disease are too well known to need description; but it may be mentioned briefly that the fungus in question forms small reddish-brown spots on the leaves and fruit, which extend with considerable rapidity, turning rust-colored on the leaves and causing them to fall prematurely, even as early as July. Such defoliation not only exhausts the tree and prevents the fruit from maturing, but hinders the proper maturing of the next year's buds.

The principal experiment upon this disease was made at Milford, where Mr. Geo. F. Platt kindly afforded facilities to the Station for the treatment of a part of his orchard, another part being left untreated. The orchard in question is arranged in rows of about fifteen large, thick bushes each; and of these, two rows were treated with Bordeaux mixture and two with the ammoniacal carbonate of copper, both of these substances being prepared according to the formulas given on pp. 110–112. The method of application is shown on Plate IV, the fungicide being carried in a hogshead set in an ox cart or single wagon, and the force-pump (Gould's double-acting) mounted directly on the hogshead. The Vermorel nozzle, with its cap-hole reamed, was used, carried on the end of light $\frac{1}{4}$-inch linen insertion tubing supported on a light pole, as in the figure. By standing in the cart and driving between the rows all parts of the bushes were easily reached. Two persons to spray, one on either side, and one to drive and pump, allowed of very rapid work; which is essential in any spraying in order to take advantage, as far as possible, of fine weather, so as to be sure that the substance sprayed will be thoroughly dried on the foliage before it is subjected to rain.

The quinces in question were sprayed only *four* times, once just before they bloomed, May 17; once as soon as the blossoms had fallen, June 2d; again on June 25th, and for the last time on July 28th. The month of July was unusually dry, otherwise a fifth application would have been necessary about the middle of this month. As it was, however, this small number of applications served to retain the foliage completely on the rows sprayed with Bordeaux mixture, as may be seen by reference to the Plates just mentioned. The rows sprayed with carbonate of copper were, however, not as well protected, saving only about 80 per cent. of their foliage, while the untreated portions retained only from 10 per cent. to *none* of their foliage. Unfortunately, whether owing to the defoliation of previous years or to causes which led to the general failure of fruit to set during the past season, the greater part of the young quinces fell off through the whole orchard soon after the blossoms had fallen; so that the effect of spraying could only be observed on the comparatively small amount of fruit which remained on the treated bushes. On the untreated bushes no fruit matured, except here and there a small, gnarled specimen; while, as Mr. Platt informs me, the fruit from the treated rows was unusually large, fair, well-flavored and juicy.

There can therefore be no question of the efficacy of the Bordeaux mixture in this disease, and it will be of interest to compare the effects of previous treatment and its absence, in connection with further trials which are planned for the coming season.

The writer also sprayed a number of quince bushes with the Knapsack Hydronette, in the orchard of Mr. N. S. Platt at Cheshire. Only three applications were made—one May 9th, which was much too early; one May 31, which was much too late; and one June 24. Despite the fact that the applications were not made at proper times and were so few in number, Mr. Platt writes under date Oct. 24: "As to the Quince trees you sprayed, they are still well covered with leaves, while all the others in the orchard are practically bare."

Black Rot of Grapes.

Mr. Coe has continued spraying for this disease in his vineyards in Meriden during the past season with very conclusive results, especially in the lower vineyard, which for several years past has been completely devastated by black rot, except when it was most thoroughly sprayed in 1889. The important precaution was taken this year of ploughing between the rows and covering the ground directly under the vines with earth enough to bury whatever diseased grapes might have fallen the previous year. The applications of Bordeaux mixture were made three times: once just before the vines blossomed, once just after the fruit had set, and once the last week in June, and were followed by two applications of ammoniacal carbonate of copper about the middle and last of July. As a result of this treatment the crop from the main portion of the vineyard was almost perfect, and when examined in September showed only here and there a cluster with a few diseased berries. Two rows were left untreated as checks, but were given one spraying by accident, so that they did not fairly show the advantages derived from the treatment. In these rows hardly a single cluster was unaffected by the rot, and a great majority of them were ruined for marketing purposes or wholly destroyed. Another section was treated twice with ammoniacal carbonate of copper and then neglected, and in this case also the great majority of the clusters were destroyed.

The use of the ammoniacal carbonate of copper was found entirely satisfactory in obviating the injury done by late treatment with Bordeaux mixture through its adherence to the grapes when harvested, no stain being left upon the clusters, which were quite clean with a perfect bloom when harvested in September.

In this connection attention may be called to the report of Prof. Chester on this subject based on his experiments at the Delaware Experiment Station (Bulletin X), which is especially valuable from the financial summary which he is able to give from detailed memoranda of one of his experiments. In this case 879 vines were sprayed four times with Bordeaux mixture and once with carbonate of copper and carbonate of ammonia mixture at an expense of labor and material amounting in all to 3 cents per vine for four applications. The net income per vine was 75 cents, leaving a balance of 72 cents per vine to be laid to the credit of the treatment.

It may be mentioned that the most critical period in this State seems to be about the last of June, the disease beginning its worst visible inroads about the 10th of July. The last spraying in June is therefore a very important one and should be made thoroughly and above all things in time, say by the 25th.

Anthracnose of Grape.—At the writer's suggestion the usual treatment for this disease was tried by the Connecticut Valley Orchard Co., with the result of a very marked improvement in the condition of the vines and in the yield of marketable grapes. The vines were very severely trimmed, all possibly diseased wood being cut out and burned, and then treated with a strong (25 per cent.) solution of sulphate of iron. The vines were subsequently sprayed with Bordeaux mixture and carbonate of copper as for the black rot. This year's experiments indicate that this disease can be successfully treated, though more serious than black rot. The severe trimming and winter treatment, either with a strong solution of sulphate of iron, or of sulphate of copper (one pound to twenty gallons) are both of the first importance and practically indispensable in contending against it.

Leaf spot of Plums and Cherries causing defoliation.—This disease, often called the "gunshot injury," is very generally injurious in the State to plums and cherries, defoliating them prematurely. Mr. Coe repeated the application made last year to several large plum trees, thereby preserving their foliage intact. The Bordeaux mixture was also used by the Valley Orchard Co. for plums and cherries with similar results, while a few trees left untreated lost their foliage in July.

Potato Blight.—Mr. N. S. Platt writes from Cheshire in regard to this disease. "We applied one spraying of Bordeaux mixture to some late potatoes about Aug. 10, a full week after the blight had made its appearance in the field. Five rows thus treated kept green three weeks after the others were dead and black. At digging, about Sept. 24th, the treated rows were much the best in size and practically free from rot. The untreated rows were smaller and considerably decayed. The measurements at digging were :

Untreated	3¾ bushels per row.
Treated	6 bushels per row."

Strawberry Rust.—A section of Mr. Atwater's strawberry bed in Cheshire was sprayed to ascertain the effect of Bordeaux mixture on the leaf spot of strawberry. Bordeaux mixture was applied once May 9, just before the plants came into blossom, and ammoniacal carbonate of copper was applied on May 31, just after the bulk of the fruit had set. Neither mixture adhered well and very little, if any, difference could be observed between the treated and untreated portions, which were both not greatly injured by the fungus.

Trials have also been made with fungicides against Black Knot of plums, Anthracnose of beans, and Mildew of peas, but further observations are necessary before making any report upon them.

Further Experiments on the "Smut" of Onions.—In the last report the writer gave the results of the season's experiments upon onion smut, which indicate that an application of flowers of sulphur sown with the seed, on very smutty land, would increase the yield in a ratio of about 34 to 7 where no sulphur was applied. In order to test the matter more fully further experiments were made in a greenhouse border infected with smut spores, the object being to discover whether a more direct application of the sulphur than was previously made might not give better results than were previously obtained. The relative proportions, however, between the number of onions surviving in the treated and untreated rows remained about the same (5 to 1). A larger experiment was also tried at Greens Farms, the fungicides being sown directly with the seed by means of a hopper cleverly devised by Mr. Guyer. This contrivance, however, was not found adapted to use in the field, although working to perfection on a smooth floor, and constant shaking and pounding was necessary to produce any flow of the fungicide, which was therefore not only distributed very unevenly, but failed entirely in many sections of the rows. In addition to this the seed also failed in a great measure, not more than from 10 to 20 per cent. coming up. The experiment was therefore practically valueless, although even under these conditions the ratio in favor of the sulphur treatment was 25 to 8. Sulphide of potassium gave a slightly better result, and sulphide of calcium showed only very slight differences; while muriate of potash, muriate and lime, and hyposulphite of sodium gave no favorable results whatever.

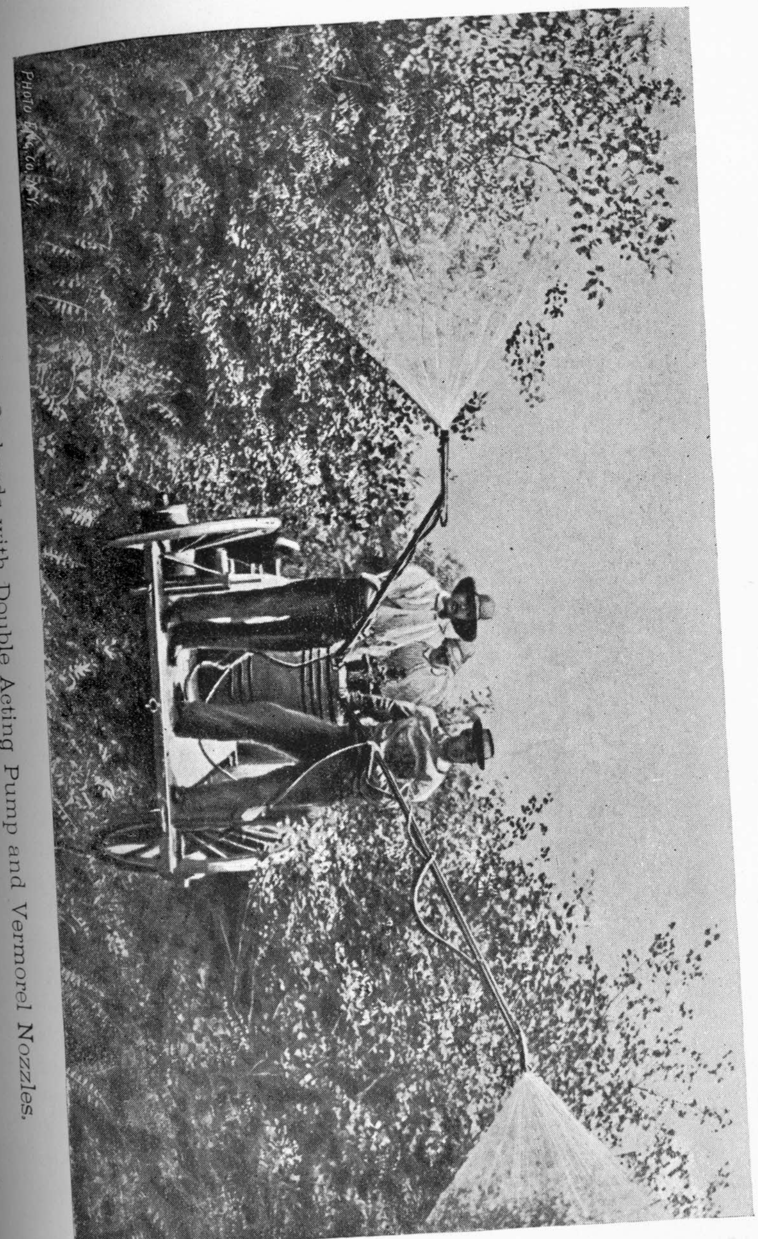
This experiment, although in itself of little value, when taken in connection with those previously made, seems to indicate that no greater advantages will be gained by using the sulphur treatment than were previously reported, and whether this advantage is sufficient to recommend its use to those troubled by the disease is for them to decide.

A single point of interest was ascertained in connection with the greenhouse cultures, namely the ability of seedlings showing smut at isolated points near the top of the first leaf to recover entirely from the disease. This fact indicates that the first leaf is susceptible to infection by the germinating smut spores, while it is being pushed up through the ground, and that the collar of the embryo can hardly be the only point thus susceptible since recovery would hardly be supposable in this case. Substances applied for treatment must therefore act not only about the seed, but in the earth through which the first leaf is pushed.

FUNGICIDES AND THEIR APPLICATION.

The present notice is designed to call the attention of farmers to the importance of gaining some practical knowledge of the use of fungicides and to furnish brief directions for this purpose. More detailed information on the subject adapted to special cases will be furnished by the Station on application, and when practicable, personal attention will be given in such cases if desired.

The advantage resulting from the application of fungicides has been so thoroughly and repeatedly demonstrated in connection with the diseases of the grape and various other similar affections that their use may be recommended without reserve in such cases. In many of the most serious diseases of this nature it is absurd any longer to talk of "experimenting" for their prevention by fungicides. Their prevention by this means is an established fact, and in no sense a theory or probability, the truth of which is still in doubt. Such "experiments," therefore, in many cases, are now quite superfluous in connection with the general demonstration that we have the means for such prevention, and are justified only as local object lessons or with a view to improving in some way upon the means or methods already known and approved. Such local object lessons are, however, of very great importance and utility for the reason that farmers are naturally conservative in their attitude towards unfamiliar modes of procedure connected with their calling, and are inclined to demand an ocular demonstration in such cases. Object lessons of this kind, in so far as they can be carried out by the Experiment Station, must necessarily be very limited in number, and farmers are therefore urged to experiment for themselves, not only by spraying for the prevention of fungus diseases, but of insect depredation as well, since the treatment of both can often be combined by mixing the fungicide with an insecticide. The Station, however, does not recommend anyone who has had no



Method of Spraying Orchards with Double Acting Pump and Vermorel Nozzles.

previous experience, either personally or from personal observation, to attempt spraying on a large scale unless under supervision; but rather to experiment on a small scale at first; so that by making a direct comparison between the results of treatment and no treatment, he may form an opinion as to the value of the application from his own experience.

It is very necessary, however, that even a small experiment should be made intelligently and thoroughly. Anyone who thinks he can do such work without previously informing himself on the subject had much better let it alone, since he is quite as likely to fail as to succeed, and thus to mislead others as well as himself. The first requisites for success in spraying, are a definite knowledge of the disease which it is proposed to treat, of the proper means to use for the purpose, and of the proper manner of using such means. Many persons imagine that all that is necessary is to get some of the fungicide on the leaves no matter how or when. As a matter of fact the "how" is of the first importance. Always in the case of fungicides and in the majority of cases in the use of insecticides a proper spraying nozzle, like the Vermorel, which will give a uniform and very fine spray is *an absolute necessity*. *All* the foliage to be treated must be wet and *not drenched*. It is quite impossible to gain this end by using an ordinary rose spray nozzle or by holding one's thumb over the mouth of a common straight nozzle. Such means ensure great waste as well as an uneven distribution of the material used, which, under these conditions, is sure to injure by drenching the foliage to which it is applied if such injury ever accompanies its use. A proper nozzle and force pump, properly mixed materials and a knowledge of the proper times for applying them in the particular case in which they are to be used, are three prime essentials for success in spraying, and if either one is disregarded success need not be expected.

Information relating to the subject should not be sought in manufacturers' circulars, which are quite as likely to mislead as to be of service; but from some authoritative source, such as the publications of Experiment Stations, or of the proper section or sections of the United States Department of Agriculture, supplemented, if possible, by personal correspondence. Such action will lead to the avoidance of all sorts of mistakes connected with the operation and greatly increase the chances of success.

Nozzles.—For all general purposes of spraying the *Vermorel* nozzle is by far the best, being adapted for liquids having substances in suspension as well as for those which are clear, and may be employed for all kinds of spraying. When used in connection with a force pump of fairly good power, the orifice in the cap through which the spray is driven, may be reamed out to twice the size of the largest hole in either of the two caps (coarse and fine) which accompany each nozzle, and thus far quicker work can be done, the spray obtained in this way being far more copious and abundantly fine. The hole must be enlarged with a reamer, *not* with a drill, since the orifice must flare to produce the broad funnel-shaped spray peculiar to this nozzle.

The *Nixon* nozzle produces a copious and direct smoky spray by driving a small stream through a fine gauze cap, and is unsurpassed for spraying *clear* liquids. Having no means by which, like the Vermorel nozzle, it may be readily cleared when it becomes clogged, it is not available for liquids like Bordeaux mixture having substances in suspension, and since the majority of liquids used are not clear, it is much less generally useful than the Vermorel.

The ordinary rose or "fine spray" nozzles, such as are advertised by most dealers, are generally useless or inefficient for the desired purpose.

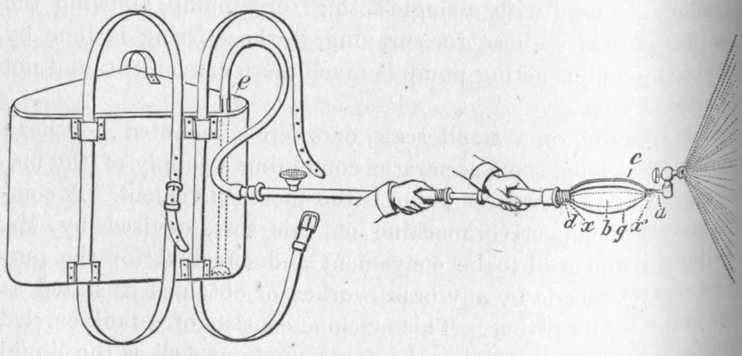
Hose, for spraying must be light, so as to be readily carried on a pole as shown in Plate IV. The best kind for the purpose is what is known as *linen insertion tubing* ($\frac{1}{4}$ inch), which combines lightness with durability and cheapness. The hose should be attached to a light pole of sufficient length to reach above the foliage to be sprayed, so that the spray may be directed downwards upon it. In order to control the duration of the spray without trouble it will be found convenient to screw a short piece, about a foot long, to the end of the pole, so that it will turn easily on the screw. Then drive two nails into the pole in such a position that this piece can only turn the distance of a right angle, that is, from a position at right angles to the pole to a position in which it is in line with the pole. Then fasten the end of the hose, together with its attached nozzle, firmly to the end of this piece, the base of which should also be attached to the hose passing over it. In this way the nozzle and hose move with the piece and can be made to turn at any angle, from a straight position adapted for direct spraying, to a position at right angles for downward spraying, by simply turning the pole on its axis. The hose should be fastened by a loose loop once to about the middle of the pole, around which it may be conveniently wound once or twice. By holding a turn of the hose between one hand and the pole a slight pressure will stop the flow of liquid, when desired, as effectually as a stop-cock.

Pumps.—For a stationary pump which is to be mounted on a hogshead or other vessel containing the substance to be sprayed and drawn from place to place, when needed, on wheels or in some vehicle, any good force pump will answer. A double-acting force pump fitted with couplings on both sides, to which two sets of hose may be attached (or three sets if one side is fitted with a Y-coupling), is very much the most useful form of pump for spraying on a large scale. Where a Y-coupling is used one set of hose may be turned into the hogshead and fitted at the end with a very small orifice, through which a fine stream may be discharged that will keep the mixture constantly stirred, while the other two sets are left free for use with nozzles, thus allowing a discharge of spray on both sides from a vehicle driven between two orchard rows, as shown in Plate IV.

The Station has used for this purpose Gould's double-acting spraying pump, which is shown in operation in Plate IV, and is powerful, while at the same time simple and compact, being easily taken apart and readily carried by one person. A Y-coupling can of course be used with a single-acting force pump, allowing the use of two sets of hose for spraying, if the stirring is done by hand: the double-acting pump is much more convenient, and not more expensive.

For spraying on a small scale, or where a mounted hogshead cannot be driven, some apparatus combining a supply of the material with a proper force pump is the most convenient. A comparatively inexpensive machine of this sort, devised by Mr. Galloway, and said to be convenient and effectual for the purpose, may be made by any brass worker or obtained as stated at the end of this article. This machine consists of a tank carried on the back and containing the force pump as well as the liquid to be sprayed, the pump being worked by a lever passing over the right shoulder, while the spraying lance, fitted with an improved Vermorel nozzle, is held in the left hand.

The writer has used for the same purpose during the last two years, a home-made apparatus which, with slight improvements, has proved very satisfactory and effective during the past season. This consists in a copper tank of convenient shape for carrying on the back, to which is adjusted an ordinary Aquanette or Hydronette hand force pump, as shown in the figure. For the wash boiler figured in Bulletin 102 of this Station, is substituted a copper tank similarly shaped, but smaller and more convenient, which with a tin cover can be made for a price ($3 or less) considerably below that of the smallest size of wash boiler. The tank used at the Station is made, as a matter of convenience, considerably larger than necessary, for the purpose of allowing the Hydronette pump to be carried in it. This tank, which holds when full about six gallons, and is filled about two-thirds full when in use, is fitted with shoulder straps (inelastic suspender straps) and a piece barely large enough to admit the hose of the Hydronette is cut out from the end of the tank cover at the edge (*e*) and a short collar soldered into it with a slot on its outer side broad enough to allow the hose to be pushed into it sideways. The hose, after it is pushed in, should project through this slot just enough to be held firmly against the edge of the tank when the tightly fitting cover is shut down. The suction basket of the pump (*f*) therefore rests in the lower left hand corner of the tank, and by making the shoulder strap on this side slightly looser than the other, and thus tipping the tank a little towards this point, all the contained liquid will be drawn out.



Since pumps of the Hydronette pattern do not throw a steady stream, acting only when the piston is driven back, some appliance is necessary to produce an even, continuous spray. This is gained by the device represented in the figure. A piece, six inches long, of *heavy* ⅝-inch rubber *tubing* (hose will not answer, neither will old bits of tubing which have been lying about in a rubber store till their elasticity is impaired) is drawn over the end of the Hydronette nozzle at *x* and over the base of the Vermorel nozzle at *x'* (the large coupling which accompanies this nozzle having been previously screwed off and laid aside) and each end *x*, and *x'*, is then firmly wound with small copper wire so that the joints are firm and tight. The Hydronette nozzle and the Vermorel are thus connected by an elastic chamber formed by the tubing; but since the latter is liable to burst if too great force is used in pumping, it is necessary to inclose the tubing in a cloth cylinder which acts to prevent undue expansion, like the netting commonly used about elastic syringe bulbs. Take a piece of stout cotton cloth, 6½ inches each way, and sew two of the edges together strongly, so as to make a cylinder 5½ inches in circumference. This allows sufficient expansion to the tubing without danger of its bursting. Slip this cylinder of cloth (*g*) over the tubing and fasten each end securely by winding it tightly with small copper wire. Then connect the two nozzles (*a*) and (*d*) by two heavy copper wires (*c*), fastened by winding once or twice around each nozzle. The Vermorel nozzle is thus held firmly in place, and as the large wires will stand any amount of bending, the direction of the stream is thus easily regulated. The size of the elastic chamber, and consequently the duration of the spray from a single stroke of the pump, may be increased by using a greater length of tubing and connecting the two nozzles by correspondingly longer wires; but it will not be found convenient to use a size of tubing larger than ⅝-inch or to use a shorter length than 6 inches. In order to reach a greater distance with the spray, a few feet of light brass tubing may be soldered on to a coupling which may be screwed on in place of the Hydronette nozzle, and to the end of this tubing the Vermorel nozzle may be adjusted as just described.

The advantage of this apparatus is that in addition to its cheapness (its total cost is a little over $8.00), it leaves the force pump free, when not wanted for spraying, for any of the numerous uses to which such a pump is ordinarily put, and is also readily made by any one of ordinary intelligence. To make it work successfully, however, several things are necessary. First, the pump must be in good order; properly packed, and the screw (*h*) which bears upon the packing must be loose enough to allow of an easy movement of the piston, which should be well oiled.

If the rubber tubing is not old and inelastic, and is properly adjusted, as described, no trouble will be found with the working of the apparatus. By alternating the motion, holding the right hand stationary and working with the left and *vice versa*, the operation is not at all laborious. If the pump is in good condition at the outset, it will not get out of order either from clogging or other causes, and very quick work can be done with it by enlarging the hole in the Vermorel cap as previously described. The writer uses this pump in preference to the Eureka sprayer owned by the Station, to which it is superior in several points, and is confident that it will give satisfaction when properly constructed.

Fungicides.—The Bordeaux mixture for general purposes can be recommended as more effectual than any of the somewhat numerous preparations which have been used as fungicides, although it seems probable that a cheaper and almost, if not quite, as effective a material will be found in some of the formulæ for precipitated carbonate of copper. Another year, however, is needed to test these thoroughly before they can be definitely recommended in place of the Bordeaux mixture. The ammoniacal carbonate of copper is decidedly inferior to the Bordeaux mixture; but is very useful for the last two sprayings in cases where there is danger of any considerable amount of the Bordeaux mixture adhering to fruit, grapes for example, when they are ready to gather.

Strong solutions of sulphate of copper or of sulphate of iron are also often useful for what is known as the winter treatment, which is very valuable, for instance, against the Anthracnose of the vine.

These three fungicides, the Bordeaux mixture for general purposes, and the others as above indicated, had best be employed by persons using fungicides for the first time, without regard to other formulæ which they may see advertised or recommended. The method of preparing them is as follows:

Bordeaux Mixture.

Sulphate of Copper (blue stone)	6 lbs.
Quicklime	4 lbs.
Water	22 gals.

Dissolve the sulphate of copper in two gallons of water, hot, to hasten its solution, which is also facilitated if the sulphate is pulverized. When all the sulphate is dissolved, dilute this solution with fourteen gallons of water. Slake the lime, which must be fresh (i. e., not partly air-slaked), with six gallons of water, adding the latter slowly and stirring the mixture to a smooth paste. Allow this mixture to stand a short time, then stir it and pour it slowly into the sulphate solution, which should be rapidly stirred during the operation. Only use that portion of the lime which is held readily in suspension by stirring slightly. *Never pour in any of the coarser sediment, which settles readily to the bottom.* By using care in this respect the Bordeaux mixture will need no straining if the vessels and water are clean; that is, free from straws, chips, etc., but must otherwise be strained through fine brass gauze.

Carbonate of Copper.—This substance can be bought ready made at from 60 to 75 cents a pound; but can be made without great trouble at about 15 cents or less. Enough for a season's use had best be made at once, as follows. The substances needed for this purpose are sulphate of copper and carbonate of soda (sal soda) in the proportion of four parts of the copper to five parts of the soda. For instance, to make one pound of carbonate of copper it is necessary to use two pounds of sulphate of copper and two and a half pounds of sal soda.

The sal soda should be dissolved in hot water in one barrel, and the sulphate of copper in another. When both are wholly dissolved and *cooled* pour the sal soda solution slowly into the copper solution, stirring during the operation, which yields a heavy green precipitate of carbonate of copper. Since the sal soda is in excess and is injurious to foliage, it has to be washed out of the carbonate of copper. To do this fill the barrel up with water and stir it thoroughly. Then allow the carbonate to settle to the bottom of the barrel, and then siphon off the clear water which stands above it. Repeat this operation once. The carbonate of copper must then be strained out on a piece of porous cloth which can be tacked over a barrel so as to form a shallow bag into which the mixture of carbonate of copper and water can be poured and allowed to drain, after which it can be dried. No difficulty will be found in the process, and as it saves several hundred per cent. on the cost of material it is quite worth while.

At the suggestion of Prof. Johnson the carbonate of ammonia was tried as a solvent for the carbonate of copper and a lot of the solution made up in the laboratory, but not used for spraying. Prof. Chester, however, of the Delaware Station, has used the same solvent in spraying during the past season, and recommends it as much better than ammonia for the purpose. Its trial, therefore, in preference to the ammoniacal solution, the formula for which is given below, may be safely recommended, as it is more than twice as cheap and easily prepared as follows, the formula being that used by Prof. Chester:

Mix three ounces of carbonate of copper and one pound of pulverized carbonate of ammonia; add two quarts of hot water, obtaining a clear solution. Dilute for use with water to fifty gallons.

Ammoniacal Carbonate of Copper.

Dissolve three ounces of carbonate of copper in one quart of strong ammonia (22°). Dilute for use with 25 gallons of water. Add the ammonia to the carbonate in a jar or bottle.

Since the prices of manufacturers and dealers in materials and apparatus necessary for spraying are very variable, special attention is called to the following quotations which are the lowest which the Station has been able to procure.

Quotations for spraying pumps and accessories given by W. & B. Douglas for goods ordered directly from their factories at Middletown, Conn. (These 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 ½-inch hose	.25
Y-couplings " "	1.00
"Aquanette" force pump	4.00
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 previously mentioned or it can be obtained from Albinson & Co., 2026 14th St., or Leitch & Sons, 1214 D St., Washington, D. C., for about	11.00
Tanks arranged for use with Hydronette or Aquanette as shown in cut on page 108 can be made of unplanished copper with tin cover by any tinman for less than	3.00

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

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
½-inch heavy rubber tubing, per foot	.20

Quotations for sulphate of copper given by The Nichols Chemical Co., 68 William St., N. Y.

For lots of 25 to 50 pounds f. o. b., New York, 5 cents per pound.

Note. By the Director.

An *Ammonia-Copper Solution*, cheap and easy of preparation is perhaps best made as follows :—Provide—

½ pound of sulphate of copper (blue vitriol) pulverized.
1 " " hard and transparent* carb. of ammonia pulverized.
6 quarts of boiling water.

The substances may be easily reduced to coarse powder without loss by pounding with a mallet or stick of wood on a stout sheet of paper or in a small box.

Bring the carbonate of ammonia and hot water together in a wooden pail and stir until foaming ceases, then add the copper sulphate and stir again as long as the mixture effervesces. The blue and nearly clear liquid diluted to 62 gallons (2 barrels) will correspond to Prof. Chester's formula, or diluted to 31 gallons will be nearly equivalent, to the "Ammoniacal Carbonate of Copper" of the preceding page.

The solutions thus obtained differ somewhat in composition from those described on page 112. As regards copper content they are alike and the fungicide efficacy of the ammonia-copper compound is most probably the same in them all, but the last described solutions contain 4¼ oz. of sulphate of ammonia in the barrel or two barrels respectively, which is in the ratio of 1 to 970 or 1940 of liquid. This small proportion of sulphate of ammonia it may be anticipated will have no injurious effect on foliage. These solutions probably contain less free ammonia or carbonate of ammonia than those noticed on page 112 and in this respect are accordingly safer applications.

This method of preparing *Ammonia-Copper Solution* will, it is hoped, render the purchase or making of carbonate of copper and the use of liquid ammonia unnecessary. Practical trials are of course requisite to establish its usefulness and to prove what dilutions are the most proper.

*If, by long keeping, the carbonate of ammonia has become soft and opake a larger amount up to 1¼ lbs. will be needful.

SYNOPSIS OF PAPER ON OAT-PROTEIDS.

THE PROTEIDS OR ALBUMINOIDS OF THE OAT-KERNEL.*

By THOMAS B. OSBORNE, Ph.D.

I. Historical.

The Proteids contained in or derived from the oat-grain have been specially studied by J. P. Norton, Baron von Bibra and Dr. W. Kreusler. Norton† recognized three proteids, viz: 1. *Albumin*, 0.5 to 2.17 p. c., which was taken up from the "epidermis," (after starch had been mechanically removed by elutriation with slightly ammoniacal water), by boiling with acetic acid and was precipitated by neutralizing the solution. 2d. *Casein* (or *avenine*, as Johnston, in whose laboratory the work was done, named it), 15.76 to 17.72 p. c., which was dissolved in the slightly ammoniacal water used in separating starch, and thrown down by acetic acid. 3. *Glutin*, 1.33 to 2.47 p. c., extracted by alcohol and separated from oil by means of ether, and from sugar by water.

Von Bibra‡ found that no coherent gluten could be got from oat-flour by kneading in water. He recognized *Albumin*, 1.24 to 1.52 p. c., precipitated by boiling the cold-water-extract of the ground oats; *Casein*, 0.15 to 0.17 p. c., the body separating from the hot alcohol-extract on cooling; *Plant-gelatin* (Dumas' *glutin*, Taddei's *gliadin*), 3.00 to 3.25 p. c., the substance soluble both in hot and cold alcohol; and *Nitrogenous substance insoluble in water and alcohol*, 11.38 to 14.85 p. c.

Kreusler§ found *Oat-Gliadin* soluble in weak alcohol and *Oat-Legumin* soluble in very dilute alkali.

Since the date of Kreusler's work, 1869, our knowledge of proteid bodies and of the methods for their investigation has been considerably extended. This advance has been chiefly in the study of the animal proteids, but little real progress having been made in our knowledge of the vegetable albuminoids. The following research was undertaken with a view to applying the newer methods of study to the plant-proteids that have agricultural importance.

*An abstract of this Paper was read by the Author before the National Academy of Sciences, in Boston. November 13th, 1890.

† Am. Jour. of Sci. and Arts, 2d ser., iii, 330, (1845), and v, 22, (1848).

‡ Die Getreidearten und das Brod. Nürnberg, (1860).

§ Jour. für Pr. Chemie, cvii, 17, (1869).

II. Oat-Proteids extracted by Weak Alcohol.

Kreusler's Work.

The Oat-proteid soluble in weak alcohol was first examined and, as results differing from Kreusler's were obtained, it will be well to give here a brief summary of his work.

Kreusler found that, on extracting ground oats with alcohol of 80 p. c. and concentrating the extract to one-third of its volume, a considerable amount of substance separated which, after subsiding from the solution, became a tough, transparent mass of amber-yellow color. The solution decanted from this substance and further concentrated, yielded a second deposit. The liquid poured from this second deposit yielded, on still further concentration, a third. The three sediments were united and dissolved in 80 p. c. alcohol at a gentle heat. On cooling, the greater part of the substance precipitated. After decanting the liquid, this precipitate was treated with absolute alcohol, which caused it to gather on the walls of the vessel as a tenacious mass. After treating with ether and again with absolute alcohol, it was dried over sulphuric acid. This Kreusler designated A.

By concentrating the solution decanted from A, on cooling, he obtained a second precipitate B. The filtrate from B by similar treatment yielded a third precipitate C.

These three precipitates showed the same behavior with various reagents and appeared to differ only in their degree of purity. The reactions agreed with those of gliadin from wheat which, according to Ritthausen, contains 18 p. c. of nitrogen.

Kreusler found that:

A contained 16.22 per cent. of nitrogen.
B " 16.21 " " "
C " 15.36 " " "

These three preparations were united, dissolved in dilute acetic acid and fractionally precipitated by dilute potash. Thus were obtained three precipitates:

I with 16.00 per cent. of nitrogen.
II " 16.51 " " "
III was too small in amount for analysis.

By this treatment the substance was separated into two portions of different nitrogen-content.

Kreusler in the next place prepared a new extract with alcohol of 80 p. c. from five pounds of ground oats, concentrated the solution until nearly all the alcohol was removed, and on cooling and treating the precipitate with ether and absolute alcohol and drying over sulphuric acid, obtained thirty grams of substance having properties like the former preparations, but not wholly soluble in acetic acid. This precipitate contained 15.36 p. c. of nitrogen. When it was heated with acetic acid, a residue was left, having 14.81 p. c. of nitrogen. The acetic acid solution, by three partial precipitations with dilute potash, gave, as before, precipitates I, II and III—the third being too little for analysis. The composition was:

	I.	II.
Carbon	----	53.41
Hydrogen	----	7.15
Nitrogen	16.99	17.14

This treatment, however, had failed to yield a product having as much nitrogen as Ritthausen's gliadin.

I and II were, therefore, united and dissolved in 60 p. c. alcohol at a gentle heat. The solution was brownish yellow, and on cooling, a part of the substance precipitated. The filtrate from this precipitate gave a second precipitate when treated with absolute alcohol. These precipitates were united and called A. The alcoholic filtrate contained a considerable amount of substance which was separated by concentration and gradual precipitation with absolute alcohol. This precipitate was marked B and resembled A in appearance. They contained:

	A.	B.
Carbon	----	52.64
Hydrogen	----	7.66
Nitrogen	17.71	16.70

Since the substance was precipitated in the presence of a considerable amount of acetic acid and might be thought to retain some of the latter, the just-described process was repeated with A and potash added to perfect neutralization. The precipitate thus obtained was slightly washed with water, and after dissolving in 60 p. c. alcohol was precipitated with absolute alcohol. B was dissolved directly in weak alcohol, and precipitated by absolute. These products then had the following composition:

	A.	B.
Carbon	52.94	53.12
Hydrogen	7.71	8.15
Nitrogen	{ 17.28 17.30	17.20

These preparations were next united and dissolved by heating in 60 p. c. alcohol; a varnish-like mass deposited on cooling. This process was repeated several times, and the substance was finally dried with absolute alcohol. It had the following composition as found in analyses I and II.

	I.	II.	Gliadin. Oats. Kreusler.	Gliadin. Wheat. Ritthausen.
Carbon	52.94	52.59	52.59	52.60
Hydrogen	7.58	7.65	7.65	7.00
Nitrogen	17.71	----	17.71	18.06
Sulphur	1.71	1.61	1.66	.85
Oxygen	20.06		20.39	21.49
	100.00		100.00	100.00

The alcoholic solution after concentrating gave on cooling a preparation with 17.2 per cent nitrogen. Kreusler rejected the highest carbon-determination (obtained without the use of lead-dioxide) as probably erroneous, and wrote his analysis of *oat-gliadin* beside Ritthausen's analysis of *wheat-gliadin*, as quoted above. Kreusler concludes that oat-gliadin is essentially different from wheat-gliadin and compares at length the behavior of the two towards reagents. The one point of difference he mentions is that the oat-gliadin dissolves in concentrated hydrochloric acid to a scarcely colored liquid, while wheat-gliadin gives a blue solution.

It is evident from Kreusler's paper that he expected to find the alcohol-soluble proteid of oats to have the same composition as wheat-gliadin. He finally accepted, as pure, a preparation having 17.71 per cent. of nitrogen, according to a single determination.

It is to be noticed on reviewing his analyses that the treatment to which Kreusler submitted his preparations, while on the whole tending to raise the nitrogen-content, sometimes appears to have had the opposite effect and the conclusion is not improbable that the fluctuations in the per cent. of nitrogen found by him are partly attributable to the then unknown errors involved in the soda-lime method of analysis—errors which Ritthausen* and U. Kreusler† in later years fully appreciated and made the subject of special investigation.

* Pflüger's Archiv., xviii, 236, (1878).

† Landw. Vs-St. xxiv, 37, (1880), und ibid, xxxi, 248, (1885).

III. Oat-Proteids extracted by Weak Alcohol.

The Writer's Work.

1. *Direct Extraction with Alcohol.* Preparations **1-8.**

As Ritthausen had separated the gliadin, mucedin and fibrin found by him in wheat gluten, from alcohol-solution by fractional precipitations, the writer judged that if more than one proteid were extracted from oats by alcohol, this fact would be shown by differences in behavior and composition of various fractions of the alcoholic extract. Accordingly four kilos. of freshly-ground oats were heated on the water bath with ten liters of alcohol, of ·915 sp. gr. After boiling for half an hour the extract was strained through cloth, the residue pressed out and the extraction repeated. The extracts were united, allowed to stand over night, decanted from sediment, and filtered clear. This solution was concentrated to one-third by distillation. After standing for twenty hours at room-temperatures, the residue deposited a bulky yellowish precipitate. About four-fifths of the solution was carefully decanted from this precipitate. The remaining one-fifth could not be filtered until a large amount of strong alcohol had been added, which caused the precipitate to separate. After filtering, the precipitate was treated with absolute alcohol, next with ether, and after removing the ether, with absolute alcohol again, and dried over sulphuric acid. This preparation, **1**, then weighed 15·5 gm. and, dried at 110° C., contained 13.92 per cent. of nitrogen. The liquid decanted from **1**, was still further concentrated to about one-third of *its* volume and cooled. The precipitate which formed, **2**, was treated with absolute alcohol and ether and, after drying over sulphuric acid, weighed 10.30 grams. Dried at 110° C., it contained 12.36 per cent. of nitrogen. The filtrate from **2** was concentrated to a thick syrup. On cooling a deposit formed on the bottom of the dish. The syrup was poured off and this deposit treated successively with strong alcohol, absolute alcohol, ether, and finally with absolute alcohol again. After drying over sulphuric acid, this precipitate, **3**, weighed 6.82 grams, and contained, when dried at 110° C., 10.37 per cent. of nitrogen.

The alcoholic liquids obtained by washing preparations **1, 2,** and **3**, were found to have dissolved a large amount of proteid, they were therefore united and concentrated on the water-bath to small volume and cooled. The abundant deposit was washed with absolute alcohol, ether, absolute alcohol again, and dried over sulphuric acid. The 14.62 grams thus obtained, **4**, when dried at 110° C., contained 16.27 per cent. of nitrogen. The filtrate from **4** was still further concentrated, and after cooling and adding a large amount of alcohol gave a precipitate, **5**, which when treated as the others, weighed 4.21 grams and contained 6.0 per cent. of nitrogen. The filtrate from **5** was highly concentrated and treated with absolute alcohol. The precipitate thus thrown down, **6**, after treating with absolute alcohol, ether, absolute alcohol again, and drying over sulphuric acid, weighed 17.78 grams and contained 8.61 per cent. of nitrogen.

To sum up: From the alcoholic extract by concentrating and cooling three times there resulted three preparations, viz:

1, of 15.5 grams, containing 13.92 per cent. of nitrogen.
2, of 10.30 " " 12.36 " "
3, of 6.82 " " 10.37 " "

From the alcoholic washings of **1**, **2** and **3** by concentration and cooling was obtained preparation

4, of 14.62 grams containing 16.27 per cent. of nitrogen.

And by further concentration and addition of much strong alcohol,

5, of 4.21 grams containing 6.00 per cent. of nitrogen.
6, of 17.78 " " 8.61 " "

The principal impurity recognized in these preparations was sugar, which was abundant in **5** and **6**.

These six preparations were examined separately.

1 was warmed with alcohol of 75 per cent., but was only partly soluble, and owing to its slimy nature could not be filtered. Three volumes of strong alcohol were added, making the solvent equivalent to 2 liters of about 88 per cent. alcohol. After heating to boiling and cooling, a little substance separated, which was filtered out, together with the undissolved portion. This precipitate and residue, **1. A.**, after treatment with absolute alcohol, ether, etc., as before described, weighed 3.68 grams and contained 14.57 per cent. of nitrogen.

The filtrate from **1. A.** concentrated to one-third and cooled, deposited but little substance. Addition of an equal volume of water produced a precipitate. The liquid was poured off and the deposit treated with a large amount of absolute alcohol. The residue, **1. B.**, after drying weighed 3.05 grams, and contained 15.39 per cent. of nitrogen. Water was added to the filtrate from **1. B.**—but only a trifling precipitate resulted. The aqueous solution was then boiled, the coagulum filtered off, washed with absolute alcohol and dried over sulphuric acid. This preparation, **1. C.**, weighed 2.45 grams and contained as follows:

COAGULATED PROTEID.—*Directly extracted from Ground Oats by Weak Alcohol.*

	1. C.
Carbon	52.66
Hydrogen	6.89
Nitrogen	16.32
Sulphur, Oxygen, Ash	24.13
	100.00

Carbon and Hydrogen.—.3120 gram dried at 110° C. gave .6025 gram CO_2 = 52.66 per cent. C, and .1934 gram H_2O = 6.89 p. c. H.

Nitrogen, by Kjeldahl method.—.5624 gram dried at 110° C. gave ammonia = 10.75 cc. HCl (1 c. c. HCl = .00854 gram N) = 16.32 p. c.

Ash could not be determined for want of material.

Nothing more could be obtained out of the filtrate from **1. C.**

2. and **3.** were united and treated with 400 c. c. of boiling alcohol of 0.9 sp. gr. A part dissolved to a deep-red solution. The residue was extracted again with hot dilute alcohol and treated in the same manner as the other preparations. Thus was obtained 9·05 grams of substance **2** and **3. A.** containing 15·47 per cent. of nitrogen.

This preparation was again treated first with hot water and then with hot alcohol of 0.9 sp. gr., but only a little dissolved and the nitrogen-content was unchanged.

The alcoholic filtrate from **2** and **3. A.** was further examined, but only 2.3 grams of substance with 7.66 per cent. of nitrogen were obtained. The long heating in very weak alcohol to which preparations **2** and **3** had been subjected, had rendered a large share of the proteid insoluble, and it was therefore lost for further purification.

4 was treated with 500 c. c. of alcohol of 0.9 sp. gr., in which a part was insoluble, **4. A.** This was washed with alcohol and ether, dehydrated with absolute alcohol and after drying over sulphuric acid weighed 8.9 grams. Its analysis follows:

Coagulated Proteid.—*Directly extracted from Ground Oats by Weak Alcohol.*

4. A.

Carbon	53.09
Hydrogen	6.96
Nitrogen	16.56
Sulphur } Oxygen }	23.39
	100.00
Ash	.35

Ash.—.5069 gram air-dried = .4555 dried at 110° C. gave .0016 gram ash = .35 p. c.

Carbon and Hydrogen.—.4354 gram dried at 110° C. gave .8445 gram CO_2 = 52.90 p. c. C, and .2716 gram H_2O = 6.91 p. c. H.

Nitrogen by Dumas' Method.—.5425 gram dried at 110° C. gave 76.12 c.c. gas at 9°C. Barometer 756 .3^{mm} at 9° C.= 16.76 p. c. less correction of .20 = 16.56 per cent. N.

The alcoholic filtrate from **4. A.** was concentrated to small volume, but as a slimy precipitate appeared, which could not be filtered, the solution was mixed with water. This did not cause the substance to separate in a manageable form, so the liquid was boiled, and after cooling the substance deposited as a gelatinous lump. After filtering, the deposit, **4 B.,** was treated with absolute alcohol and with ether and dried over sulphuric acid. It weighed 2.6 grams. Its analysis is subjoined:

Coagulated Proteid.—*Directly extracted from Ground Oats by Weak Alcohol.*

4. B.

	I.	II.
Carbon	53.12	----
Hydrogen	6.91	----
Nitrogen	16.52	16.39
Sulphur } Oxygen } Ash }	23.45	----
	100.00	

Ash.—Very little. Not determined for want of substance.

Carbon and Hydrogen.—.3445 gram dried at 110° C. gave .6700 gram CO_2 = 53.12 p. c. C and .2143 gram H_2O = 6.91 p. c. H.

Nitrogen.—I. By Dumas' method—.2693 gram dried at 110° C. gave 37.93 c. c. gas at 8° C. less correction of .7 c. c. Barometer 756.3 mm. at 9° C.=16.52 p. c. N.

Nitrogen.—II. By Kjeldahl method—.2693 gram substance dried at 110° C. gave ammonia = 9.68 cc. HCl (1 cc. HCl = .00854 gram N) = 16.39 p. c.

The filtrate from **4. B.** was evaporated to dryness and yielded one gram of substance containing 7.5 per cent. of nitrogen.

6. evidently contained a large amount of sugar. It was first treated repeatedly with water, in which it formed a pasty lump. This was dehydrated with absolute alcohol, and when dried over sulphuric acid weighed 7.63 gm. and contained 14.61 per cent. of nitrogen. **6. A.**

6. A. was then treated with 100 c. c. of water, with which it formed a stringy lump which, after thoroughly kneading under water, assumed a semi-liquid condition and could not be separated from the solution either by boiling or freezing. The solution after concentrating on the water-bath to about 30 c. c. was poured into 300 c. c. of absolute alcohol. This threw down a curdy white precipitate which, after treating with absolute alcohol and drying over sulphuric acid, weighed 6 gm. and contained 15.67 per cent. of nitrogen when dried at 110° C. **6. A. 1.**

6. A. 1. was treated with 500 c. c. of alcohol of 0.9 sp. gr. But little dissolved and the solution was too slimy to filter. The whole was then concentrated to one-third and cooled, but no separation took place which would allow of filtering or decanting the solution. The solution was, therefore, diluted with water and boiled. After cooling, a curdy precipitate settled out, leaving a turbid liquid. This liquid was decanted and poured into a large amount of absolute alcohol. On standing a precipitate separated which, when treated with absolute alcohol and dried over sulphuric acid, weighed .455 gm. and contained, when dried at 110° C., 16.40 per cent. of nitrogen. **6. A. 2.**

There was thus obtained of the proteid soluble in alcohol a large number of fractional precipitations with different nitrogen-content. It will be noticed, however, that five of these preparations have from 16.27 to 16.56 per cent. of nitrogen. No preparations were obtained having a higher percentage of nitrogen, and none of the other preparations approximate to a constant nitrogen-content.

4. had 16.27 per cent. of nitrogen. When this was separated into two parts, one soluble in dilute alcohol, **4. B.** and the other insoluble, **4. A.**, the two parts were found to contain the same proportion of nitrogen, and agreed together exactly in content of carbon and hydrogen. This is what might be expected of a pure proteid, for some of these bodies become insoluble without change of composition, so far as can be detected by our methods of analysis. **1. C.** without correction for ash, has nearly the same composition as **4. A.** and **4. B.** a correction would tend to bring it into closer agreement; the amount of substance however, was insufficient for an ash-determination.

As all the preparations analyzed thus far, were the insoluble modification of the proteid, a new extract was prepared. Five pounds of freshly-ground oats were boiled up with 10 liters of alcohol of 0.915 sp. gr. The extract was pressed out, and added to another five pounds of oats and again heated to boiling. After filtering, a perfectly clear, deep ruby-red solution was obtained. This was concentrated by distillation on the water-bath to about one-third of its original volume. On cooling, a large amount of substance separated. This was thrown upon a filter and, after 24 hours, about seven-eighths of the solution passed through. The filter, with its contents, was then returned to the flask and boiled in 10 liters of 60 per cent. alcohol, with a reflux condenser, for four hours. The substance entirely dissolved to a clear, deep red solution. The solution was then concentrated by distillation to about one-half and cooled rapidly to 35° C., when it filtered readily. The precipitate formed a tough, jelly-like mass which did not adhere to the paper. It was boiled, as before, for several hours, with 10 liters of 60 per cent. alcohol until dissolved completely. The perfectly clear solution was concentrated to one-half its volume, during which operation a large part of the substance deposited on the interior of the flask as a thick, leather-like coating. This coating readily separated from the glass in large pieces of a dark-brown color. On cooling the liquid, a finely-divided yellowish precipitate appeared which did not settle out on standing. The muddy liquid was poured off and the leathery deposit was minced and treated with absolute alcohol in order, if possible, to dehydrate the substance and render it pulverizable for analysis, but as it remained 48 hours without change the attempt was abandoned. The substance suspended in the muddy liquid was now caused to separate by adding alcohol. After filtering, washing first with strong, then with absolute alcohol, the precipitate was united to the portion which had been digested with absolute alcohol and

the whole was boiled in two liters of 60 per cent. alcohol with return condenser. After three hours' boiling, about one-half had dissolved. Two liters more of 60 per cent. alcohol were then added and the boiling continued. Considerable proteid still remained in a gelatinous form on the sides of the flask. The solution was filtered off and 1200 c. c. of absolute alcohol were poured on the residual substance. This caused the jelly to break up into coarse lumps, whereupon 800 c. c. of water were added, making two liters of 60 per cent. alcohol, and the boiling on the water-bath was continued for several hours. Some of the substance dissolved, the liquid was filtered, and the insoluble residue was treated for many days with absolute alcohol. It was then ground to a fine powder while still moist with alcohol, extracted with ether, and dried over sulphuric acid. This preparation, **7.**, weighed 9.1 grams.

The alcoholic solution filtered from the insoluble portion was concentrated to one-half and filtered while hot from the large amount of substance which had separated. The latter resembled raw rubber in appearance and consistence but not in elasticity. It was finely minced, and after digesting with absolute alcohol was pulverized, treated again with absolute alcohol, washed with ether, and dried over sulphuric acid. This, **8.**, weighed 26 grams, and was a light powder of yellowish color. Unlike all the other preparations extracted from the oats by weak alcohol, which were analyzed, **8** was still largely "uncoagulated" and soluble in that solvent.

These two preparations were analyzed with the following results:

COAGULATED PROTEID.—*Directly extracted from Ground Oats by Weak Alcohol.*

7.

	I.	II.	III.	I. Ash-free.
Carbon	52.98	----	----	53.10
Hydrogen	6.86	----	----	6.87
Nitrogen	16.34	16.41	16.39	16.39
Sulphur, Oxygen	----	----	----	23.64
Ash	.25	----	----	----
				100.00

Ash.—1.007 gm. air-dried substance =.9291 gm., dried at 110° C. gave .0023 gm. Ash = .25 p. c.

Carbon and Hydrogen.—.5076 gm. dried at 110° C., gave .9860 gm. CO_2 = 52.98 p. c. C, and .3131 gm. H_2O = 6.86 p. c. H.

Nitrogen, I. Dumas' Method—.5000 gm. air-dried = 4606 gm. dried at 110° C. gave 64.1 cc. gas at 8° C. Barometer 750 mm., at 15° C. = 16.54 p. c. less .20 found in blank = 16.34 p. c. N.

Nitrogen, II. Kjeldahl Method—.5000 gm. air-dried = .4606 gm. dried at 110° C., gave ammonia = 8.85 cc. HCl (1 cc. HCl = .00854 N) = 16.41 p. c.

III.—.5000 gm., air-dried = .4611 gm., dried at 110° C., gave ammonia = 8.85 cc. HCl = 16.39 p. c. N.

SOLUBLE PROTEID.—*Directly extracted from Ground Oats by Weak Alcohol.*

8.

	I.	II.	III.	IV.	I. Ash-free.
Carbon	52.92	----	----	----	53.06
Hydrogen	6.93	----	----	----	6.94
Nitrogen	16.33	16.33	16.45	16.54	16.38
Sulphur	2.25	2.21	----	----	2.26
Oxygen	----	----	----	----	21.36
Ash	.24	----	----	----	----
					100.00

Ash.—1.0045 gm. air-dried, equal to .9027 gm. dried at 110° C., gave .0022 gm. ash = .24 p. c.

Carbon and Hydrogen.—.4821 gm. dried at 110° C., gave .9356 gm. CO_2 = 52.92 p. c. C., and .3003 gm. H_2O = 6.93 p. c. H.

Nitrogen, I.—Dumas' Method.—.5000 gm. air-dried = .4554 gm., dried at 110° C., gave 63.1 cc., gas at 10° C. Barometer 759.5 mm. at 16° C. = 16.53 p. c., less correction .20 = 16.33 p. c. N.

II.—.5000 gm. = .4490 gm., dried at 110° C., gave 62.42 cc. gas at 14° C. Barometer 770.3 mm., at 17° C. = 16.53 p. c. Corrected = 16.33 p. c. N.

III.—Kjeldahl Method.—.5000 gm. = .4490 gm., dried at 110° C., gave ammonia = 8.65 cc. HCl (1 cc. HCl = .00854 gm. N) = 16.45 p. c. N.

IV.—.5000 gm. = .4490 gm., dried at 110° C., gave ammonia = 8.70 cc. HCl = 16.54 p. c. N.

Sulphur, I.—1. gm., air-dried = .9107 gm., dried at 110° C., gave .1850 gm. $BaSO_4$, which when fused with Na_2CO_3 and reprecipitated, gave .1495 gm. $BaSO_4$ = .20532 gm. Sulphur = 2.25 p. c.

II.—1. gm. = .9107 gm., dried at 110° C., gave .1575 gm. $BaSO_4$, which, when fused with Na_2CO_3, and reprecipitated, gave .1469 gm. $BaSO_4$ = .20175 gm. Sulphur = 2.21 p. c.

These analyses are observed to agree closely with each other, as well as with several of the preparations obtained under various conditions from the first extract already described, as is shown by the following table.

OAT-PROTEID EXTRACTED BY WEAK ALCOHOL.

	Soluble.	Coagulated					
	8	7	1C*	4A.	4B.*	4	6A.2*
Carbon	53.06	53.10	52.66	53.09	53.12	----	----
Hydrogen	6.94	6.87	6.89	6.96	6.91	----	----
Nitrogen	16.38	16.39	16.32	16.56	16.52	16.27	16.40
Sulphur	2.26	23.64	24.13	23.39	23.45	----	----
Oxygen	21.36					----	----
	100.00	100.00	100.00	100.00	100.00		

* Not corrected for ash.

The figures given by Kreusler for the nitrogen of two precipitates from his first alcoholic extract are likewise in close agreement with the above, viz :—16.22 and 16.21 p. c. From his "oat-legumin" Kreusler also extracted by means of alcohol a substance with 16.38 p. c. nitrogen.

It seems hardly probable that such concordant analyses could result from impure preparations or from a mixture of two or more proteids, especially in view of the varying conditions under which the preparations were obtained.

The very high content of sulphur is remarkable. No other analysis of a vegetable proteid approaches this amount. Ritthausen (Pflüger's Archiv., Bd. xxi, p. 95, 1880), found indeed in a single preparation from sesame press-cake, 2.36 p. c., but he attributed this high percentage to some foreign substance precipitated with the proteid. He afterwards (Jour. f. Pr. Chem., 1882, Bd. xxvi, p. 444), stated the percentage of sulphur as 1.25, and ascribed the high figure first obtained to calcium sulphate. Among the animal-proteids besides *Keratin*, some forms of human *serum-albumin* contain 2.3 p. c. of sulphur.*

The fact that sulphur in my analyses is .60 p. c. more than found by Kreusler in his gliadin, indicates that his substance had undergone chemical change during the processes of preparation.

Ritthausen believes to have obtained from wheat-gluten by extracting with alcohol, three distinct proteids, to which he applies the names fibrin, gliadin and mucedin, and he includes under one or the other of these terms all the alcohol-soluble proteids which he and Kreusler found in their extended study of the cereals. That portion of wheat-gluten which is insoluble in alcohol Ritthausen denominated *gluten-casein.*

On the authority of Ritthausen, his names and the composition attributed by him to these substances, have passed into chemical literature and have superseded the mostly different designations and analyses of the older investigators.

The alcohol-soluble proteid of the oat which I have obtained, differs, however, essentially in composition from all these preparations of Ritthausen and Kreusler. Kreusler's analysis of mucedin from barley-grits alone fairly agrees with my results, as respects carbon, hydrogen and nitrogen, but the same chemist's analysis of mucedin from barley-meal gives .84 p. c. higher nitrogen than that from grits and but .68 p. c. sulphur.

* Starke. Jahresbericht der Thier-Chemie, xi, p. 19 (1881).

In case of the other substances the discrepancies are still more decided. The properties and reactions given by Kreusler for the substance called by him oat-gliadin are true of the body just described, but these reactions mostly belong to proteids in general, or to the mucedin and fibrin of Ritthausen, and are not characteristic of any one body. Ritthausen states that on evaporating the alcohol-solution of the gluten-fibrin prepared by him from wheat-gluten, a pellicle forms on the surface which renews itself as often as removed, and that neither mucedin nor gliadin show this property. I have frequently observed the formation of films on evaporating solutions of the alcohol-soluble proteid from oats. This body, however, can not be a mixture of Ritthausen's fibrin and gliadin as its sulphur-content so largely exceeds theirs.

2. Extraction with Alcohol after treatment with Water.
Preparation **9.**

Five pounds of oats were treated with water as long as any proteid was dissolved. The residue was then twice extracted with alcohol and strongly pressed. The first alcoholic extract was evaporated so far as to remove nearly all the alcohol. On cooling, the solution became turbid and after standing deposited a brown slimy substance exceedingly soluble in dilute alcohol. The liquid was decanted and the precipitate dissolved in dilute alcohol. After evaporating off the alcohol and cooling, the substance separated as before; the now aqueous solution was decanted and the slimy residue treated with ether. Ether extracted a fatty oil from this material and caused it to assume a more solid consistence. The substance was then treated with alcohol of 93 p. c. which dissolved a little and converted the remainder into a solid lump so that it could be transferred to a flask and digested with ether. By the continued action of ether the viscid substance was transformed into a loose yellowish powder. After standing under ether for 24 hours the body was filtered out and dissolved in dilute alcohol. This alcoholic solution was filtered and evaporated on the water-bath to a small volume. After cooling, the solution was poured from the gummy substance adhering to the dish, which was washed with water and repeatedly digested with absolute alcohol. As long as the substance retained water, a little dissolved during treatment with alcohol. The

residue became granular and brittle and was easily reduced to a fine powder. When impregnated with absolute alcohol the mass absorbed moisture rapidly from the air and became soft and viscid.

After thorough dehydration with absolute alcohol, the substance was rapidly filtered out and dried over sulphuric acid. It weighed 7.88 grams.

In testing the purity of this substance it was found to yield something to water. The whole preparation was, therefore, washed out completely with distilled water and again treated with absolute alcohol and ether and dried over sulphuric acid. Analysis of this preparation, **9.** gave the following results:

SOLUBLE PROTEID—*Extracted by Weak Alcohol from Ground Oats after treating them with Water.*

	9. I.	II.
Carbon	53.64	----
Hydrogen	6.88	----
Nitrogen	15.70	15.36
Sulphur	1.75	----
Oxygen	22.03	----
	100.00	

Ash—.6007 gm. air-dried left no ash.

Carbon and Hydrogen—.5886 gm. dried at 110° C. gave 1.1579 gm. CO_2=53.64 p. c. C. and .3642 gm. H_2O=6.88 p. c. H.

Nitrogen. I. Dumas' method—.5000 gm. air-dried =.4479 gm. dried at 110° C. gave 60.68 cc. gas at 8° C. Barometer 757 mm. at 12° C. =15.90 p. c. N, less .20 for blank =15.70 p. c.

II. Kjeldahl method—.5000 gm. air-dried =.4479 gm. dried at 110° C. gave ammonia =8.05 cc. HCl (1 cc. HCl=.00854 gm. N.)=15.36 p. c.

Sulphur—.8958 gm. dried at 110° C. gave .1142 gm. $BaSO_4$=.0157 gm.=1.75 p. c. sulphur.

3. Extraction with Alcohol after treatment with Salt-Solution.
Preparations **10** and **11.**

Five pounds of oats were repeatedly treated with 10 per cent. solution of sodium chloride until nothing more was dissolved, and after pressing out as thoroughly as possible, the residue was twice treated with alcohol of .912 sp. gr., being pressed out each time and the extracts kept separate. The first and second alcohol-extracts were united, evaporated on the water bath, until all alcohol had escaped and the residue was cooled to 10° C. At this temperature the deposit formed brittle lumps which, after decanting the solution, were treated with ether and absolute alcohol. The lumps were thus brought into a granular state, in which condition the substance was treated for some time with ether until all fat was removed. It was then dissolved in hot dilute alcohol, filtered and evaporated on the water-bath to a small volume. On cooling the proteid separated in a mass on the bottom of the dish. The aqueous liquid was poured off and the residue treated with absolute alcohol and ether, whereupon it became brittle and was easily ground to a fine powder. This powder was washed with water until it no longer gave with silver nitrate a reaction for chlorine. It was then treated with absolute alcohol and dried over sulphuric acid. In appearance and behavior it resembled in all respects the substance extracted by alcohol after the oats had been treated with water. When analyzed it was found to have the composition stated under **10.**

The third alcoholic extract of the oats was treated in the same way, and the product obtained analyzed with the following results, **11:**

SOLUBLE PROTEID—*Extracted by Weak Alcohol from Ground Oats after treating them with Salt-Solution.*

	10. I.	10. II.	10. III.	11. I.	11. II.
Carbon	53.97	----	----	53.55	----
Hydrogen	7.14	----	----	6.80	----
Nitrogen	15.71	15.66	15.68	15.61	15.52
Sulphur	1.80	----	----	} 24.04	----
Oxygen	21.38	----	----		----
	100.00			100.00	
Ash	.56			.25	

Details of Analyses of **10.**

Ash—1 gm. air-dried =.9361 gm. dried at 110° C. gave .0053 gm. ash =.56 p. c.

Carbon and Hydrogen—.3443 gm. dried at 110° C. gave .6780 gram CO_2=53.70 p. c. C, and .2200 gm. H_2O=7.09 p. c. H.

Nitrogen—I. Dumas' Method—.5000 gm. air-dried =.4681 gm. dried at 110° C. gave 60.47 cc. gas at 8° C. Barometer 772 mm. at 8° C.=15.80 p. c. less .20 for blank =15.60 p. c. N.

II. Kjeldahl Method—.5000 gm. air-dried =.4681 gm. dried at 110° C. gave ammonia =8.53 cc. HCl (1 cc. HCl =.00854 gm. N.)=15.57 p. c. N.

III. .5000 gm. gave ammonia 8.55 cc. HCl=15.59 p. c. N.

Sulphur—1 gm. air-dried substance =.9361 gm. at 110° C. gave .1232 gm. $BaSO_4$=.0169 gm.=1.80 p. c. Sulphur.

Details of Analyses of **11.**

Ash—.8680 gm. dried at 110° C. gave .0022 gm. ash=.25 p. c.

Carbon and Hydrogen—.3676 gm. dried at 110° C. gave .7190 gm. CO_2=53.42 p. c. C, and .2242 gm. H_2O=6.78 p. c. H.

Nitrogen—I. Kjeldahl Method—.5000 gm.=.4715 gm. dried at 110° C. gave ammonia=8.60 cc. HCl (1 cc. HCl=.00854 gram N)=15.59 p. c. N.

II. .5000 gm.=.4715 gm. dried at 110° C. gave ammonia=8.55 cc. HCl=15.49 p. c. N.

4. *Extraction with Alcohol after treatment with Water and Salt-Solution.* Preparation **12.**

Five pounds of oats were extracted with water and then with 10 p. c. salt-solution as long as anything was removed. The residue was twice digested with alcohol of .9 sp. gr., the two alcohol-extracts were united and concentrated to a small volume on the water-bath. After cooling, the substance which deposited was filtered out and dissolved in dilute alcohol. The filtered solution was evaporated until nearly all the alcohol was expelled and finally poured into cold water. The abundant precipitate thus produced settled rapidly, forming a pasty mass on the bottom of the dish, from which the water could be completely decanted. By treatment with ether and absolute alcohol the substance was rendered dry and brittle, and was easily ground to a yellowish powder. This was transferred to a flask and digested for 24 hours with a mixture of absolute alcohol and ether, then washed with ether to remove the alcohol and dried in the air. The product weighed 12 grams. After dissolving this preparation in dilute alcohol and evaporating to a small volume on the water-bath, the concentrated solution was poured into a liter of cold distilled water. The substance thus precipitated was washed by decantation with distilled water until all chlorides were removed, then treated with absolute alcohol and ether and dried over sulphuric acid. This preparation was found to have the following composition:

SOLUBLE PROTEID—*Extracted by Weak Alcohol from Ground Oats after treating them with Water and with Salt-Solution.*

12.	I.	II.
Carbon	53.63	----
Hydrogen	7.16	----
Nitrogen	15.83	15.86
Sulphur	1.74	----
Oxygen	21.64	----
	100.00	
Ash	.11	

Ash—.7593 gm. dried at 110° C. gave .0008 gm. ash = .11 p. c.

Carbon and Hydrogen—.2850 gm. dried at 110° C. gave .5595 gm. CO_2 = 53.58 p. c. C, and .1836 gm. H_2O = 7.15 p. c. H.

Nitrogen—I. Dumas Method—.4168 gm. dried at 110° C. gave 56.95 c. c. N at 18° C. Barometer 764.5^{mm} at 22° C. = 15.81 p. c.

II. Kjeldahl Method—1.0183 gm. dried at 110° C. gave ammonia = 19.63 c. c. HCl (1 cc. HCl = .00822 gm. N) = 15.84 p. c.

Sulphur—.9682 gm. dried at 110° C. gave .1218 gm. $BaSO_4$ = .01673 gm. sulphur = 1.74 p. c.

Recapitulation.

The following statement brings together the analyses of the four preparations last described.

PROTEID EXTRACTED FROM OATS BY WEAK ALCOHOL.

After treatment of the meal with—

	Water. 9.	Salt-solution. 10.	Salt-solution. 11.	Water and Salt-sol. 12.	Average.
Carbon	53.64	53.97	53.55	53.63	53.70
Hydrogen	6.88	7.14	6.80	7.16	7.00
Nitrogen	15.70	15.71	15.61	15.83	15.71
Sulphur	1.75	1.80	} 24.04	1.74	1.76
Oxygen	22.03	21.38		21.64	21.83
	100.00	100.00	100.00	100.00	100.00

When the above analyses are compared, as below, with those of the preparations obtained without previous treatment of the oats with water or salt-solution, it is evident that we have in hand two quite different and distinct substances, neither of which agrees in composition with Kreusler's *Oat-Gliadin.*

PROTEID EXTRACTED FROM OATS BY WEAK ALCOHOL.

	Without action of water or Salt-Solution. 8.	After action of water or Salt-Solution. Average.
Carbon	53.06	53.70
Hydrogen	6.94	7.00
Nitrogen	16.38	15.71
Sulphur	2.26	1.76
Oxygen	21.36	21.83
	100.00	100.00

The differences in behavior of the two substances are much more marked than those of composition. The body extracted by

alcohol without the previous treatment with water becomes insoluble in alcohol with great readiness and after having been dissolved and precipitated a few times is again dissolved very slowly and only in a large amount of hot alcohol of .9 sp. gr. When wet with absolute alcohol it can be exposed to moist air without becoming gummy.

On the other hand, the body extracted by alcohol after the action of water or 10 p. c. salt-solution shows no tendency to become insoluble even after long heating with very dilute alcohol. It is freely soluble even in cold alcohol of .9 sp. gr., and when wet with absolute alcohol it immediately attracts moisture from the air, becoming sticky and viscid. In appearance the two bodies do not materially differ, both being light yellowish powders when prepared as described.

Both these substances are soluble in dilute acids and alkalies to solutions from which on neutralization they precipitate, retaining solubility in dilute alcohol.

The fact that weak alcohol acts as a solvent on these bodies, which are insoluble in either pure (absolute) alcohol or pure water, is doubtless due to the formation of hydrates that, while insoluble in water, are soluble in alcohol, but that cannot exist in strong alcohol, being thereby dehydrated.

The proteid whose composition is expressed by analysis **8**, was first obtained by Norton, who extracted ground oats directly with hot alcohol, distilled the solution carefully to dryness, dissolved out the oil by ether and the salts and sugar by water. Norton designated this body *Glutin*, and considered it "analogous to the glutin of wheat;" he states that the preparation which he thus separated and weighed was no longer soluble in alcohol, but he did not attempt any further investigation of its properties or composition (*Am. Jour. Sci.*, 2d Ser., III. 229).

Von Bibra who found in oats 3.00 p. c. of *Plant-gelatin* (Pflanzenleim), does not describe its mode of preparation, but states that it contained 15.6 p. c. of nitrogen.

Kreusler indeed extracted crushed oats directly by 80 p. c. alcohol, and in his first preparations, found 16.22 and 16.21 p. c. of nitrogen; but the substance, from whose analysis he decided upon the composition of *Oat-gliadin*, had been "purified" by dissolving in acetic acid and precipitating by potash-solution, and according to his results, contained 1.3 p. c. more nitrogen, 0.65 p. c. more hydrogen and, 0.6 p. c. less sulphur than exists in either of the alcohol-soluble proteids which I have analyzed.

It would be premature to attempt a revision of the nomenclature of these proteids until after re-investigating the alcohol-soluble proteids of the other cereals.

IV. Proteids extracted by Water.

The water-extract of freshly ground oats has a strong acid reaction. The acidity measured by litmus is much less than by phenol-phthalein. 100 cc. of an aqueous extract became neutral to delicate litmus paper after adding 10 cc. of 2-tenths p. c. KOH solution, and 5 cc. more of the same solution were added before phenol-phthalein showed an alkaline reaction. On neutralizing the water-extract of oats with 2-tenths p. c. potash, using phenol-phthalein as an indicator, a considerable precipitate appeared which was soluble in the slightest excess either of alkali or of the acid contained in the extract. This neutralization-precipitate indicates the presence of so-called *Acid-albumin*. The perfectly neutralized solution when heated to boiling remained clear. On adding 10 p. c. of sodium chloride to the neutralized and filtered liquid a considerable precipitate formed upon boiling as well as on the addition of acetic acid. When the unneutralized extract was boiled and the resulting coagulum filtered off, neither sodium chloride nor acetic acid gave a precipitate in the filtrate on boiling. The substance remaining in solution after neutralization, but precipitated by boiling, in the presence of sodium chloride or on the addition of acetic acid, is a *Globulin*, to be described later.

The water-extract, when heated slowly in a test tube immersed in a beaker of water which in turn was set in a larger beaker of water, showed a turbidity first at 57° C. and minute flocks appeared at 64° C. Heated to 70° and filtered, the solution remained clear until raised to boiling, when a slight precipitate formed. When 10 p. c. of sodium chloride was added to the extract, the turbidity appeared at 44° C. and flocks formed at 64° C.

Five pounds of oats were treated with 6 liters of water for 24 hours, pressed out and extracted a second time for 24 hours with the same amount of water. The aqueous extract reacted strongly acid to litmus, but was not neutralized as the possible action of the acid was kept in mind and the immediate object in view was to find what substances were extracted by the use of water

alone. The two extracts were united, saturated with commercial ammonium sulphate and the precipitate thereby resulting was filtered off, and scraped from the filter, the paper was washed out with water, the solution being added to the dark olive-green precipitate which partly dissolved to a brown solution. After the solution and suspended precipitate had dialyzed for 14 days in a stream of running water, thymol being added to prevent decomposition, the solution was found to be nearly free from sulphate. The contents of the dialyzer were then filtered from a dark green precipitate which had not dissolved on removing the salts. The filtrate was found not to coagulate on boiling and was evaporated to dryness on the water-bath, leaving a brown residue which weighed between 1 and 2 grams and gave the following reactions.

With the biuret test it yielded a red-purple color, of a bluer tint than given by peptones or albumose, which increased on standing. Millon's reagent with the aqueous solution gave a strong reaction. Alcohol of .9 sp. gr. dissolved a portion which, after removal of the alcohol, was readily soluble in water and reacted for proteids with Millon's reagent and the biuret test. After evaporation of the alcohol on the water-bath, the substance was but partially soluble in water. The alcoholic solution was precipitated by adding stronger alcohol. Fehling's solution gave no reaction until after heating with dilute acid, when a very slight precipitate of Cu_2O appeared. Very dilute HCl gave no precipitate in the solution, and stronger acid made a slight turbidity. These reactions indicate presence of a *Proteose* and absence of true *albumin*.

The substance remaining after dialyzing the ammonium sulphate precipitate was treated with 10 p. c. brine of sodium chloride; the resulting solution was filtered off and dialyzed till free from chlorides. Nothing precipitated on removal of the salt, the proteid being soluble in water. This fact shows that no globulin had been extracted from the substance which separated on dialysis of the aqueous extract, the globulin having been converted into an insoluble form. This dialyzed solution was not coagulated by boiling, and was therefore evaporated to dryness on the water-bath. The residue, weighing about 1 gram, was not quite completely soluble in water. As much as possible was dissolved in a small amount of water, and filtered from a slight residue. The solution was colored deep yellow-brown, contained a trace of chlorides, gave no precipitate with hydrochloric acid, either very dilute or strong. No biuret reaction was discernible in the colored solution, which gave the proteid coloration with Millon's test, and did not reduce Fehling's solution before treatment with acids. On long standing, after heating with HCl, a little Cu_2O separated. Evidently this substance is the same (*proteose?*) as that obtained from the solution remaining after dialyzing the ammonium sulphate precipitate.

The substance remaining after dialysis and insoluble both in water and in 10 p. c. brine was found to be partly taken up in ½ p. c. sodium carbonate solution, and in dilute hydrochloric acid, being the result of the alteration of globulin, which had passed into solution, by means of the salts derived from the oats. The neutralization-precipitate from sodium carbonate solution was slightly soluble in 10 p. c. brine of sodium chloride. The fact that the ammonium sulphate used in this work was crude and had a slightly acid reaction and a bluish tint, to which the green color of the precipitate was due, may throw doubt on the results here recorded, but as they were mostly corroborated on repeating the trials with pure and neutral ammonium sulphate, I have given them in detail.

The results of a second examination of water-soluble proteids here follow. Five pounds of oats were treated with 7 liters of water for 48 hours, thrown on a sieve, the residue pressed out and treated for a short time with 6 liters more of water. The two extracts were united and allowed to settle, when the nearly clear liquid was syphoned off and saturated with pure ammonium sulphate. After the white precipitate thus produced had stood over night, it separated in large flocks from the liquid, and was filtered out and dissolved mostly in 10 p. c. NaCl-brine, filtered and the clear solution dialyzed. The precipitate was not completely soluble in 10 p. c. NaCl-brine nor in water, in these respects resembling the precipitate obtained from the first extract after it had been dialyzed. The clear filtered solution in 10 p. c. NaCl-brine, on standing slowly deposited a part of the dissolved substance. The solution, with the precipitate which had formed, was dialyzed until free from salts, and the solution after filtering again was evaporated to dryness on the water-bath, leaving a residue of 1.11 grams. The precipitate filtered out was quite small in amount. The total proteid obtained by saturating with ammonium sulphate was less than that got in the first extraction, probably because the oats were allowed to stand twice as long in contact with water as in case of the first extract, for it was found that the clear, filtered extract of the ammonium sulphate precipitate in 10 p. c. NaCl-brine, on standing deposited the dissolved substance, so that before the conclusion of the dialysis nearly all the proteid originally soluble in water had lost its solubility.

Weyl states that water converts vegetable globulins into "albuminates," that is into forms no longer soluble in salt-solutions but soluble in 1 p. c. Na_2CO_3 solution, or .8 p. c. HCl, and that a long continued action of water finally converts the albuminates thus produced into modifications that are no longer soluble in 1 p. c. Na_2CO_3 solution, or .8 p. c. HCl. They are then not to be distinguished from "coagulated proteids." This latter change he has observed only for the globulins of peas and oats.

Transformations of this character occurred in the two extracts just described. In the first, after dialysis, the residue insoluble in 10 p. c. NaCl-brine, was partly soluble in ½ p. c. Na_2CO_3 solution, and in the second a body was formed insoluble in water, and in 10 p. c. NaCl-brine but soluble in ½ p. c. Na_2CO_3 solution.

To sum up—We have in the aqueous extract of the oat kernel the following bodies:

1. An *Acid-Albumin*, precipitated by exact neutralization of the extract.

2. One or more *Globulins*, precipitated from the neutralized extract, by sodium chloride and acetic acid; also precipitated by saturation with ammonium sulphate; remaining insoluble in water on dialysis, being, as it would appear, by the action of water, converted into an "albuminate."

3. A *Proteose*, remaining in solution after dialysis of the ammonium sulphate precipitate. This body exists also in the dialyzed solution of the ammonium sulphate precipitate from the sodium-chloride extract.

V. Proteids extracted by Cold Sodium Chloride Solution.

1. *Direct Extraction with Salt Solution.* Preparations **13** and **14.**

Freshly ground oats extracted with 10 p. c. brine of sodium chloride* at 15°–20°, gave a brown solution which, when filtered clear, coagulated as follows: Heated to 42° C. a very slight tur-

* The sodium chloride employed, was the "Diamond Crystal Table Salt," Eureka Salt Company, New York, which is "remarkably free from impurities."

bidity formed, which increased very slowly up to 57°, at which temperature it was still slight. Above this point it increased more rapidly, at 61° the solution being opaque, at 72° flocks formed. Heated at 73° some minutes and then filtered, the filtrate became turbid again at 70°, the turbidity increasing somewhat up to 87°; from 87° to 90° the increase was more rapid, but the amount separated at 90° was small. The solution heated to 90° and filtered, became turbid again at 85° with little change up to 97°. Heated to boiling for a short time and filtered, the filtrate gave an abundant precipitate with acetic acid.

Dilute acetic or hydrochloric acid yields a large precipitate in the brine extract, which is insoluble in a slight excess of the acid. Either saturation with sodium chloride or dilution with water throws down a copious precipitate. The precipitate produced by water, on standing in the dilute salt solution two days, becomes insoluble in 10 p. c. sodium chloride brine and in ½ p. c. sodium carbonate solution.

Saturation with ammonium sulphate completely precipitates the proteids from this solution in 10 p. c. sodium chloride brine.

Five pounds of freshly ground oats were treated twice with 10 p. c. sodium chloride solution, and after filtering, the extract was saturated with commercial but perfectly neutral ammonium sulphate, which gave a dark greenish color to the extracted substances without otherwise affecting their properties. The bulky precipitate was filtered off, suspended in water and dialyzed 14 days, until nearly free from sulphates.

A heavy precipitate remained undissolved. This was filtered out and the filtrate and precipitate were separately examined.

Filtrate.—When heated very slowly in a test tube, in the manner previously described, the solution was found to become turbid at 58° C.; at 70° C. flocks were formed. Heated to boiling and filtered, the filtrate gave a strong reaction with Millon's reagent. The entire solution was therefore concentrated to a small volume at 40° C. and dialyzed until all salts were removed. The coagulation-point of the solution was again taken and found to be the same as before; turbidity at 58° C.; flocks at 73° C. The solution was strongly colored, appearing almost black by reflected light, and by transmitted light a greenish brown. It gave good biuret and Millon's reactions; was not affected by very dilute hydrochloric acid but was precipitated by stronger acid in the cold. Fehling's solution suffered no reduction, either before or after the action of acid. This solution was then evaporated on a plate below 50° C. and yielded about 6 grams of a very brittle, greenish-black shining substance, very soluble in water, from which alcohol of .9 sp. gr. dissolved some proteid.

It is seen that when oats are extracted with 10 p. c. NaCl-solution, a substance soluble in water and coagulating at 58° to 73° C. is formed, which does not exist in the oats originally, for the aqueous extract, when treated in the same way, yields no substance coagulable even upon boiling.

The amount of this coagulable proteid, which has the properties characteristic of an *Albumin*, was too small for analysis (0.5 gram from 2¼ kilos. of oats) but its importance in a study of these bodies is great, for Weyl has undertaken to classify the vegetable proteids after the manner now commonly adopted for those of animal origin, and has stated that the extracts of oats and other seeds in 10 p. c. NaCl-solution coagulate at 55° to 60° C. and consequently contain a *myosin*, since the myosin from animal muscle coagulates under these conditions at this temperature. He also states that besides myosin, *vitellin* exists in these seeds, as shown by filtering out the coagulum formed at 60° C. and heating the solution gradually to 75°, when a second coagulation takes place.

The salt-soluble proteid to be described further on, was found, when dissolved in a 10 p. c. NaCl-solution, to become turbid at 81° C. and to form flocks at 97°. This then has a coagulation-point not far from that of vitellin, but it differs from vitellin, in being readily precipitated by sodium chloride even before saturation.

It is seen from the experiments above described that the presence of a very little coagulable substance may be highly misleading, and gives no certain basis for classifying or identifying the vegetable proteids unless each body is separated from all the others and examined in detail by itself. Weyl did not attempt this except for one preparation from the Brazil nut (*Bertholletia*), and therefore his conclusions based on coagulation-points need further study before they can be accepted.

Precipitate.—The precipitate from the dialyzer, filtered out of the solution just considered, was treated with 10 p. c. NaCl-solution. A part of the substance which did not dissolve was filtered out and the clear filtrate dialyzed till free from chlorides when the proteid was found to be precipitated. This precipitate was filtered out, washed with water, absolute alcohol and ether and dried over sulphuric acid.

The *Globulin* thus obtained, **13**, had the following properties:

In 10 p. c. brine of sodium chloride it dissolved readily to a clear solution. Addition of an equal volume of water to this solution produced a copious precipitate. Addition of sodium chloride gave a large precipitate even before saturation. When the solution was diluted till turbid the turbidity disappeared on warming gently.

Very dilute acetic or hydrochloric acid dissolved the substance readily when salts were not present. The addition of more acid gave no precipitate. Addition of a *very* little sodium chloride to a solution of the substance in very dilute acid made a slight precipitate; the addition of more sodium chloride threw down an abundant curdy precipitate. The more acid present, the more salt-solution was required to produce a precipitate, and the more salt-solution present, the less the amount of acid required for precipitation.

Dilute solution of citric acid in water (1 : 2000) gave results like acetic acid and dissolved the substance readily to a solution which was *not* coagulated on boiling.

From solution of the substance in 10 p. c. brine, hydrochloric acid throws down a precipitate which is wholly insoluble even in strong solution of sodium carbonate (the filtrate giving no biuret-reaction), and is also insoluble in an excess of dilute acid. Acetic acid on the other hand gives a precipitate which, at first, is readily soluble in *very* dilute sodium carbonate, but the solution, on standing, becomes turbid.

Hydrochloric acid, in the presence of salt, converts this proteid into a "coagulated proteid," acetic and citric acids transform it into an "albuminate."

The preparation gave the usual reactions with Millon's reagent, with cupric sulphate and potash, and with nitric acid. The solution in 10 p. c. brine of sodium chloride, on heating became turbid at 81° C. and at 97° C. the formation of flocks occurred. The same solution allowed to stand at summer temperature for more than a month, showed no signs of turbidity, decomposition being prevented by adding from time to time a drop of a 20 p. c. alcoholic solution of thymol. The composition of this globulin is given on the next page.

OAT-GLOBULIN—*First direct extraction with 10 per cent. Salt-Solution.*

13.

	I.	II.	III.	I. Ash-free.
Carbon	52.23	52.22	----	52.32
Hydrogen	7.15	6.99	----	7.19
Nitrogen	16.92	17.07	16.90	16.95
Sulphur	.88	----	----	.88
Oxygen	----	----	----	22.66
Ash	.20	----	----	----
				100.00

Ash.—.7937 gm. gave .0015 gm. ash = .20 p. c.

Carbon and Hydrogen.—I. .3561 gm. gave .6822 gm. CO_2 = 52.23 p. c. Carbon and .2300 gm. H_2O = 7.15 gm. Hydrogen.

II. .4584 gm. gave .8778 gm. CO_2 = 52.22 per cent. Carbon and .2883 gm. H_2O=6.99 per cent. Hydrogen.

Nitrogen.—I. Dumas' Method—.6225 gm. gave 90.85 c. c. Nitrogen at 18° C., Barometer 765.5 mm. at 22° C. = 16.92 p. c.

II. Kjeldahl Method—.5760 gm. gave ammonia = 11.95 c. c. HCl. (1 c. c. = .00822 gm. N.) =17.07 p. c.

III. 1.0476 gm. gave ammonia = 21.54 c. c. HCl =16.90 p. c.

Sulphur.—.8022 gm. gave .0513 gm. $BaSO_4$ = .00705 gm. Sulphur = .88 p. c.

A second preparation of Globulin was as follows: Five pounds of ground oats were digested with 8 liters of 10 p. c. sodium chloride solution for 48 hours and pressed out. The residue was again subjected to the same treatment. The two extracts were united, filtered, the clear filtrate saturated with pure ammonium sulphate, and the precipitate thus produced was filtered off. This precipitate was found to be completely soluble in 10 p. c. salt-solution, save a slight turbidity, which was readily cleared up by very dilute sodium carbonate solution. It was therefore removed from the filter, suspended in water and dialyzed for 11 days, whereby the salts were nearly all removed. The precipitate was filtered off and the filtrate and precipitate were separately examined.

Filtrate.—The clear brown filtrate was evaporated to dryness at 50°, leaving an amber-brown, instead of a greenish-black, residue, as was obtained from the first salt-extract.

The properties of this residue agreed exactly with those from the first salt-extract, the difference in color being due to impurities in the ammonium sulphate used in saturating the first extract.

Precipitate.—The precipitate in the dialyzer was found to remain almost entirely soluble in salt solution, the trifling residue not taken up by that solvent yielded to dilute sodium carbonate, and when this solution was neutralized with a slight excess of acetic acid the separated substance dissolved in solution of common salt.

The dialyzed precipitate was therefore filtered, washed by decantation with water, alcohol, ether, and absolute alcohol, and dried over sulphuric acid. This body had all the properties of the one similarly prepared and already described, **13**. Twenty grams of substance were thus obtained and by extracting the Oat-residue with 10 p. c. sodium chloride solution, until no more proteid was taken up, and proceeding as just detailed, ten grams more of globulin were secured. The yield was accordingly 1.3 p. c. of the air-dry oats. The analyses of this preparation here follow.

OAT-GLOBULIN—*Second direct Extraction with 10 per cent. Salt-Solution.*

14.

	I.	II.	III.	I. Ash-free.
Carbon	52.28	52.33	----	52.37
Hydrogen	7.23	7.17	----	7.24
Nitrogen	16.78	16.90	17.01	16.81
Sulphur	.89	----	----	.89
Oxygen	----	----	----	22.69
Ash	.21	----	----	----
				100.00

Ash.—.8060 gm. gave .0017 gm. ash = .21 p. c.

Carbon and Hydrogen.—I. .2894 gm. gave .5545 gm. CO_2 = 52.28 p. c. Carbon and .1883 gm. H_2O = 7.23 p. c. Hydrogen.

II. .2190 gm. gave .4200 gm. CO_2 = 52.33 p. c. Carbon and .1412 gm. H_2O = 7.17 p. c. Hydrogen.

Nitrogen.—I. Dumas' Method—.5314 gm. gave 77.1 c. c. Nitrogen at 18° C., Barometer 763.5 m.m. at 22° C. = 16.78 p. c.

II. Kjeldahl Method—.4732 gm. gave ammonia = 9.73 c. c. HCl (1 c. c. = .00822 gm. Nitrogen) = 16.90 p. c.

III. .9973 gm. gave ammonia = 20.64 c. c. HCl = 17.01 p. c. Nitrogen.

Sulphur.—.8400 gm. gave .0547 gm. $BaSO_4$ = .007513 gm. Sulphur = .89 p. c.

2. Extraction with Salt-Solution after treatment with Alcohol.

PREPARATION **15.**

Since digestion of oats first with water or with salt-solution altered the alcohol-soluble proteid, it was thought possible that by preliminary treatment with alcohol a salt-soluble body might be obtained different from the one extracted directly by salt-solution.

To test this hypothesis three pounds of fine-ground oats were extracted, in the cold, three times with 6 liters of alcohol of .9 sp. gr. After pressing out as thoroughly as possible, the residue was treated three times with 10 p. c. sodium chloride solution, the solvent each time being allowed to stand in contact with the oats for 24 hours. The first and second extracts were united, filtered and saturated with sodium chloride. The precipitate was filtered out and found to be but partly soluble in 10 p. c. brine. It was therefore dissolved in solution of sodium carbonate of ¼ p. c., and the filtered liquid was exactly neutralized with acetic acid which separated the proteid as a white precipitate. After washing thoroughly by decantation with distilled water, with dilute alcohol, with ether, and finally with absolute alcohol, the substance was dried over sulphuric acid. As it weighed only 2.1 grams, the greater part of the salt-soluble proteid in the oats had evidently been converted into an "albuminate."

OAT-GLOBULIN—*Extracted by 10 p. c. Salt-Solution after treatment with Alcohol. Dissolved in ¼ p. c. Sodium Carbonate Solution and precipitated by Acetic Acid.*

15.

		Ash-free.
Carbon	52.39	52.48
Hydrogen	6.93	6.94
Nitrogen	16.82	16.85
Sulphur	.57	.57
Oxygen	----	23.16
Ash	.17	----
		100.00

Ash.—.3773 gm. gave .0006 gm. ash = .17 p. c.

Carbon and Hydrogen.—.3187 gm. gave .6122 gm. CO_2 = 52.39 p. c. Carbon and .1993 gm. H_2O = 6.93 p. c. Hydrogen.

Nitrogen.—Dumas' method—.3220 gm. gave 47.17 c. c. Nitrogen at 18° C. Barometer 759.3 m. m. at 28° C. = 16.82 p. c.

Sulphur.—.7435 gm. gave .0304 $BaSO_4$ = .004216 gm. sulphur = .57 p. c.

VI. PROTEIDS EXTRACTED BY WEAK POTASH SOLUTION.

1. Extraction after treatment of the Ground Oats with Alcohol.

PREPARATION **16.**

Another extraction was made in nearly the same manner as that employed by Kreusler in preparing his "Oat Legumin:" Five pounds of freshly-ground oats were treated in the cold with alcohol of .9 sp. gr. as long as any proteid was removed. The residue was digested for some time with 7 liters of $\frac{2}{10}$ p. c. potash-solution. The whole was then thrown on a sieve and the turbid percolate allowed to stand for 24 hours.

The dark-colored solution was syphoned off, let stand another 24 hours, decanted from the slight sediment and then precipitated with very dilute acetic acid. After 24 hours the substance had so far settled that about two-thirds of the liquid could be decanted. To the remainder, alcohol was added until the solution had a sp. gr. of .93. On further standing, the precipitate deposited and was transferred to a filter. It was washed with stronger alcohol, removed from the paper and dissolved again in $\frac{2}{10}$ p. c. potash-solution. A turbid liquid resulted which could not be filtered until a little sodium chloride had been added, which precipitated some of the dissolved proteid. This precipitate was soluble both in additional potash-solution and in brine. More salt was therefore added, the nearly clear solution was then filtered, which process lasted for about a week. Decomposition was entirely prevented by the use of thymol. The filtrate obtained each day was precipitated with dilute acetic acid, the precipitate was washed on a filter with water, then with dilute and afterwards with strong alcohol and was finally transferred to a flask filled with absolute alcohol. When the filtration was completed and the united precipitates had been digested with absolute alcohol, they were treated with ether and again with absolute alcohol and lastly dried over sulphuric acid, yielding preparation **16.**

OAT-PROTEID—*Extracted by $\frac{2}{10}$ p. c. KOH Solution after treatment of the Ground Oats with Alcohol.*

16.

	I.	II.	III.	I. Ash-free.
Carbon	52.11	52.18	----	52.45
Hydrogen	6.87	6.74	----	6.92
Nitrogen	16.52	16.48	16.40	16.63
Oxygen	----	----	----	23.19
Sulphur	.81	----	----	.81
Ash	.66	----	----	----
				100.00

Ash.—.7373 gm. gave .0049 gm. ash = .66 p. c.

Carbon and Hydrogen.—I. .3666 gm. gave .7005 gm. CO_2 = 52.11 p. c. Carbon and .2265 gm. H_2O = 6.87 p. c. Hydrogen.

II. .4523 gm. gave .8651 gm. of CO_2 = 52.18 p. c. Carbon and .2746 gm. H_2O = 6.74 p. c. Hydrogen.

Nitrogen.—I. Dumas' method—.3577 gm. gave 51.44 c. c. Nitrogen at 18° C. Barometer 758.7 mm. at 22° C. = 16.52 p. c.

II. Kjeldahl method—.5037 gm. gave ammonia = 10.1 c. c. HCl (1 c. c. HCl = .00822 gm. N) = 16.48 p. c. Nitrogen.

III. 1.0412 gm. gave ammonia = 20.77 c. c. HCl = 16.40 p. c. Nitrogen.

Sulphur.—.8670 gm. gave .0510 gm. $BaSO_4$ = .0070 Sulphur = .81 p. c.

For comparison the analyses of the last four preparations are here stated together.

	13.	14.	15.	16.
Carbon	52.32	52.37	52.48	52.45
Hydrogen	7.19	7.24	6.94	6.92
Nitrogen	16.95	16.81	16.85	16.63
Sulphur	.88	.89	.57	.81
Oxygen	22.66	22.69	23.12	23.19
	100.00	100.00	100.00	100.00

13 and **14.** Extracted directly by 10 p. c. NaCl solution.
15. Extracted by 10 p. c. NaCl solution after treating the ground oats with alcohol, then dissolved in ½ p. c. Na_2CO_3 solution and precipitated by acetic acid.
16. Extracted by $\frac{2}{10}$ p. c. KOH solution after exhausting the ground oats completely with alcohol.

The four preparations agree in composition so closely that it is fair to assume that they were pure and that the analyses correctly represent the composition of one and the same proteid.

Of the above analyses, **13** and **14** represent the composition of oat-globulin as extracted by 10 p. c. solution of pure sodium chloride and still soluble in that menstruum, while **15** and **16** represent the insoluble or "albuminate" modification of the same proteid.

Analysis **15** indicates that the globulin is not essentially changed in composition by being dissolved in weak sodium carbonate solution and precipitated therefrom by dilute acid.*

Since all proteids, except the coagulated, are soluble in weak alkali, analysis **16**, made on a substance extracted by $\frac{2}{10}$ p. c. potash-solution, may be taken to exhibit the composition of whatever uncoagulated proteids remain in the oat after the direct extraction with weak alcohol. The close agreement of **16**

* The low figure for sulphur in **15** is accidental, some loss having been incurred in oxidizing the substance by fusion with alkali-nitrate and carbonate. The determination could not be repeated for lack of material.

with the other analyses leads to the conclusion that the oat-proteids which are not extracted by weak alcohol mainly consist of either the salt-soluble globulin or its "albuminate" modification or else of a proteid from which these are derived under the influence of the solvents employed in their preparation.

The amount of these preparations obtained in a form suitable for analysis was a very small fraction of the total proteid contained in the oats. This was probably due to the conversion of the globulin into an "albuminate" or a "coagulated proteid."

The exact cause of this change has not been ascertained. To test the hypotheses that it might be due to the action of an acid or acid-salt contained in the oats, 100 grams of the freshly ground grain were treated with 800 c. c. of $\frac{2}{10}$ p. c. potash-solution. The resulting mixture was neutral to litmus and did not redden phenolphthalein. Eighty grams of sodium chloride were then added and the solution, after standing some time, was filtered. Very little proteid was thus extracted. In another trial, 10 p. c. solution of sodium chloride mixed with $\frac{2}{10}$ p. c. of sodium carbonate, extracted but a small part of the proteids.

100 grams of oats treated with $\frac{2}{10}$ p. c. solution of sodium carbonate gave an extract containing much proteid, which on addition of a little sodium chloride yielded an abundant precipitate. Neutralizing the sodium carbonate extract, gave a precipitate which was insoluble in sodium chloride solution.

These experiments indicate that the insolubility of the greater part of the oat-proteids in 10 p. c. brine is not due to the presence of an acid or acid-salt.

Weyl has stated that when wheat flour is extracted with sodium chloride solution, the residue yields no gluten on kneading with water, and he considers that the gluten does not preëxist in the wheat but is a product of ferment action. It was thought that if a ferment occasioned alteration of oat-proteids, its effect might perhaps be prevented by treating the ground oats with a sodium chloride solution heated to 75° C. so that all the soluble proteids coagulable below that temperature would be rendered insoluble and inoperative as ferments. The globulin coagulating at 80° C. ought not to be affected by this treatment. Experiments made to prove this view did not result in the extraction of much if any more globulin than was obtained when a cold salt solution was employed.

The trials next to be described have an important bearing on the alterations of proteids which take place in the presence of water.

2. *Direct Extraction of the Ground Oats with weak Potash-Solution.* Preparation 17.

100 grams of freshly ground oats were treated with 500 c. c. of $\frac{2}{10}$ p. c. potash-solution. The mixture, after standing some time, was found to be neutral to litmus paper. It was then strained through a coarse cloth to remove the husks and the residue was treated with 100 c. c. of $\frac{2}{10}$ p. c. potash solution and squeezed out nearly dry. The solutions and washings were united and 100 c. c. $\frac{2}{10}$ p. c. potash-solution added thereto, making 700 c. c. in all. The liquid was then faintly alkaline to litmus. On standing the insoluble matter settled out; the solution was decanted, filtered and the residue treated again with $\frac{2}{10}$ p. c. potash-solution. The first potash-extract was very dark brown in color, the second much lighter. A third extract contained very little proteid. The first and second extracts were united, filtered and precipitated with acetic acid added to acid reaction, washed thoroughly with water, alcohol and ether and dried over sulphuric acid. The preparation weighed 7.8 grams. A portion treated with $\frac{2}{10}$ p. c. potash-lye was completely soluble giving a perfectly clear solution. The rest of the preparation was treated with hot alcohol of .9 sp. gr. which took up a little proteid. It was washed with hot alcohol of .9 sp. gr. until nothing more was removed, then with absolute alcohol and finally with ether and was dried over sulphuric acid. After drying at 110° C. the substance was analyzed with the following results:

OAT-PROTEID.—*Directly extracted with $\frac{2}{10}$ per cent. KOH-Solution.*

17.

	I.	II.	Ash-free. I.	Ash-free. II.
Carbon	52.96	----	53.49	----
Hydrogen	6.93	----	7.01	----
Nitrogen	16.23	16.10	16.39	16.26
Sulphur	.98	----	.99	----
Oxygen	----	----	22.12	----
Ash	1.00	----	----	----
			100.00	

Ash.—.7063 gm. dried at 110° gave .0071 gm. of Ash=1.00 p. c.

Carbon and Hydrogen.—.2651 gm. gave .5148 gm. CO_2=52.96 p. c. C, and .1654 gm. H_2O=6.93 p. c. H.

Nitrogen.—I. Kjeldahl Method—.7395 gm. gave ammonia=14.6 cc. HCl (1 cc.=.00822 gm. N)=16.23 p. c. N.

II. Dumas' Method—.4285 gm. gave 69.82 cc. Nitrogen at 15° C, Barometer 751.5 mm. at 21° C.=16.10 p. c. N.

Sulphur.—.5196 gm. gave .0373 gm. $BaSO_4$=.00512 gm. Sulphur=.98 p. c.

3. *Extraction of the Ground Oats with weak Potash-Solution after One Hour's treatment with Water.* Preparation **18.**

One hundred grams of ground oats were next treated with 800 c. c. of water, the mixture was passed through a cloth to remove husks and the residue washed with 200 c. c. of water. The liquid, with suspended starch, etc., was made up to the volume of a liter and after the oats had been for an hour in contact with the water an equal volume of $\frac{2}{10}$ p. c. potash-solution was added and intermixed.

After standing over night the strongly colored solution was decanted from the residue, filtered, precipitated with acetic acid, the precipitate washed with hot alcohol until nothing more could be removed and then with absolute alcohol and ether and dried over sulphuric acid. This preparation weighed 4.25 grams. The residue was treated a second time with $\frac{2}{10}$ p. c. solution of potash and *very little* more proteid was extracted. After drying at 110° C., this preparation was analyzed with the following results:

OAT-PROTEID—*Extracted by $\frac{2}{10}$ p. c. KOH-Solution after 1 Hour's Contact of the Ground Oats with Water.*

18.

	I.	II.	Ash-free. I.	Ash-free. II.
Carbon	51.51	----	52.36	----
Hydrogen	7.16	----	7.27	----
Nitrogen	16.95	17.03	17.23	17.31
Sulphur	.69	----	.70	
Oxygen	----	----	22.44	
Ash	1.63	----	----	
			100.00	

Ash.—.2760 gm. dried at 110° C. gave .0045 gm. ash=1.63 p. c.

Carbon and Hydrogen.—.2953 gm. gave .5576 gm. CO_2=51.51 p. c. C, and .1904 gm. H_2O=7.16 p. c. H.

Nitrogen.—I. Kjeldahl Method—.5867 gm. gave ammonia=12.1 cc. HCl (1 cc.=.00822 gm. N)=16.95 p. c.

II. Dumas' Method—.5120 gm. gave 75.49 cc. N at 15° C., Barometer 753.6 mm. at 23° C.=17.03 p. c.

Sulphur.—.7210 gm. gave .0365 gm. $BaSO_4$=.005013 Sulphur=.69 p. c.

In this analysis the fusible ash made the combustion of the last traces of carbon difficult; hence probably ash and nitrogen are stated a little too high and the carbon is slightly inaccurate.

4. *Extraction with Potash Solution after 24 Hours' contact of the Ground Oats with Water.* Preparation **19.**

100 grams of oats were treated in the manner just described except that instead of the 1000 c.c. of potash solution first added, 1000 c.c. of distilled water were used. After standing 24 hours the aqueous solution which had become clear was decanted and 1000 c.c. of $\frac{2}{10}$ p. c. potash-solution were added to the residue and let stand upon it over night. The solution was then decanted from the residue, filtered, precipitated with acetic acid, the precipitate was washed with hot alcohol of .9 sp. gr. and with absolute alcohol and ether and dried over sulphuric acid. The preparation weighed 2.55 grams. The following figures were obtained in its analysis.

OAT-PROTEID—*Extracted by $\frac{2}{10}$ p. c. KOH-Solution after 24 Hours' Contact with Water.*

19.

		Ash-free.
Carbon	52.29	52.61
Hydrogen	6.88	6.92
Nitrogen	16.89	16.99
Sulphur	.89	.89
Oxygen	22.46	22.59
Ash	.59	----
	100.00	100.00

Ash.—.5578 gm. dried at 110° C. gave .0033 gm. ash =.59 p. c.

Carbon and Hydrogen.—.3300 gm. gave .6327 gm. CO_2=52.29 p. c. C, and .2042 gm. H_2O=6.88 p. c. H.

Nitrogen.—Kjeldahl Method—.5426 gm. gave ammonia=11.15 c.c. HCl. (1 c.c.=.00822 gm. N)=16.89 p. c.

Sulphur.—.8310 gm. gave .0543 gm. $BaSO_4$=.00746 gm. Sulphur =.89 p. c.

The three preparations last described were made by extraction with the same dilute potash-solution and under essentially the same conditions in all respects, with the single difference, that while in case of **17**, the oats were directly treated with this solvent, **18** was extracted by potash-solution after the ground oats had been kept in contact with water for 1 hour, and **19** after digestion with water for 24 hours.

The amount of proteid extracted in the first instance was 7.80 gm. **17.**
" " " " second " 4.25 gm. **18.**
" " " " third " 2.55 gm. **19.**

The composition of the three preparations is placed in comparison with that of the oat-globulin **13,** in the subjoined statement.

OAT-PROTEID.

	Extracted by— NaCl solution. Direct.	Potash Solution— Direct.	After contact with water for 1 hour.	After contact with water for 24 hrs.
	13.	**17.**	**18.**	**19.**
Carbon	52.32	53.49	52.36	52.61
Hydrogen	7.19	7.01	7.27	6.92
Nitrogen	16.95	16.39	17.23	16.99
Sulphur	.88	.99	.70	.89
Oxygen	22.66	22.12	22.44	22.59
	100.00	100.00	100.00	100.00

The experiments just detailed tend to show that the action of water upon the crushed oat-kernel induces rapid changes of composition in these proteids simultaneously with their conversion into insoluble modifications.

They also indicate that the *globulin* itself is a result of changes brought about in the presence of water and is not a body existing as such, ready-formed, in the oats.

5. *Norton's Avenine and Kreusler's Oat-Legumin.*

The substance extracted directly by potash-solution without previous exposure of the oats to water **17,** is probably the same as that which Johnston and Norton originally termed *Avenine* and which the latter obtained by digesting ground oats in water to which a little ammonia was added to prevent souring, as the weather was very warm (Am. Jour. Sci., 2 Ser., v, p. 23). The preparation which Norton analyzed, as Avenine, was however extracted by water alone and was accordingly a mixture (loc. cit., p. 28). Both Norton and Kreusler applied weak alkali-solution to the extraction of proteid bodies from oats *after* the ground grain had been subjected to the action of water.

Norton made and analyzed two preparations, accomplishing the extraction by means of dilute ammonia, and threw down the proteid by adding acetic acid to the ammoniacal solution. One preparation **A,** was redissolved in strong ammonia at nearly the boiling point and again precipitated by acetic acid, then washed (presumably with water), and boiled in alcohol and ether until no more fatty matter was taken up. Another preparation B, was boiled in alcohol and ether *before* re-dissolving in very dilute ammonia at 70° to 80° C.

Norton made a single analysis of A and two fairly accordant analyses of B, the average of which is the basis for the corrected analysis given below. He found in both substances 1 p. c. of phosphorus which he includes in the analyses reckoned ash-free. This phosphorus in A nearly equals and in B exceeds the ash. If this phosphorus be deducted and the analyses recalculated to a per cent. statement we have the corrected analyses given below. As Norton published no analytical details and used a method of doubtful accuracy (Berthier's) for estimating phosphorus, this correction is perhaps not altogether satisfactory. Norton's nitrogen determinations were all made by Dumas' method. Norton gives to this substance no special name but designates it as a "protein body" simply.

Kreusler's preparation of *Oat-legumin* **A,** was obtained by suspending 1½ pounds crushed oats in 5 liters of water adding, to neutralize the acidity, over 3 grams of potassium hydroxide. The mixture stood 12 hours in a cool place, was then thrown on a sieve, the residue washed with water and the liquid left to rest over night. The turbid liquid was poured off and acidified with acetic acid. The precipitate was washed first with alcohol of 40 p. c. then with that of 80 p. c. then with ether, and lastly, was treated with absolute alcohol and dried over sulphuric acid and at 100°. To purify this substance from starch it was dissolved in dilute potash (1 gram to the liter of water) and from the solution after deposition of all suspended matter, it was thrown down again by acetic acid and washed and dried.

Another preparation B, was obtained from oats that had been extracted by cold alcohol—and a third C, from oats exhausted with hot alcohol—previous to treatment with weak potash-solution. The analyses of A and C, corrected by deduction of ash and phosphoric acid, are here tabulated. In his preparation B, Kreusler found 16.74 p. c. of nitrogen but carried the analysis no further.

PROTEID *obtained from Ground Oats after treatment with Water by extracting with weak solution of—*

	Ammonia. Norton. A	B	*Potash.* Kreusler. A	C
Carbon	53.72	52.35	52.09	51.58
Hydrogen	7.00	6.93	8.03	8.01
Nitrogen	16.94	16.55	16.83	17.61
Sulphur	.60	1.12	0.96	----
Oxygen	21.74	23.05	22.09	----
	100.00	100.00	100.00	

Norton remarks of his preparation **A** that dissolving it in hot strong ammonia would seem to have darkened the color and somewhat affected the composition. It will be observed that Norton's **B** does not differ greatly from my analyses **13** and **19**.

Kreusler doubting the purity of his preparations boiled them in alcohol of 60 p. c. and finding that something was thereby dissolved, especially from **A**, continued this treatment as long as anything was removed. The dissolved substance contained 16.38 p. c. of nitrogen. The thus "purified" preparations had the following composition, ash-free:

	A	C	Average.
Carbon	51.40	51.85	51.63
Hydrogen	7.49	7.49	7.49
Nitrogen	17.29	17.03	17.16
Sulphur	0.85	0.73	.79
Oxygen	22.97	22.90	22.93
	100.00	100.00	100.00

The average of the last two analyses Kreusler gives as expressing the composition of OAT-LEGUMIN.* He observes, in concluding his paper, that the substance purified by long boiling with alcohol had almost entirely lost solubility both in potash and acetic acid. It was in fact converted into coagulated proteid; but, that the change of composition was not entirely due to the removal of impurities and in part at least was owing to alteration of the substance itself, must be regarded as almost certain.

It is to be concluded that the "globulin" extracted by 10 p. c. salt-solution and the "legumin" removed by dilute potash solution after action of water upon the crushed grain, are very similar, perhaps identical in composition, and that neither of them pre-exists in the grain; but the investigation on these points is not altogether conclusive and needs to be continued.

Assuming that Kreusler's analyses are correct there can be little doubt that his Oat-legumin as finally analyzed was different from

* In a paper already referred to (Pflüger's Archiv., xviii, 236), Ritthausen decided that the soda-lime method used by Kreusler was untrustworthy and stated, as the result of his own analysis by Dumas' method, the nitrogen-content of *Oat-legumin* to be 17.45 p. c. It is now well understood that Dumas' method, carried out as Ritthausen describes, in the paper referred to, usually gives too high results due to retention of air in the oxide of copper, etc., and formation of carbon monoxide during the combustion. See report of this Station for 1878, p. 111 and for 1879, p. 124.

the proteid at first existing in the potash-extract, and was essentially altered in composition as well as in solubility, during the processes of preparation and "purification."

VII. PROTEID EXTRACTED BY HOT SODIUM CHLORIDE SOLUTION.

Preparation 20.

Freshly-ground oats were treated with distilled water heated to 65° C. and then sodium chloride was added sufficient to make a 10 per cent. solution. When the addition of salt was begun the liquid had a temperature of 60° C.; when finished, the temperature was 45°. The mixture was digested for about an hour at 45° and a portion of the extract was filtered. The filtrate became turbid immediately on cooling. When gently warmed the turbidity completely disappeared. The perfectly clear solution on further heating coagulated as follows: at 57° C. a very slight turbidity was seen that increased but little up to 78°, whence it rapidly augmented with formation of flocks at 85°.

The remainder of the extract together with the crushed oats was heated up to 75° and filtered as rapidly as possible. A perfectly clear filtrate was obtained which became turbid on cooling. The vessel containing the hot extract was placed in a large water-bath at 75° and cooled very slowly. A dense deposit formed which closely adhered to the bottom of the dish and under the microscope was seen to consist entirely of minute *spheroids* about $\frac{1}{100}$th of a millimeter in diameter.

The residual oats extracted twice again, yielded little more to the hot salt-solution. The proportion of proteid thus obtained was apparently little if any greater than that dissolved by sodium chloride solution at 15° to 20°.

The deposit of spheroids was almost wholly freed from the mother-liquor by simple decantation and was treated with cold 10 per cent. sodium chloride solution in which it dissolved very slowly. On warming to about 40° the substance melted to a soft plastic mass which became softer as the temperature rose, and could be drawn out into glistening threads. At 65° the substance became so fluid that the mass broke up and rapidly dissolved to a clear solution.

When a portion of this solution was heated to 78° a slight turbidity developed that increased very little up to 98° at which point a few flocks separated. These were filtered out and the filtrate gave on boiling a considerable coagulum. The filtrate from this coagulum yielded another precipitate on boiling again and the same result followed these operations to the fourth time. The final filtrate gave with hydrochloric acid a copious precipitate.

This substance was now prepared in greater quantity in the following manner. Five pounds of ground oats were treated with twelve liters of 10 per cent. sodium chloride solution, strained through a hair sieve to remove the husks and then heated to 60° in a water-bath of 70° and maintained at that temperature for an hour. The extract was then filtered as rapidly as possible. The extract after decanting from a deposit which separated out on cooling, was saturated with pure ammonium sulphate and the precipitate thus formed was filtered off and added to the deposit formed on cooling. The substance thus obtained was then treated with three liters of 10 per cent. sodium chloride solution heated to 65° in a water-bath of 70° and filtered as rapidly as possible on a funnel surrounded by hot water. The clear filtrate, which became turbid at once on cooling, was received in a vessel set in a large water-bath heated to 70° and the whole was allowed to cool very slowly. When cold the liquid was decanted from the dense deposit that adhered to the bottom and sides of the beaker.

As the substance dissolved to an opalescent solution in distilled water, it was washed with 50 per cent. alcohol as long as any chlorine was discoverable in the washings with silver nitrate, then with absolute alcohol, and with ether and dried over sulphuric acid; 8.5 grams of substance were thus obtained. The salt-solution from which the spheroids had deposited was next dialyzed and the proteid which separated out on the removal of the salts was filtered off, washed in succession with dilute alcohol, absolute alcohol, and ether, and dried over sulphuric acid. This preparation weighed 5.64 grams.

The residue of the oats was extracted a second time in the same manner and the solution was at once saturated with ammonium sulphate. The precipitate thus produced was washed directly with 50 per cent. alcohol, but since the substance dissolved on washing with dilute alcohol as long as much ammoniun sulphate remained, the final yield was only 2.6 grams.

The product obtained from the solution of the first ammonium sulphate precipitate in hot brine has the following properties. Under the microscope, before washing, it appears to be perfectly homogeneous and to consist entirely of spheroids about $\frac{1}{100}$th of a millimeter in diameter. After washing and drying it forms a

dense snow-white powder. In cold distilled water it dissolves to an opalescent solution which gives a heavy precipitate on the addition of a little sodium chloride; a little more sodium chloride precipitates the aqueous solution almost completely and on addition of still more salt this precipitate is again dissolved.

Hot distilled water dissolves this proteid completely to a perfectly clear solution from which a considerable part of the substance deposits on cooling.

Dilute acetic acid alone gives no precipitate in the aqueous solution. Addition of a little salt together with the acid precipitates it. The precipitate thus produced is soluble in alcohol of .9 sp. gr.

When treated with hot dilute alcohol the substance melts and remains suspended in the solution in transparent droplets; addition of either a little salt or a little acetic acid produces no change but both together give a clear solution. This solution in alcohol on cooling forms a very bulky transparent jelly. On evaporation, the substance separates as a skin on the surface which is readily soluble again in dilute alcohol of .9 sp. gr.

On analysis the composition of the dried spheroids was found to be as follows:

OAT-PROTEID—*Extracted by Sodium Chloride Solution at 65° C.*

20.

	I.	II.	Ash-free. I.	Ash-free. II.
Carbon	52.13	52.16	52.20	52.24
Hydrogen	6.93	7.02	6.94	7.03
Nitrogen	17.72	17.87	17.75	17.90
Sulphur	.81	.73	.81	.73
Oxygen	----	----	22.30	22.10
			100.00	100.00

Ash—.4694 grams substance dried at 110° C. gave .0009 grams of ash = .19 per cent.

Carbon and Hydrogen—I. .3639 gram dried substance gave .6955 gram CO_2 = 52.13 per cent. C, and .2270 gram H_2O = 6.93 per cent. H.

II.—.4728 gram dried substance gave .9036 gram CO_2 = 52.16 per cent. C, and .2985 gram H_2O = 7.02 per cent. H.

Nitrogen—Kjeldahl Method I.—.7768 gram substance gave ammonia = 16.75 cc. HCl Sol. (1 cc. = .00822 gr. N) = 17.72 per cent. N.

Dumas' Method II.—.4080 gram dried substance gave 62.36 cc. N, at 15° C. Barometer 762^{mm} at 21° C. = 17.87 per cent.

Sulphur—I. .7841 gram dried substance gave .0463 gram $BaSO_4$=.0064 gram S.=.81 per cent.

II.—.8670 gram dried substance gave .0460 gram $BaSO_4$=.0063 gram S.=.73 per cent.

The fact that this substance separated from warm sodium chloride solutions so readily in the form of spheroids indicated that, under proper conditions, it might be obtained in recognizable crystals. After a very large number of attempts which resulted only in the production of spheroids, a portion of that substance which had deposited on dialyzing the mother liquor from Preparation **20**, was converted into a mixture of spheroids and crystals. The latter were about $\frac{1}{10}$ mm. in their greatest diameters and to all appearance had distinct rhombic faces, but they were not perfectly developed and have not since been observed, many efforts to reproduce them having completely failed.

These crystals were obtained by saturating with the globulin a 10 per cent. sodium chloride solution heated to about 60° C. and allowing it to cool slowly in a large bath of warm water.

After many trials with Preparation **20** a portion of it was completely converted into perfectly formed octahedral crystals which Prof. S. L. Penfield kindly examined and pronounced to be isometric. These crystals were obtained by dissolving some of Preparation **20** in cold distilled water and cautiously adding sodium chloride until a copious precipitate resulted. On immersing the test tube in warm water the precipitate dissolved to a perfectly clear solution. This solution was then allowed to cool slowly in a bath containing about four liters of water heated to 60° C. After 24 hours the deposit was examined under the microscope and found to consist entirely of crystals.

By saturating *distilled water* heated to 60° C. with Preparation **20** and allowing the solution, surrounded by a large volume of warm water to cool slowly, an abundant deposit of octahedral crystals was obtained which were, however, not quite so perfectly developed as those just described.

No analysis of these distinct crystals has as yet been made. Their further investigation will be undertaken directly.

VIII. Methods of Analysis.

Drying.—Preparations preceding **12** were dried in hydrogen at 110° C. to a constant weight. Those following were dried in air at 110° C. Carbon and hydrogen were determined by combustion in a platinum boat in open tube filled with copper oxide and containing in addition a layer of lead chromate and a roll of metallic copper. In the analyses preceding **12** the portions taken for each carbon determination were dried separately to a

constant weight at 110° C. in a stream of hydrogen and weighed in a closed tube. For those following the entire sample was dried to a constant weight in air. By the latter method of drying, slightly higher percentages of hydrogen were obtained when the substance analysed was in the form of a light hygroscopic powder, the dense preparations obtained from alkaline solutions not being so hygroscopic gave slightly lower percentages of hydrogen, the difference is attributable to moisture unavoidably absorbed by the dry, light powder during weighing and transferring to the combustion tube, the analyses being made in very damp summer weather.

The accuracy of the determinations was repeatedly controlled by analyses made on pure sugar.

Nitrogen.—Nitrogen determinations were made both by the Kjeldahl and Dumas methods, in the manner customary in the Station Laboratory.* Preceding **12** the determinations were made upon the substance dried over sulphuric acid, a correction being applied for the moisture contained in the sample as found by drying it at 110° C. Subsequent determinations were made on the fully dried sample.

Sulphur.—Sulphur was determined by fusion with sodium-hydroxide and potassium nitrate, dissolving the fused mass in water, neutralizing the alkali with a considerable excess of hydrochloric acid, evaporating to dryness to decompose nitrates and to remove excess of acid, dissolving the dry residue in six or seven hundred centimeters of water, allowing the solution to stand for 24 hours, filtering, heating to boiling, and precipitating with three cubic centimeters of a 10-per cent. solution of barium chloride.

In the analyses of **8**, evaporation to dryness was omitted, the barium sulphate being fused with sodium carbonate and reprecipitated. In all cases the ash of the preparations was carefully examined for sulphates, but none was found in any instance.

Blank experiments with the reagents proved them to be entirely free from sulphur.

Ash.—Ash was determined by combustion in a platinum crucible, no difficulty being experienced in burning any of the preparations except **18**.

* Annual report of this Station for 1879, p. 124, and American Chemical Journal, vol. 2, p. 27.

IX. Summary of Results.*

1. The proteid body removed from fresh-ground oats by direct extraction with weak alcohol, first observed by Norton and by him designated *glutin*, when dehydrated by absolute alcohol and dried over sulphuric acid is a light yellowish powder, insoluble in pure water as well as in absolute alcohol, soluble in mixtures of alcohol and water, soluble also in dilute acids and alkalies, and from these solutions thrown down by neutralization. Separated from its solution in alcohol of 60 per cent. by evaporating off the alcohol, it forms a yellowish, slimy mass. Its composition (as found for Preparation **8**, p. 12), is given in the table, p. 46, under **I.** This substance is remarkable for its considerable content of sulphur, which is exceeded by that of keratin alone among the proteids, and is otherwise equaled only by that recorded in some analyses of serum-albumin. See pp. 5–14.

2. When the substance described above is heated with dilute alcohol for some time it coagulates and becomes insoluble in that liquid, but without apparent change of composition. **II.**, p. 46, is the average of three accordant analyses of this coagulated form of the alcohol-soluble proteid made on Preparations **7**, **4 A** and **4 B**; pp. 7–12.

Kreusler obtained this material from the oat, but what Ritthausen and he named *oat-gliadin* was a product of its further alteration by the chemical treatment to which it was subjected, with a view to purification. See pp. 4, 13 and 19.

3. When oats are first treated with water or 10-per cent. solution of common salt, before extraction with dilute alcohol, the alcohol-soluble proteid undergoes alteration, and a body of different composition and properties results. In the table, **III.**, is the mean of closely-agreeing analyses of this substance made on Preparations **9**, **10**, **11**, and **12**; it is much more soluble in dilute alcohol than **I.**, and is not coagulated or transformed into an insoluble modification. When wet with absolute alcohol, the moisture attracted from the air shortly renders it gummy and tenaciously adhesive, unlike **I.**

* This Summary is a revision of a part of Bulletin 105, issued by the Connecticut Agricultural Experiment Station, December, 1890, which contained some minor errors that are here corrected.

Its composition, as regards carbon, hydrogen, and nitrogen, is very near to that found by Dumas and Cahours, and also by v. Bibra, for *gliadin* or *plant-gelatin* (extracted by hot alcohol from wheat-gluten and remaining dissolved in the alcohol when cold).

4. The chief proteid extracted by cold 10-per cent. salt solution behaves toward reagents like the *myosin-globulin* from animal muscle, as first stated by Weyl. Contrary to Weyl's observations, however, the coagulation temperature (80°—100°) is much higher than that of animal myosin (55°—60°). This proteid appears to be the result of a transformation similar to that by which myosin is formed from myosinogen. Its composition—the average of several analyses on Preparations **13** and **14**—is given under **IV**, and is very near to that of muscle myosin. The greatest proportion of this proteid extracted by salt-solution from the oat was 1.3 per cent. See pp. 23–28.

5. The proteid extracted, after complete exhaustion of the oats with alcohol of 0.9 sp. gr., by 10-per cent-salt-solution, (analysis of Preparation **15** under **V.**) and that dissolved out by dilute potash, (analysis of Preparation **16** under **V.***a.*), have so nearly the same composition as the globulin extracted by salt-solution directly, that they may be regarded as originally identical, **IV.** representing the soluble form, **V.** and **V.***a.* the insoluble or "albuminate" modification. See pp. 28–32.

6. When ground oats are directly extracted by weak potash-solution without previous treatment with water or dilute alcohol, nearly the whole of the proteids is dissolved. The substance so extracted, after completely removing the body soluble in weak alcohol, is perhaps the same as that first designated *Avenine* by Johnston and Norton, who extracted oats with dilute ammonia-water. Its composition, as indicated by analysis of a single Preparation, **17**, is stated under **VI.**, see also pp. 33 and 36.

7. When ground oats are exposed to the action of water, a large share of the proteids becomes insoluble in dilute potash-solution, the amount so rendered insoluble increasing with the duration of the contact with water. One hour's treatment with water rendered one-half, 24 hours' treatment made two-thirds insoluble in $\frac{2}{10}$ per cent. solution of potash. The composition of the part soluble in potash, after action of water (and removal of the alcohol-soluble proteid), as found in analyses of preparation **18** and **19**, the average of which is stated under **VII.**, is the same as that of the globulin soluble in salt solution, **IV.**

This proteid, obtained by extraction with potash, *after* the action of water, is probably the substance which Kreusler converted into his *Oat-Legumin* by the "purifying" process to which he subjected it. It is also the "protein body" which Norton extracted by weak ammonia and analyzed. See pp. 34–38.

8. When ground oats are extracted with 10 per cent. sodium chloride-solution heated to 65° C. a proteid separates on cooling, in the form of spheroids. This substance differs in composition and properties from that obtained by cold salt-extraction as well as from all proteids hitherto described. It is soluble in pure water, precipitated from such solutions by a little sodium-chloride, is again dissolved by a certain additional quantity and is precipitated completely by saturation with this salt. In the presence of a little sodium-chloride and acetic acid it is soluble in alcohol of 0.9 sp. gr. From solutions in distilled water, as well as from those in sodium chloride brine, it has been obtained crystallized in regular octahedrons. Analysis (of spheroids) under **VIII.** See pp. 39–41.

9. The aqueous extract of ground oats was found, in agreement with Norton and Kreusler, to contain very little proteid substance. The proteids thus dissolved appear to be, first, an *Acid-albumin;* second, a *Globulin* or *Globulins* similar in reactions to that extracted by 10-per cent.-salt-solution, and third, a *Proteose.* No true albumin was found in the water extract. See pp. 20–23.

10. In the salt-extract a very small amount of a body was found, having the reactions of *Albumin,* but not analyzed. pp. 23–25.

X. Table of Composition of Proteids from the Oat-Kernel.

	I.	II.*	III.*	IV.	V.	V. *a.*	VI.	VII.*	VIII.
Carbon	53.06	53.10	53.70	52.34	52.48	52.45	53.49	52.49	52.22
Hydrogen	6.94	6.91	7.00	7.21	6.94	6.92	7.01	7.10	6.98
Nitrogen	16.38	16.49	15.71	16.88	16.85	16.63	16.39	17.11	17.85
Sulphur	2.26	23.50	1.76	.88	.57	.81	.99	.80	.77
Oxygen	21.38		21.83	22.69	23.16	23.19	22.12	22.50	22.18
		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The numbers over the analyses in the above table correspond with those of the paragraphs in the foregoing summary.

* Average of several analyses.

XI. Key to Table X.

	Extracted by			
I	Alcohol of .9 sp. gr.,	directly,	Soluble,	**8,** pp. 126–127.
II	" "	"	Coagulated,	**7,** etc. pp. 124–125.
III	" "	after water,	Soluble,	**9–12,** pp. 128–132.
IV	Cold 10 p. c. NaCl Sol.,	directly,	Soluble globulin,	**13, 14,** pp. 137–142.
Va	" "	after alcohol,	Albuminate "	**15,** p. 143.
V	1-10 p. c. KOH sol.,	"	" "	**16,** p. 144.
VI	" "	directly,	Initial proteid?	**17,** p. 117.
VII	" "	after water,	Albuminate globulin,	**18, 19,** pp. 148–150.
VIII	hot 10 p. c. NaCl Sol.,	directly,	Soluble spheroids,	**20,** pp. 153–156.

GRASS-GARDENING.

By J. B. Olcott.

"Natural history should be based upon natural facts, and not upon the artificial products of cultivation." *De Candolle*—Origin of Cultivated Plants. London, 1884, p. 409).

The author quoted for the above text was writing of the confusion among names of the cotton plant (*Gossypium*), and advising us to seek with care varieties "which are wild" as a way out of our difficulties.

For the solution of grass-problems this course is even more necessary. De Candolle was right in warning us not to base conclusions upon the "products of cultivation," for Grass-Gardens, at their best, will be but indexes and title-pages of the world at large. Observations confined to them must be no better than reading which stops at the introductions and prefaces of books.

The Grass-Garden lately established at South Manchester had its origin in that at New Haven, as the latter had in the forage of Connecticut and elsewhere; both growing out of the general desire to know more of the grasses we already have and of those the world outside can furnish to our agriculture and gardening.

In laying out the South Manchester grass-garden the Station collection at New Haven was drawn upon for plants or small bits of sod, of the desired grasses, in April, May and at other times during 1890, and also—its soil being excellent for growing and ripening them—for seeds from the collection of pasture-sods made in 1887, and of other sward-producing varieties that had come into its possession by the good will of its friends, purchase, or the accident of being found growing without name and by mistake, from packets of trade-seed.

It may be repeated here, that in the spring of 1887, the writer, as agent of the Station gathered more than six hundred sods —cutting them with a mason's trowel, by the top of a quart strawberry basket—from two or three hundred landed estates

of all sizes, bearing interesting spots and patches of close sward, in Rhode Island and eastern, central or southern Connecticut. This collection was made chiefly with a view to throw light on the *Agrostis* tribe, so that we might know whether it is proper to sell two or more kinds of seed out of the same bag.

Incidentally, varieties of *Festuca* and other genera, that were making turf, or were curious, unknown and promising, were sampled in passing, and the names of the people owning the land entered upon, were attached to the labels of the specimens whenever possible. Hence the seeds saved at the Station from what are there called the "Old State-Sods," had a certain value, as their origin was in some degree *known*.

In the gardens at New Haven and Manchester, the same rule of choosing sods for propagation by their useful performances on the ground somewhere, and in as many places as possible, has been applied with even more determination this year, and with very satisfactory results. In this way we begin with something of history and pedigree. Like does produce like, in grass as assuredly as among cattle, horses and men. Many sods of less than a square-foot, selected about Manchester for their evident turf-making habits and power, cut into fifty or seventy-five pieces and planted in April and May, now each cover completely fifty or seventy-five feet of land. Similar prolific varieties of *Agrostis*, *Festuca* and *Poa* are scattered about the older parts of the old Northern States, as have been seen by the writer, in part within the present year.

Late in May, for instance, Dr. Thomas Meehan of Germantown, Pa., sent to the Manchester garden by mail, from his fifty-years'-old lawn a sod of *Festuca* so small and thin that the postage was but four cents. That grass and six inches depth of the soil it now covers, would over-load a pair of horses. More extraordinary results proceeded from sods sent from a hundred-years'-old meadow by Wm. H. Rhawm, of the Bank of the Republic, Philadelphia.

The soil of the Manchester garden is a brown loam, gravelly and dry at one end of the acre chosen, and liable to be too wet at the other end. It was in stiff turf, manured from the farm and plowed in November, 1889. The part first planted was the site of neglected raspberry-rows, quince-bushes and red-cherry trees; tough ground, full of roots; but as this condition yielded to thorough tillage the land became fairly pleasant for surface work by the time the seed-plats were begun in July. Something more than half of this acre is now occupied by two hundred and fifty or more plats, four feet square, and by two broad rows of grasses, all in clean cultivation. The remainder lies fallow and ready for another year's transplanting and sowing.

Many of the plats are duplicates to insure against accidents. Some stocks are small because, though valuable, no more seeds or sods were to be had. Stocks of two varieties are larger because of the kindness of a neighbor, Knight D. Cheney, who had them growing and increasing for one or two years in his own garden. This gentleman brought from abroad in July eight samples of the "best" English lawn-grass-seeds, telling the dealer they would be tested here. The seeds looked nicely, yet all but one of the best varieties for sward, (and there was no *Agrostis* among them), were so badly mixed that it is a pity such seeds should be imported free of duty. In each case the foreign seeds were tested and compared by sowing them side by side with seeds of the same kind or, at least, of the same name, saved by Dr. Jenkins or an agent of the Station.

Many tests and experiments are in progress, such as proving the uniformity of growth which springs from the divided product of turf from a single seed; the sowing of such "pedigree" seeds as were to be had, and the transplanting of stocks of sod, believed to be worthy, at different times and especially, late in the season.

How much we generally know about any grass may be judged by the fact that very few are aware that the only variety of *Phleum* we use—and the grass we oftenest sow—is of an amphibious nature and in some places, fairly an aquatic. The past season was too wet for us to assert that we have given any so-called aquatic grasses very severe tests. But we have several under cultivation, and the indications are curious and instructive.

Two door-yards in New Haven (those of Prof. Brewer and Prof. Johnson), have been put under experiment to show that a single variety of grass, well chosen, will shortly cover the ground. It takes some years to make felted turf, but those door-yard trials may be considered successful as far as they have gone. The grasses—a creeping *Agrostis* and a tillering *Festuca*—planted in tufts, or bits of sod, set 12 inches apart, in the middle of April, were not chosen because they were known to be the best, but because they were the only promising ones we had a sufficient stock of for so large plantings at the time. The earth was well enriched and in August the *Agrostis* with fair exposure to sun had completely hidden the ground, while the *Festuca* sets had grown from less than two to five or six inches in diameter though the yard, with northerly aspect, was much shaded.

It is too early in American grass-gardening to assert or deny many things. But as yet we find no evidence that any variety of grass is pining for alien company and none that a mixture of seeds promotes the growth of any kind. There are plenty of grasses which evidently love to creep in and get what their neighbors are living on. If all flesh is grass, it is a rule which works both ways, for there are graminaceous families that exhibit the selfish and fleshly proclivities of human and animal nature strong enough to attract the attention of moralists. And these appear in gardens not under strict government, now, as they did in "the beginning." Hence, grass-gardens are needed to teach us what to cherish and what to condemn, or keep in check.

But with regard to mixing grass-seeds, look at our chief practices. Indian Corn is our most valuable grass. Do we mix beans or pumpkins with it, or allow weeds to grow in it, to the benefit of the corn-crop? Do we sow any thing with wheat, rye, oats or barley, thinking to increase the yield of grain?

Take timothy—the principal perennial grass we sow—do we mix other things with it to increase the yield of *Phleum?* Does the grower of this hay for market like to see other grasses driving the main one out of his land? No—and all these questions will be answered in the negative. We may choose to mix seeds some times, but we also choose when we can that our seed shall be pure, and that we may know enough to mix it wisely.

It should be remarked, in passing, that our "experiments" with grass are not so experimental as they may appear to those who have paid little or no attention to this particular branch of natural history. We walk by the light or towards it. As the honey-hunter lines the bee-tree with loaded bees, having two points, he reasonably expects to find the third. We place small reliance on strange seeds, but having seen a variety of grass making strong turf against odds, we have a certain confidence in that grass, and proceed to study its behavior under cultivation. Our treatment of it may be mere meddling—a series of blunders—or it may be skillful; therein chiefly lies the experiment; it is partly a test of ourselves. Smooth turf is not a wild but a domestic thing, and with the expert grazier or gardener, a product of careful labor and art. If we think that tough sward is not a matter of the first agricultural importance, let us consider how the rudest and greediest forms of culture prosper so long as there is plenty of sod to break up and destroy.

In the Manchester garden we used seeds from the "Old State-Sods" which were planted at New Haven so near together, that according to all we know of grass-pollen, the seed might have been mixed and impure. Yet, so far as we can see, by observing the young grasses for this one season of two or three months only, they appear true to their kind and the question may be asked, "Why not rely upon seeds that we may gather from any interesting plants, rather than upon roots for these beginnings of exact culture?"

In reply it may be said that growth from individual seeds of sweet corn from the same cob for instance—grown entirely away from any other variety of maize—is liable, within narrow limits, to vary, and does vary so that nice cultivators take advantage of this fact of variation in changing and improving sweet corn by selection from repeated plantings. Maize in our climate is strictly annual, and we must rely on seeds, but with hardy perennial grass it is better—much better and safer in our opinion—(in these early stages of legitimate grass-gardening), to get the roots of any variety we deem worthy of propagation when we wish to convey to another hand a variety of grass in its integrity. Having a stock of the mother-plants we should prefer not to distribute to other gardens, plants which grew last fall from seeds of the Old State-Sods. In default of older roots of a variety, we shall do our best with the produce of seeds that from their liability to vary need more tests and longer watching.

Seeds so small as grass-seeds will trouble a beginner to distinguish them and keep them free from weeds and especially from other grasses in the first weeks of their sprouting and growth. But roots are more tangible. They grow quicker and begin to teach us the difference in grasses as soon as we unpack them from paraffine paper and moss and read their labels.

The transportation of roots is more troublesome than that of seeds, but they may safely go long distances in cool weather, many kinds in a box. Two distinct sods, shipped us by Hon. Augustine Heard, U. S. Consul at Seoul, Corea, reached us alive, as we are going to press, and in hopeful condition for propagation, with due care.

There will certainly be several varieties of grass-gardening. A farmer and grazier, intent on something he can use and perhaps grow seed of for sale, will choose a few kinds of sods which seem most promising, cut them in pieces and plant them in rows in different places. Or at first he may prefer to plant a row of forty or fifty named sorts in bits of sods, in his garden, for the edification of himself, his family and his friends. This should be no more trouble the first season, than rows of strawberries of the same length.

A gardener, desirous of improving dooryards and lawns, will select varieties of grass with finer textures and curious colors, and if he sees, as many gardeners do, that we spend money freely for fanciful and beautiful things, he will prepare himself to plant or sow lawns in tasteful mosaics and arabesque patterns, as our grandmothers pieced bed-quilts and wove counterpanes.

Superintendents of city and village parks, wishing to learn what good sward can be composed of and to show their cultivated patrons how the grasses, that we all live by, appear separately, and to teach ruder people that there are wild things worth hunting, besides rabbits under farmer's stone walls, might do worse than to copy the plant at Manchester with modifications to fit local tastes. There is not the least necessity for testing or exhibiting grasses by growth in rectangular patterns. They can be made to fit any shape, like silk, or cotton goods.

State grass-gardens may and should lead in testing and introducing the best native and foreign varieties, unless enterprising seedsmen, heartily ashamed of our present ignoble predicament as regards seeds, should combine to go ahead of us all in radical demonstrations of what can be done with this oldest, most promising and best-neglected industry.

To see whether it is possible for an agent of the Station to plant a small grass-garden on the land of unofficial parties, and trust the care of the same to its owners, as we do plantings of corn, potatoes, etc., a test was made in the garden of the Misses Gilman of Norwich Town. Twenty-three small plats of divided sod were planted June 14th. These were given perfectly clean tillage, and but a single plant was lost. In September, more than that number of plats, of sod or seed, were planted or sown. That fresh interest in grass-growing, and a more exact knowledge of the varieties we do or may cultivate, must spring from a little center of that kind is as obvious as it is true. Similar institutions of learning ought to be established throughout the State.

In like manner, on a larger scale, with more trouble and expense, not borne by this Station, its agent was enabled to coöperate with the Station of another State and a collection of grasses was well begun at State College, Center County, Pennsylvania. It is believed by those who have thought much about it, that the evils of mixed grass-seeds and mixed grass-names can be abated in a reasonable time, by the cultivation of the best varieties in gardens, with the coöperation of Experiment Stations.

Our plan for multiplied observations of precisely the same grasses, by the distribution and exchange of sods, and their growth in widely separated public and private gardens, is the shortest way out of the fog which envelops us. Testing seeds, as now gathered from all manner of uncertain or unknown sources, only adds to the muddle of names and varieties. When books don't agree, and writers are uncertain, we have a right to go to the plants themselves, separate them, compare them, and save seed from the best. Isolated States cannot prosecute this great business to advantage alone, against contrary opinions pouring in upon them. There must be close and exact coöperation.

Other Stations have given their adhesion to the methods practised in Connecticut, and there are indications of popularity in the movement towards better turf-grasses. Farmers and gardeners, who are judges of old and new things, with a desire to prove all, and hold fast that which is good, will govern themselves accordingly.

The plats at Manchester were marked for sod-planting with a light ten-barred frame of three-inch slats, crossing each other, through which six-inch · · · · · wire-spikes were driven half-way, and cut off, · · · · · so the projecting heads would imprint mellow · · · · · earth as here shown. Round pine rods $\frac{3}{4}$ inch · · · · · diameter might serve as well as the wire-spikes. · · · · · As the frame is exactly four feet square outside, the plant-centers, twenty-five in number, are not quite 12 inches apart.

For the seed-sowing, was used a frame four feet square *inside* made of $1\frac{1}{4}$ inch pine-plank, six inches wide, halved together at the corners, and fastened with wire nails and screws. This was very convenient to stand upon while sowing the seed and covering it with fine earth. The edges of the young grass came up neat and square, as in a miniature field. The handsomest plats in the Manchester garden can be repeated by the acre, without extraordinary expense, when we have sods or seeds enough.

These frames are as large as one person can handle, and may be recommended for the general purposes of large testing and propagating gardens.

The seed-frame has two inch-square notches at its middle, inside and opposite each other, to receive the two one-foot pegs of squared and pointed $\frac{7}{8}$ pine, which are driven in line, at alternate distances of two and four feet, to mark the exact places of plats. The sod-frame, when in use, can be ranged by its center slat on these pegs, fitting between the pairs of them, which also mark the two-feet alley-spaces, and are handy to knock clogged weeding tools upon in wet weather. A smooth bit of plank, weighing ten or twelve pounds, and 12×15 inches square with an upright handle, to firm the soil; together with a sixteen-foot pole, with notches, to gauge distances between the aforesaid pegs, in driving them by the line; complete the list of special tools for plat-seeding or planting.

The tillage and weeding at Manchester was a rather serious affair, at first, and it would not be advisable for any one to undertake such ground as that was, unless fully aware of the difficulty of governing it. But the thrift of the grasses, both planted and sown, on that tough sod-land, was very gratifying.

Four hundred pounds of a good commercial fertilizer were used on the part of the land now in grass, because, presumably, the upturned soil, in the clutch of roots, would not be very fertile at first, and that the farm manure beneath the sod would be inoperative at the surface early in the season. The cause of certain faded spots in the grass and of its short growth in those places is not known at this writing. That matter has long called for investigation.

Serviceable plats for the comparative culture of grasses can be planted and sown of any size we please. The smaller they are the less our experiments will cost, especially if we have weedy land. A good plan for beginning a grass-garden is to prepare sod-land the season before we need it, as the fathers prepared ground for flax and other crops.

For the weeds at Manchester special tools had to be contrived and made, or the garden would have been an ignominious failure, only fit for the plow. This feature of the undertaking had been thought of for years, however, and these tools were illustrated in the May, October and November numbers of the *American Garden* for 1890. Some of them are being manufactured to order by Smith Harper, Fox-Chase, near Philadelphia.

Because of the general inattention to varieties, hitherto, in this country, no varietal names are known for many sorts of *Agrostis*, *Festuca* and *Poa*. By their record and history several of these grasses, evidently prolific and fixed in type, must be very valuable. How can this value be realized? By propagating each, after its kind, from roots, slips or cuttings, and seeds—operations quite as easy when once well learned, as the increase of corn and potatoes. There is material at Manchester to start a hundred similar grass-gardens.

Another element of value consists in the fact that these garden grasses have become as nearly *pure* as possible in the time spent upon them. Except one variety (*Poa annua*), nothing has been allowed to go to seed, in the Manchester experiments. When many sorts of seed are allowed to scatter, the difficulties of grass-gardening are enormously increased, and the purity of the collection will be lost or placed in jeopardy. No instance of crossing between varieties, has been observed by recent Connecticut experimenters; but the nature of the subject demands extreme caution, since the chances are practically unknown.

Success at New Haven and Manchester, in the selection of varieties distinctly useful, must lead observers and reasoners to inquire: If these valuables can be picked up in a country where the conditions that produce domestic sward are comparatively new, what shall we find, under sward-making conditions, where cultivation is thousands of years older?

No farmer or grazier can examine these grass-gardens, even as late as Nov. 16th, the date of this writing, without being disturbed in his mind as to whether he has yet enjoyed the use and profit of the best grasses. So far as the useful grasses of the world are involved, our collections should be made complete as soon as possible, lest more labor and time be lost in propagating inferior varieties.

The beginner, in collecting valuable varieties of grass from the short sward of door-yards, pastures and meadows will need more instruction than can be given here; and attentive observation, while walking at leisure, will help vastly in illustrating the few words that may be ventured in a matter which requires, most of all, an experienced eye. The rather common impression that all spots in turf come from unequal fertility, is mistaken. The droppings of animals do make many distinct spots, in pastures and meadows, no doubt, greatly changing the color and fiber of grasses. The learner must have practice enough to distinguish these appearances, and may find it easier to read the sward where no animals have been—as in door-yards, parks and lawns. There the gray or blue-green and sharply pointed leaves of some form of *Agrostis*, may be the first to attract attention. Or the shining spears of a *Poa*, a *Festuca* or a *Lolium*, may quickest take the eye. The identification of any one prevalent grass, wherever it occurs—like deciphering the prevailing letter in secret writing for a clue—will help greatly in distinguishing the rest. As we learn to know people at sight, without formal introduction, so we may recognize perfectly a number of grasses, when we have met them times enough, without knowing their names. Prof. McAlpine's work "How to Know Grasses by the Leaves" (David Douglas, Edinburgh, 92 pages, illustrated, price, 3 shillings 6 pence), will greatly assist those who know how to use good books to begin with. But to select turf that is worthy of propagation, requires keen sense of color and form, and will utilize all the practice possible to the farmer, gardener, and grazier. The acutest assistant at Manchester—Mr. Eli Risley —is a specialist in neither of these directions, however; but a veteran cassimere maker. His long experience with all manner of woolen fabrics, combined with his trained eye for colors, made him a practical connoisseur in turf fabrication almost at once. We have thousands of ingenious and cultivated people, who may become equally skillful, when their attention is turned to the matter, greatly to the advantage of Agriculture and Gardening.

As the skilled physician diagnoses disease or health, in part, by the skin of his patients, so the expert grazier or farmer always judges the condition of land by the appearance of its turfy integument; and often recognizes, by spots of this, that, or the other grass in the sward, the waning or increasing fertility of fields. And whether one becomes expert in knowing grasses by their leaves, roots, color, taste, feel, habits and habitats or not, the least training of the eye and judgment in these directions cannot fail of being useful to those who would govern the land. The best season for collecting sward-grasses is early in spring or late in fall or during open winters, while annual vegetation is dead.

What are called the "Pasture Plats" at the New Haven Station were laid down with the idea of having many known kinds of grass that could be cared for and observed through a number of years for grazing at will. The pasture-plats were planted a year ago last October. Sixty-four plats, with three or four exceptions, all of grasses and clovers, were set in the common sward of the Station (much improved of late years by broad-cast manuring and the grazing of cows well-fed in the stable) where they are distributed over a space sixty feet square. The ground of the plats was thoroughly dug fifteen inches deep, and fertilized as it should have been for planting a shrub or a small tree. In most instances, the roots or turf of the desired plants were set in place, flush with the general surface, and as closely as the stock in hand would allow. This method was chosen to make plats that would endure, as soon as possible, the treading of the two cows at the Station. The greater part of these plats were filled from the Station Forage Garden. The stock for five of them was sent in one barrel from South Windsor, East Hartford and Manchester. The material for as many more plats, perhaps, was picked up in the vicinity of New Haven. Weedy and mixed sods require persistent care to purify them. *Juncus Gerardi* (black grass), and *Spartina cynosuroides* (cord grass), were taken from the salt marshes. There is a plat of *Achillea millefolium* (yarrow), said to be a valuable forage-plant by English writers, whose seedsmen put *Plantago lanceolata* (narrow-leafed plantain), in their catalogues. The last-named weed was already in the four-feet wide alleys of the old pasture that surrounded each plat. There are many kinds of vegetation that domestic animals will eat at one time or another, but the burning questions are: How many of these need we take the pains to cultivate? How many ought to be allowed in trade seed-mixtures? The presence of a plant in the neglected pastures, is not sufficient proof that it is good husbandry to sow it anywhere. The absence of a plant from long-used pasturage may be evidence that we have allowed domestic animals to love it, not wisely but too well.

One of those pasture-plats was set with the roots of *Equisetum arvense* (horse tail), and it is thriving. This very persistent rush is said to injure horned cattle and *not* horses, in Germany, while in New England we hear that it kills horses, but other animals may eat it with impunity. Thousands of acres of the best natural meadow in Connecticut produce more or less of this plant, which tastes very like some excellent grasses. Hundreds of tons of it are fed to our animals. Hence, as we know very little accurately about it, while many people fear it, and no one probably cares to see it in his land, *Equisetum arvense* becomes a legitimate subject for inquiry.

Other plats bring other forage-plants into strong contrast. *Carex vulgaris* (cut-grass), grows very near *Poa arachnifera* (Texas blue grass). The *Agropyrum repens* (quack grass) is not far from *Agropyrum glaucum*, which the cattle and horses of western ranges are said to be very fond of.

Eight frames made of six-inch chestnut fence-boards, covered with wire-netting, like quail-traps, were provided to protect any of these plats from too much grazing while they are in a state of probation; or while any of them are being renewed or changed by sowing or planting with other kinds of forage, which it is desirable to test by grazing, etc., or to put under surveillance.

Early last May, when some twenty-five or thirty of these plats had made a luxuriant growth of three to eight or twelve inches, according to their various natural statures; and while the white clover and "blue-grass" of the alleys was half-leg deep, the cows, that had been a week or two in pasture similar to that of the alleys, were turned in for three days in succession.

Several sets of notes were made at the Station upon this occasion, more for the sake of fixing our minds upon it than for publication. The patent fact was that those two cows reached entirely over the lush feed, they were used to, in the alleys, and licked out the strange plats which were in season, clean to the blanched stubble and roots, like the bottoms of so many meal-tubs. Evidently milch cows appreciate a variety of food quite as well as we do.

A veteran observer remarked that, "When dairymen and farmers get their eyes open to 'grass' they will be growing it pure, in five and ten-acre lots for the sake of variety." This would be reasonable for fodder as well as for seed. To make milk, and beef plenty and good, cattle must EAT, and it is evident that the proper variety of fodder will tempt them to eat and keep them in health while they are consuming and producing their utmost.

After the three days of grazing the pasture-plats had a long rest, and some nursing. It is not good farming to graze pastures closely that are less than a year old. Twice afterwards, at intervals the cows were let in; once when all the plats were as tough and dry as they could well get during a wet August, and only the lawn-mowed alleys were succulent; but Daisy and Nancy proved themselves excellent judges of fodder. They used the tall wiry grass of some plats like pasture bushes to knock the flies off, and showed their preference for fresh vegetation every time.

Whether public opinion should require every agricultural experiment station, school, or society to devote so much as sixty square feet of land to grass-tests of a like character, may be a question. That such a requisition would tend to purge our literature of grass-mistakes, and our farms of weeds, by bringing sheep and cattle back, with the common consent of the butcher, the wool-manufacturer, village dog and politician, there is no doubt whatever.

A certain proportion both of sward and of forest is needed for public safety. The American States have immense areas of ruined woods and wasted sod to make good. A careful and systematic study of the best methods for their renovation is most appropriate work for our Experiment Stations.

FEEDING STUFFS.

Here follow such analyses of Feeding Stuffs as are not discussed elsewhere in connection with field experiments. For explanations regarding the nature and uses of the separate food ingredients, the compounding of rations, "feeding standards," etc., reference may be had to earlier Reports of this Station, in particular the one for the year 1886.

COTTON SEED MEAL.

2980. "Sea Island Meal." An undecorticated meal having a reddish-brown color. Sampled and sent by Messrs. Meech and Stoddard, from stock purchased of Butler, Breed & Co., of Boston. The fertilizing ingredients of this sample have been already given on page 25.

3073. "Sea Island Meal." Sampled and sent by F. M. Bartholomew, East Wallingford, from stock bought in New Haven, at $25.00 per ton.

3105. "Cotton Seed Bran." Sampled and sent by Horace Burr, Winchester. This sample in appearance and composition is not very different from the two samples of Sea Island Meal just mentioned.

3006. Purchased of R. H. Ensign, Simsbury, for $27.00 per ton.

3009. Purchased of J. and H. Woodford, Avon, for $27.00 per ton. The last two samples were drawn and sent by S. S. Stockwell, Sec'y Advance Grange, No. 22.

3106. From stock purchased and sampled by Horace Burr, Winchester.

ANALYSES—*As received.*

	2980	3073	3105	3006	3009	3106
Water	11.12	8.60	10.03	10.46	8.29	8.09
Ash	4.69	4.87	4.92	7.07	7.85	7.20
Albuminoids *	22.93	25.50	24.13	40.88	42.31	40.13
Fiber	17.48	17.65	21.39	7.53	3.78	8.53
Nitrogen-free extract	36.11	35.12	34.06	25.18	24.13	27.69
Fat	7.67	8.26	5.47	8.88	13.64	8.36
	100.00	100.00	100.00	100.00	100.00	100.00

* Total Nitrogen × 6.25.

Water-free.

	2980	3073	3105	3006	3009	3106
Ash	5.3	5.3	5.4	7.9	8.5	7.9
Albuminoids	25.8	27.7	26.8	45.7	46.1	43.7
Fiber	19.7	19.2	23.7	8.4	4.1	9.3
Nitrogen-free extract	40.7	38.8	38.0	28.0	26.3	30.0
Fat	8.5	9.0	6.1	19.0	14.9	9.1
	100.0	100.0	100.0	100.0	100.0	100.0

The last three samples are decorticated meal of usual quality. Nos. 2980, 3073 and 3105 are strikingly different in appearance, quality and feeding value. The low per cent. of albuminoids and the lower manurial value are due to the presence of hulls which are greatly inferior to the kernels in respect of the ingredients named. Undecorticated meal is fed at the South with good results, but the undecorticated meal at $25.00 is not nearly so economical as the decorticated meal at $27.00 per ton.

A statement of the fertilizing ingredients in two of the above samples and a valuation per ton *as fertilizers* follow. In the valuation nitrogen is reckoned at 15 cents, phosphoric acid at 7 cents, and potash at 6 cents per pound.

	2980	3006
Nitrogen	3.67	6.54
Phosphoric Acid	1.60	3.03
Potash	1.45	1.79
Valuation per ton	$14.99	$27.56

Linseed or Oil-Cake Meal.

2981. Steam-cooked Cleveland Oil-cake Meal.
2982. " " " Fine Linseed Meal.
3003. " " " Coarse Linseed Meal.
Sampled and sent by the Cleveland Linseed Oil Co., Cleveland, Ohio.

2662. Cleveland Linseed Meal, sent by J. W. Yale, Meriden.

2663. Old process Linseed Meal, bought of Mann Bros. & Co., Buffalo, N. Y., by J. W. Yale, Meriden.

3063. Old Process Linseed Meal, sampled and sent by Chas. M. Cox & Co., 10 Broad St., Boston, Mass.

Analyses.

	2981	2982	3003	2662	2663	3063
Water	12.52	12.79	12.45	9.60	12.76	9.48
Ash	6.05	5.44	5.96	5.53	5.59	5.40
Albuminoids (N. × 6.25)	31.81	35.69	37.81	37.11	32.75	37.56
Fiber	7.63	7.62	7.71	8.04	6.83	7.75
Nitrogen-free extract	35.34	35.33	33.94	37.09	33.01	32.95
Fat	6.65	3.13	2.13	2.63	9.06	6.86
	100.00	100.00	100.00	100.00	100.00	100.00

Water-free.

	2981	2982	3003	2662	2663	3063
Ash	6.9	6.2	6.8	6.0	6.4	6.0
Albuminoids	36.3	40.9	43.2	41.1	37.5	41.5
Fiber	8.7	8.7	8.8	9.1	7.8	8.5
Nitrogen-free extract	40.5	40.6	38.8	40.9	37.9	36.5
Fat	7.6	3.6	2.4	2.9	10.4	7.5
	100.0	100.0	100.0	100.0	100.0	100.0

The manurial ingredients were determined in several of these samples, as follows:—

	2981	2982	3003
Nitrogen	5.09	5.71	6.05
Phosphoric acid	1.59	1.79	2.12
Potash	1.30	1.37	1.47
"Valuation"*	$19.06	$21.28	$22.88

* Nitrogen 15 cents, phosphoric acid 7 cents, and potash 6 cents per pound.

Next to Cotton Seed Meal, Linseed Meal carries a larger quantity of fertilizing ingredients per ton than any other commonly used feed. Like cotton seed it is sometimes used as a fertilizer.

Miscellaneous Feeds.

3007. Malt Sprouts. Stock of J. & H. Woodford, Avon. Sampled and sent by S. T. Stockwell, Sec'y, Advance Grange, West Simsbury.

3056. Brewers' Grains from Quinnipiac beer brewery.

3057. Brewers' Grains from ale brewery.

3068. Brewers' Grains from Weibel's beer brewery. Sampled by Station Agent.

3053. Middlings. Sent by H. P. Morse, So. Canaan. Suspected of adulteration.

3008. Corn and Oat Feed. Bought of J. & H. Woodford, Avon. Sampled and sent by S. T. Stockwell as above.

3101. Buffalo Sugar Feed. Bought by J. H. Webb, Hamden. Sampled by Station Agent.

ANALYSES.

	3007	3056	3057	3068	3053	3008	3101
Water	12.25	76.02	78.36	76.81	12.63	11.23	11.40
Ash	5.97	.90	.86	1.25	4.97	4.64	1.05
Albuminoids	26.13	5.78	4.20	5.75	16.62	7.00	22.06
Fiber	10.37	3.46	3.83	3.36	7.57	11.53	5.13
Nitrogen-free extract	44.20	12.37	11.33	11.57	54.54	62.68	51.13
Fat	1.08	1.47	1.42	1.26	3.67	2.92	9.23
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Cost per ton	$18.00	$3.33	$3.33	$3.33		$24.00	$25.00
Water-free.							
Ash	6.8	3.8	4.0	5.4	5.7	5.2	1.2
Albuminoids	29.8	24.1	19.5	24.8	19.0	7.9	24.9
Fiber	11.8	14.4	17.7	14.4	8.7	13.0	5.8
Nitrogen-free extract	50.3	51.6	52.2	49.9	62.4	70.6	57.7
Fat	1.3	6.1	6.6	5.5	4.2	3.3	10.4
	100.0	100.0	100.0	100.0	100.0	100.0	100.0

The "Corn and Oat Feed" sample No. 3008, is a much less concentrated feed than either sound corn or sound oats, or any mixture of the two could be if the whole grain was used. This will be clear if we compare the composition of the three.

	Maize kernel. 211 analyses.	Oats. 27 analyses.	"Corn and oat feed."	Hay from mixed meadow grasses.
Water	10.9	11.0	11.23	14.5
Ash	1.5	3.1	4 64	5.1
Albuminoids	10.5	11.5	7.00	7.3
Fiber	2.0	9.8	11.53	29.1
Nitrogen-free extract	69.7	59.8	62.68	41.7
Fat	5.4	4.8	2.92	2.3
	100.0	100.0	100.00	100.0

The "Feed" contains much less albuminoids and fat than either oats or maize, and much more fiber and ash. It is probably a mixture of maize and inferior oats and chaff, or of clippings from oats. It has less albuminoids than good hay even though probably a larger percentage of digestible albuminoids.

There is no security in the purchase of mixed feeds. They are a sort of "dumping ground" for light seed, screenings and all kinds of mill-refuse.

No. **3053,** Wheat Middlings, bears no evidence of adulteration and is of fair quality as far as can be learned from the analysis.

MAIZE KERNELS, FIELD-CURED AND ENSILAGED.

Mr. D. H. Van Hoosear sent to the Station two ears of maize. One taken from the silo Dec. 22, the other field-cured, with the inquiry whether there had been a loss of any ingredients in the silo. Not knowing the original weight of the maize, the only point that could be ascertained was whether the samples differed widely in the composition of their dry matter.

The analyses follow :

ANALYSES.

	As received.		Water-free.	
	From silo.	Field-cured.	From silo.	Field-cured.
Water	40 47	13.92	----	----
Ash	.74	1.26	1.25	1.47
Albuminoids	6.90	10.03	11.59	11.64
Fiber	1.56	1.53	2.63	1.78
Nitrogen-free extract	47.38	69.08	79.57	80.24
Fat	2.95	4.18	4.96	4.87
	100.00	100.00	100.00	100.00

It is seen that the composition of the dry matter of these two samples is practically identical, and the analyses go to show that there has been no material change in the composition of the kernels in the silo.

This accords with the results of elaborate investigations made elsewhere on the same subject. The well-managed silo excludes air from the forage and impregnates it with powerful and harmless antiseptics, carbonic and other acids. These acids are products of fermentative change and are mainly formed out of the sugar in the broken and juicy parts of the ensilaged crop. The seeds of unhusked maize would naturally be little involved in this temporary fermentation, which is soon arrested by the acids developed in its progress, and occasions no more loss of nutritive substance than accompanies curing in the field.

Salt Herrings as Cattle Food.

Early in 1891, Mr. Maltby Gelston of East Haddam, sent to this Station a sample of alewives or herring with the following interesting account of his experience with them as a food for stock.

"I have fed the fish for the past three years. Three years ago last July I had a part of a barrel of alewives left over; not having enough to fill it I could not ship it to New York with my spring catch. Remembering that years ago when shad were plenty, if our cows went wrong at calving, we used to give as a remedy, the tails of these fish with good results, it occurred to me that alewives would answer the same purpose. This thought led to others. I remember that the largest sheep I ever saw, and one whose usual clip was about 16 pounds, was a cosset that fed near our fish place, and frequently used to steal our fresh shad as they lay on the banks of the river and eat them. This was sixty years ago, when I was a boy. I concluded to try salt alewives on my cows, and accordingly gave each of them a fish. Some of them would at first only lick them, while others would eat them at once. By degrees all of them began to like them exceedingly, since then I have fed them regularly during the winter, from three to six salt alewives each, once or twice a week. When I give them the fish I withhold their ration of grain. I give them the fish in the morning, that they may have free access to water should they want it. We have noted no effect either in the flow or flavor of the milk, but find the cows greatly improved in condition.

For poultry, we soak the fish till quite fresh, boil them and mix with meal or boiled potatoes, say about equal weight of each. We have now forty-one hens and five geese to which we give, every other morning, seven fish thus boiled and mixed. The poultry eat every bone and scale. The result is good.

These fish are caught in the spring in all rivers emptying into the ocean between Cape Hatteras and Nova Scotia. They can be bought at the fish place, same as samples, in bulk, at from $30.00 to $35.00 per ton.

Hayti and St. Domingo have been our market for them since the war of the Rebellion, for which market they usually bring about $4.00 per barrel of 200 lbs., delivered in New York. Previous to our late war the Slave States bought them at about the same price. The additional expense of fitting them for and placing them on the market as food for man, together with commissions for selling, would make $30.00 per ton at the fish place as remunerative to the fishermen as the price obtained in the foreign markets. Query: Are they worth $30.00 per ton for feed for stock, with cereals or hay at the present prices"?

The fish as received were quite wet and very tender, easily breaking to pieces. A dozen of them weighed four pounds and fifteen ounces. Their composition was as follows:

	Undried.	Water-free.
Water	52.94	----
Salt	15.33	30.58
Other mineral matter*	3.58	9.59
Albuminoids †	18.10	38.46
Nitrogen-free extract	.85	1.81
Fat	9.20	19.56
	100.00	100.00
*Containing phosphoric acid	1.84	3.89
†Containing nitrogen	2.90	6.15

These salt fish contain more albuminoids, usually the most costly ingredient of feeds, than hay or any of the cereal grains. They contain one or two per cent. more of albuminoids than wheat bran, and two and a half times as much fat, but practically no other non-nitrogenous matter.

Fish suitably prepared is a valuable cattle food, and is regularly used for that purpose in some places, and for milch cows as well as other cattle.

The quantity of salt present in this sample would limit the feeding of it. Half a dozen alewives like those analyzed contain six ounces of salt, which is too much for an every-day ration. That number of herring would supply as much digestible albuminoids and two or three times as much digestible fat as three pounds of wheat bran. There is no reason why, fed after Mr. Gelston's method, they should not be a valuable addition to the winter feed of live stock.

Finely ground fish scrap as well as dried blood in the shape in which they are now offered in our markets are worth cautious and intelligent trial as food for stock. Their use would be to supply a concentrated nitrogenous product comparatively poor in non-nitrogenous matter to balance rations which in the great majority of cases are deficient in albuminoids.

On the Market Prices of the Ingredients of Feeding Stuffs.

The present market quotations of concentrated feeds and mill products show a peculiar condition of things regarding the actual cost of albuminoids, fat, and carbhydrates (including fiber).

Cotton seed meal, which is the most concentrated feed in market, richest in both albuminoids and fat, has remained for the last few years quite constant in price. Linseed meal, which is also rich in albuminoids, has fallen decidedly within two years. The average price in January, 1888, was $32.25 for old process meal, and at the same date in 1890, $28.00. But on the other hand the corn and wheat feeds and by-products, which are relatively poor in albuminoids but rich in carbhydrates, some of them also in fat, have risen greatly in price, from 20 to 25 per cent.

It thus happens that in our ordinary mill feeds carbhydrates cost as much as albuminoids, as is seen in the following comparative statement of the average cost of food ingredients in fine mill feeds for the years 1888 and 1890:

	In 1888.	In 1890.
Albuminoids (N. × 6.25)	1.6 cents per pound.	1.4 cents per pound.
Fat	4.2 " "	2.9 " "
Carbhydrates (including fiber)	.96 " "	1.4 " "

Now while the carbhydrates take nothing from the land at harvest and add nothing as a fertilizer in the manure, every sixteen pounds of albuminoids harvested from the land carry with them a pound of nitrogen. And so too every sixteen pounds of albuminoids fed to cattle add a pound of nitrogen to the manure—less the amount withdrawn in the flesh or milk, which latter may be estimated at somewhere near half a pound of nitrogen to 40 quarts of milk.

It is true at any time that a generous and comparatively concentrated feed is the most economical; but, in view of the facts just cited, it is urged that feeders should give special care to their feeding, in order to have no waste of carbhydrates and to feed an excess of albuminoids, which enrich the manure, rather than an excess of carbhydrates, which have no manurial value.

Cotton seed and linseed meal, gluten meal, malt-sprouts, and brewers' grains seem at present to be the most economical of our concentrated feeds.

The Comparative Effects of Planting in Hills and Drills on the Quantity and Quality of the Maize Crop.

Aside from the alleged advantage of cross-cultivation which is made possible by planting in hills the claim is frequently made that on an acre of land a given number of stalks standing in hills will, other things being equal, yield more than the same number of stalks planted in drills. The reasons given are in general that stalks in hills mutually support each other, that the ground is not so completely shaded by the crop and in consequence is warmer and air also circulates more freely when the planting is in hills.

When the stalks stand at a uniform and reasonable distance in the drill there would seem to be opportunity for all necessary circulation of air, and the more evenly plants are arranged in a field the more even will be the distribution of light among them, provided they stand close enough to secure the maximum yield and so to shade each other very considerably. What is gained by one plant in a hill in the way of exposure to light must be lost to another. That certain spots on the soil might be warmer when maize is planted in hills may be granted, but that the mass of the surface soil is made warmer by this means seems doubtful, as does the advantage of one method of planting over the other in the way of mutual protection by the stalks in heavy storms.

The following experiment was undertaken as a contribution to the discussion of the question.

The land used was the same as that described on pages 10 and 219 of the Report of this Station for 1889, where the history of the land is given and all details as to previous crops, fertilizers etc. It is the same as represented on page 12 of that Report, plots A to L. In 1889, plots A to F were fertilized and planted precisely like the corresponding plots from G to L as described on page 219 of the Report for 1889.

Arrangement of the Field.

The accompanying diagram page 184 will make clear the arrangement of the field and its division into strips and plots. The two strips of the previous years, running from A to F and from G to L respectively and containing six-tenths of an acre each, were in 1890, divided as in the figure, making *four* strips running north and south each containing three-tenths of an acre and divided into six plots A_1, B_1, etc. Each plot therefore in 1890, contained $\frac{1}{20}$ of an acre.

ARRANGEMENT OF THE FIELD.

Each strip is divided into 6 plots of equal size and an area of $\frac{1}{20}$ acre. The strip running north and south from A_1 to F_1 received cow manure, A_2 to F_2 hog manure. G_1 to L_1 received mixed chemicals and G_2 to L_2 no fertilizer.

NORTH.

F_1	F_2	L_1	L_2
E_1	E_2	K_1	K_2
D_1	D_2	J_1	J_2
C_1	C_2	I_1	I_2
B_1	B_2	H_1	H_2
A_1	A_2	G_1	G_2

SOUTH.

The same variety of maize had been raised on this land for two years previous to this experiment. The fertilizers applied and the crops harvested were both accurately weighed and analyzed and the exhaustion or enrichment of the soil calculated. The total quantities of nitrogen, phosphoric acid and potash per acre applied in the fertilizer and removed by the crops of 1888 and 1889, were as follows:

	Nitrogen.	Phosphoric acid.	Potash.
Put on in the fertilizer	90.2	214.4	155.6
Taken off in the crop	152.0	69.8	95.8
Gained, [+], or lost, [−] by the soil.	−61.8	+144.6	+59.8

A yield of 100 bushels of shelled corn per acre in 1890 would take from the soil 109 pounds of nitrogen, 47.8 of phosphoric acid and 70.5 of potash. The intention therefore was to apply nitrogen at the rate of 171 pounds per acre in order to make up for past deficiencies in the fertilizer and give a very liberal dressing for the coming season.

The strips A_1 to F_1, received 20,925 pounds or 3.2 cords of cow manure which is at the rate of 10.7 cords per acre.

The strips A_2 to F_2, received 21,141 pounds or 4 cords of hog manure which is at the rate of 13.3 cords per acre.

The strip G_1 to L_1, received a mixture of chemicals consisting of 100 pounds of nitrate of soda, 80 pounds of sulphate of ammonia, 80 pounds of dried blood, 125 pounds of cotton seed meal, 90 pounds dissolved bone black, and 40 pounds of muriate of potash which is at the rate of 1700 pounds per acre.

The strip G_2 to L_2 received no fertilizers. The analyses of the samples of manure are given on page 71, of this Report. The quantities of nitrogen, phosphoric acid, and potash in these several applications are as follows:

	Nitrogen.	Phosphoric acid.	Potash.
Strip A_1 to F_1, three-tenths of an acre	87.9	42.7	62.7
" A_2 to F_2, " " " "	122.6	170.8	21.6
" G_1 to L_1, " " " "	51.5	48.6	20.8
" G_2 to L_2, " " " "	----	----	----

The manure was plowed in. The commercial fertilizer was sowed by machine after plowing and was harrowed in.

Planting.

The rows of hills and drills were alike four feet apart. On the following plots the maize was planted in drills, the stalks to stand 10 inches apart, A_1, C_1, E_1, A_2, C_2, E_2, G_1, I_1, K_1, G_2, I_2, K_2.

On the following plots the planting was in hills 40 inches apart, stalks to stand four in a hill, B_1, B_2, H_1, H_2.

On the following plots the planting was in hills 30 inches apart, stalks to stand three in a hill, D_1, D_2, J_1, J_2.

On the following plots the planting was in hills 20 inches apart, stalks to stand two in a hill, F_1, F_2, L_1, L_2.

The planting was done May 29th by members of the Station staff with great care, dropping the seed by measuring line. Excess of seed was used to insure a full stand and when the plants were five inches high they were thinned so that the drills averaged exactly one stalk in ten inches and the variations from that distance were in all cases very small.

This arrangement of the field and fertilizers makes possible a comparison of the relative effects of planting in hills and drills on plots quite different as far as manuring goes but otherwise believed to be quite uniform in quality.

Cultivation and Notes during Growth.

The plots were all cultivated at the same time and in precisely the same way. The season was a very favorable one and the crop grew and ripened without any serious accident. Two weeks before cutting, the corn was badly beaten down by storms but it did not lie on the ground to any serious extent and ripened off well. No difference in lodging could be observed on the different strips or between the hills and drills. The following notes were made:

July 8. The maize growing on the hog manure is decidedly the tallest in the field, thicker at the butt and darker in color. Next in thriftiness appears to be that which was dressed with cow manure. The strip which received fertilizer chemicals and the one that received no fertilizer look precisely alike and are much inferior in development to the other two. The color of the foliage is paler.

There is a spot of backward, spindling growth on the north end of G_1, also on the northeast end of A_1 and on the west side of B_1.

The differences between the four strips are most striking at the south end of the field and almost disappear at the north end, though even there the maize on the hog manure is taller and thicker at the butt than the rest.

July 22. The maize growing on the hog manure is still the tallest though that on the cow manure is nearly as large. The maize on both these strips is a foot taller than that growing on chemicals, but this in turn is well ahead of the fourth strip that received no fertilizer.

Harvest.

The crops on all the plots were sampled, cut and stacked on the 29th and 30th of September in precisely the same manner as described on page 14 of the Report of this Station for 1889. Each crop was weighed and sampled from an area of $\frac{1}{40}$ acre taken from the centre of each plot.

The crops on the separate plots were husked, weighed and harvested on the 4th and 5th of November.

Results of the Experiment.

Both kernels and stover were separately analyzed. The cob was weighed but it was assumed that its composition was alike on all the plots. The error introduced by this assumption at the most can be but very slight because the total yield of cobs is very small in comparison with that of the kernels and stover. The composition of the kernels and stover from the individual plots are given in a table appended to this paper.

From the weights of the several crops and their chemical analyses the following statement of the harvest is calculated.

The first table, Table I, presents the sum of the weights of the field-cured crops on all the plots planted in drills compared with the corresponding weights of the crops from all the plots planted in hills. The dry weights of the crops and the weights of each ingredient in the crops are given also.

TABLE I.—CROPS CALCULATED TO YIELD PER ACRE IN POUNDS.

	Planted in Drills.	Planted in Hills.
Weight field-cured	14446	13278
Water	5899	5251
Dry matter	8547	8027
Ash	339	326
Albuminoids	652	611
Fiber	1746	1612
Nitrogen-free extract	5586	5274
Fat	224	204

TABLE II.—YIELD OF THE SEPARATE PLOTS. POUNDS PER $\frac{1}{40}$ ACRE.

	No. of Plot.	Fresh Weight.	Dry Weight.	Water.	Ash.	Albuminoids. (Protein.)	Fiber.	Nitrogen-Free Extract. (Starch, Gum, etc.)	Fat.
Drills dressed with cow manure	A_1	463.9	231.5	228.2	9.8	18.8	45.0	151.3	6.6
	C_1	434.0	260.4	173.6	12.5	20.0	58.6	163.8	5.5
	E_1	356.0	208.2	147.8	7.3	16.0	39.8	139.7	5.5
	Total	1253.9	700.1	549.6	29.6	54.8	143.4	454.8	17.6
Hills dressed with cow manure	B_1	411.0	226.1	184.9	8.5	18.9	42.6	150.0	6.1
	D_1	361.9	221.9	140.0	8.5	17.6	43.1	146.6	6.1
	F_1	343.5	204.1	139.4	8.4	15.8	39.5	134.9	5.5
	Total	1116.4	652.1	464.3	25.4	52.3	125.2	431.5	17.7
Drills dressed with hog manure	A_2	470.3	271.1	199.2	11.0	22.9	52.0	178.2	7.0
	C_2	389.0	232.6	156.4	9.3	18.2	48.8	149.8	6.5
	E_2	379.1	224.9	154.2	8.6	16.8	42.8	149.9	6.8
	Total	1238.4	728.6	509.8	28.9	57.9	143.6	477.9	20.3
Hills dressed with hog manure	B_2	417.9	258.0	159 9	12.8	21.3	50.4	167.2	6.3
	D_2	351.9	207.4	144.5	8.4	16.1	39.2	138.3	5.4
	F_2	369.0	221.4	147.6	9.4	17.6	43.9	145.0	5.5
	Total	1138.8	686.8	452.0	30.6	55.0	133.5	450.5	17.2
Drills dressed with fertilizer chemicals	G_1	456.0	272.0	184.3	12.1	22.3	56.7	172.9	7.7
	I_1	307.0	196.4	110.6	7.1	15.7	42.7	126.4	4.5
	K_1	302.0	184.2	117.8	6.2	14.9	37.3	121.2	4.6
	Total	1065.0	652.6	412.7	25.4	52.9	136.7	420.5	16.8
Hills dressed with fertilizer chemicals	H_1	367.1	211.2	155.9	8.4	16.8	45.5	135.4	5.1
	J_1	288.8	187.5	101.3	7.2	14.8	40.1	121.0	4.4
	L_1	268.0	159.3	108.7	6.1	12.4	34.0	103.1	3.7
	Total	923.9	558.0	365.9	21.7	44.0	119.6	359.5	13.2
Drills, no fertilizer	G_2	295.0	185.6	109.4	6.4	12.3	35.9	125.7	5.3
	I_2	235.5	135.8	99.7	4.7	8.5	28.9	90.3	3.4
	K_2	246.1	161.4	84.7	6.8	9.3	35.4	106.2	3.7
	Total	776.6	482.8	293.8	17.9	30.1	100.2	322.2	12.4
Hills, no fertilizer	H_2	323.9	212.3	111.6	8.4	13.7	43.3	141.6	5.3
	J_2	234.5	147.4	87.1	5.8	9.1	30.5	98.2	3.8
	L_2	246.0	151.6	94.4	6.0	9.3	31.5	100.9	3.9
	Total	804.4	511.3	293.1	20.2	32.1	105.3	340.7	13.0

This table shows that a larger crop and a larger yield of every food ingredient in the crop was harvested from the planting in drills than from the corresponding planting in hills.

Table II presents in detail the yield of each ingredient from each plot, of $\frac{1}{40}$ acre. From this it appears that the three plots of drills dressed with cow manure, together yielded 7.7 per cent. more dry matter than the corresponding plots in hills.

The three plots of drills dressed with hog manure together yielded 6.1 per cent. more dry matter than the corresponding plots in hills.

Dressed with commercial fertilizers the drilled plots yielded 14.8 per cent. more dry matter than the plots in hills.

Where no fertilizer was applied the yield of dry matter from the drilled plots was only 94.4 per cent. of that from the plots planted in hills.

The facts that in three experiments on manured land the planting in drills gave larger yield while on the other hand in the fourth experiment on unmanured land the planting in hills gave a larger yield, are difficult to explain except by inequalities of soil or error in weighing the crop.

An examination of the yields of the separate plots which received no fertilizer shows that the total dry matter of the crop from two of the drilled plots, I_2 and K_2 was 297.2 while from the corresponding plots planted in hills J_2 and L_2 it was 299.0, a difference of only 1.8 pounds. It also appears from the analysis of the crop of the other two plots G_2 and H_2, that the dry weights of kernels and cobs were 102.0 and 103.5 respectively. But the dry weight of stover from plot G_2 was recorded as 83.6 pounds while from H_2 it was recorded as 108.8 pounds, a difference of 25.2. The difference in yield then between the hills and drills where no fertilizer was applied lies almost wholly in the stover of a single plot.

If these weights are correct it is surprising that an increased dry weight of 25 pounds, equivalent to 37 pounds of field-cured stover should not have carried a correspondingly increased weight of ears.

An examination of the field notes shows that the weights of the three stacks on each plot was as follows :

Plot. G_2	Plot. H_2
110	131
95	106
90	87
295	324

A single stack on H_2 weighed 21 pounds more than any other of the six, a thing which happened nowhere else in the experiment, while the ears from it did not weigh more than from the others. These facts lead us to believe that there was an error in taking the weight of a single stack on plot H_2 and that where no fertilizer was applied the actual weight of crops on the drilled plots was very nearly the same as on the plots planted in hills. The general result then of the experiment is as follows:

In this experiment the maize planted in drills gave about six per cent. larger yield of dry matter than the maize planted in hills and also a larger yield of each food ingredient.

From Table II is calculated the percentage composition of the dry matter of the several crops which is as follows ·

TABLE III.—PERCENTAGE COMPOSITION OF THE DRY MATTER OF THE CROPS.

	Cow Manure.		Hog Manure.		Mix'd Chemicals.		No Fertilizers.	
	Drills.	Hills.	Drills.	Hills.	Drills.	Hills.	Drills.	Hills.
Ash	4.2	3.9	3.9	4.4	3.8	3.9	3.7	3.9
Albuminoids	7.8	8.0	7.9	8.0	8.1	7.9	6.2	6.2
Fiber	20.5	19.2	19.7	19.4	20.9	21.4	20.8	20.6
Nitrogen-free Ex.	65.0	66.2	65.7	65.7	64.7	64.4	66.7	66.8
Fat	2.5	2.7	2.8	2.5	2.5	2.4	2.6	2.5
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

This statement of percentage composition shows two things,

1. The composition of the crop and therefore its feeding value per pound was practically the same whether planted in hills or in drills.

2. The composition of the crops grown on the different fertilizers is practically the same; but where no fertilizer was applied the per cent. of albuminoids in the crop is about 1.7 lower with a corresponding increase in the per cent. of fiber and nitrogen-free extract.

In considering these results it should be remembered that in 1888 and 1889 this land had received very considerably more of both potash and phosphoric acid than had been removed in the crops of those years, but that on the other hand the crops had removed some 60 pounds more of nitrogen from the soil per acre than had been replaced and therefore it is fair to assume that in the spring of 1890 the nitrogen of the soil was relatively at a minimum, as compared with potash and phosphoric acid. Hence where no fertilizer was applied in 1890 it was to be expected that the crop would be reduced in quantity and would be less rich in nitrogenous substance, as a result of a striking deficiency of food supply. It is altogether likely that a considerable deficiency of either potash or of phosphoric acid would have a like effect.

It has also been shown by our experiment of the two preceding years that the per cent. of albuminoids in the crop may be strikingly increased or decreased by changing the distance of planting. To illustrate :—

The per cent. of albuminoids in the dry matter of the crops grown last year on this same land was as follows—Report for 1889, page 223 :

Distance of Planting.	Per cent. of Albuminoids in Crop.
One stalk in four feet	8.7
" " two "	7.9
" to a foot	6.4
Two stalks to a foot	5.7
Four " " "	5.6
Eight " " "	5.9

These are illustrations of a general rule that an abundant and not excessive supply of heat, water and plant food and a full supply of light are necessary for the fullest production of crop and that when the supply of either one of these factors of vegetable production is reduced beyond a certain limit the exigency is shown by a striking decrease in the proportion of nitrogenous matter which is most intimately associated with the growth and activity of assimilating cells and in consequence with the reserve supply in the seed.

The following table (Table IV), shows the largest crops of dry matter, reckoned to the acre, which were harvested in 1888 and 1889 and their percentage composition together with all crops from drills in 1890 calculated to an acre. The rows were four feet apart in all three years.

The plots marked A were on cow manure, B were on hog manure, C on commercial fertilizers, and D had no fertilizer.

As it is customary to judge of a maize crop by the yield of "shelled corn" in bushels, the yields have also been calculated in this way with the results given in the fourth column of the table. In this calculation twenty per cent. has been added to the weight of water-free kernels for the water in corn cured enough to shell and 50 pounds has been assumed as the weight of such shelled corn per bushel.

TABLE IV.—YIELD OF DRY MATTER AND "SHELLED CORN" PER ACRE FOR THREE YEARS.

Year.	Distance of Planting.	Yield of Dry Matter per Acre.	Bushels of Sound Shelled Corn.	Percentage Composition of Dry Matter. Ash.	Albuminoid.	Fiber.	Nitrogen-free Extract.	Fat.
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 " "	6352						
1890A	" 10 inches apart,	9014	91	4.0	7.9	19.8	65.7	2.6
1890B	" 10 " "	9436	97	4.2	8.0	19.6	65.5	2.7
1890C	" 10 " "	8070	87	3.9	8.0	21.2	64.4	2.5
1890D	" 10 " "	6626	51	3.8	6.2	20.7	66.7	2.6

The next table, Table V, explains the last one by showing the quantities of nitrogen, phosphoric acid and potash applied each year to the soil in the fertilizer and the quantities annually removed in the crops and the consequent exhaustion or enrichment of the soil. The phosphoric acid and potash in the crops of 1890 were not determined but have been assumed to have the same relation to the nitrogen of the crops as they had in the crop of 1888.

TABLE V.—POUNDS OF NITROGEN, PHOSPHORIC ACID AND POTASH PUT ON IN FERTILIZER AND TAKEN OFF IN MAIZE CROP FOR THREE YEARS.

	Nitrogen.	Phosphoric acid.	Potash.
Put on in fertilizer in 1888 per acre	45.1	107.2	77.8
Taken off in crop in 1888 per acre	94.8	39.4	50.2
Gained (+), or lost (—) by the soil in 1888	—49.7	+67.8	+27.6
Put on in fertilizer in 1889 per acre	45.1	107.2	77.8
Taken off in crop in 1889 "	60.9	28.7	48.5
Gained or lost by the soil in 1889	—15.8	+78.5	+29.3
Gained or lost by the soil per acre in two years' cropping	—65.5	+146.3	+56.9
Put on in cow manure per acre in 1890	293	142	209
Taken off in crop per acre in 1890	114	47	60
Gained or lost by the soil per acre in 1890	+179	+95	+149
Put on in hog manure per acre in 1890	409	569	72
Taken off in crop per acre in 1890	120	50	64
Gained or lost by the soil per acre in 1890	+289	+519	+8
Put on in mixed chemicals per acre in 1890	172	162	69
Taken off in crop per acre in 1890	103	43	55
Gained or lost by the soil per acre in 1890	+69	+119	+14
Taken off in crop in 1890 from land which received no fertilizer	66	27	37
Gained or lost by the soil per acre in 1890	—66	—27	—37

The gain or loss of these three ingredients by three years cropping with maize expressed in pounds per acre is as follows:

	Nitrogen.	Phosphoric acid.	Potash.
Dressed with cow manure in 1890	+114	+241	+106
" " hog " " "	+224	+665	+ 65
" " mixed chemicals "	+ 4	+265	+ 71
No fertilizers in "	—132	+119	+ 22

In 1888 the available nitrogen supply from the fertilizer and the decaying turf were presumably sufficient for the needs of the maize crop. In 1889 the supply was probably quite insufficient while in 1890 it was probably quite in excess of the needs of the crop, at least where cow manure and hog manure were applied.

TABLE VI.—ANALYSES OF FIELD-CURED MAIZE KERNELS FROM THE PLOTS DESCRIBED IN THIS PAPER.

Plot.	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.
A_1	38.11	.96	6.84	1.27	49.45	3.37	1.55	11.06	2.05	79.90	5.44
C_1	37.00	.85	6.43	1.15	51.46	3.11	1.35	10.15	1.82	81.77	4.91
E_1	36.93	.78	6.37	.96	51.91	3.05	1.24	10.10	1.53	82.29	4.84
A_2	36.20	.98	7.26	1.03	51.29	3.24	1.54	11.39	1.62	80.37	5.08
C_2	37.86	.85	6.51	1.01	50.75	3.02	1.37	10.46	1.63	81.67	4.87
E_2	36.08	.85	6.75	1.04	52.15	3.13	1.33	10.47	1.62	81.67	4.91
G_1	38.24	.97	6.64	1.21	49.92	3.02	1.57	10.78	1.97	80.78	4.90
I_1	38.38	.76	6 62	1.23	50.24	2.77	1.24	10.77	2.01	81.48	4 50
K_1	38.91	.81	6.39	1.12	50.11	2.66	1.36	10.46	1.82	82.00	4.36
G_2	37.59	.93	5.66	1.17	51.61	3.04	1.49	9.05	1.90	82.69	4.87
I_2	37.71	.79	5.44	1.18	51 97	2.91	1.27	8.74	1.89	83.34	4.76
K_2	35.60	.79	5.31	1·22	54.25	2.83	1.23	8 27	1.90	84.19	4.41
B_1	37.13	.83	6.52	1.25	51.05	3.22	1.36	10.37	2.05	81.11	5.11
D_1	35.24	.87	6.60	1.19	52.81	3.29	1.30	10.19	1.84	81.59	5.08
F_1	37.81	.84	6.30	1.05	51.03	2.97	1.36	10.16	1.69	82.00	4.79
B_2	36.43	.91	6.84	1.11	51.68	3.03	1.42	10.76	1.74	81.33	4.75
D_2	37.50	.81	6.47	1.08	51.28	2.86	1.32	10.43	1.74	81.91	4.60
F_2	38.43	.77	6.29	1.00	50.58	2.83	1.26	10.28	1.63	82.20	4.63
H_1	46.02	.79	5.80	1.08	43.73	2.58	1.46	10.78	2.00	80.97	4.79
J_1	37.79	.83	6.71	1.34	50.60	2.73	1.34	10.79	2.13	81.34	4.40
L_1	41.87	.78	6.05	1.23	47.72	2.35	1.29	10.40	2.12	82.14	4.05
H_2	36.44	.90	5.88	1.20	52.52	3.06	1.41	9.25	1.86	82.68	4 80
J_2	37.40	.81	5.31	1.19	52.41	2.88	1.30	8.50	1.92	83.66	4.62
L_2	38.06	.78	5.57	1.12	51.69	2.78	1.26	9.03	1.82	83.38	4.51

TABLE VII.—ANALYSES OF FIELD-CURED MAIZE STOVER FROM THE PLOTS DESCRIBED IN THIS PAPER.

Plot.	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.
A_1	59.17	2.93	2.61	13.55	21.26	.48	7.17	6.40	33.22	52.04	1.17
C_1	42.20	4.12	3.90	19.66	29.49	.63	7.12	6.75	33.84	51.04	1.25
E_1	46.02	3.59	3.64	17.87	28.11	.77	6.67	6.74	33.09	52.08	1.42
A_2	47.78	3.74	3.52	17.05	27.23	.68	7.16	6.75	32.64	52.14	1.31
C_2	41.60	3.81	3.95	19.63	30.26	.75	6.51	6.78	33.61	51.82	1.28
E_2	45.04	3.63	3.14	17.52	30.00	.67	6.63	5.70	31.86	54.59	1.22
G_1	42 52	4.23	4.08	20.10	28.31	.76	7.35	7.09	34.98	49.25	1.33
I_1	34.00	4.15	4.27	22.93	33.86	.79	6.25	6.44	34.87	51.24	1.20
K_1	39.38	3.90	4.03	20.75	31.19	.75	6.44	6.65	34.23	51.45	1.23
G_2	36.11	4.08	3.28	22.28	33.49	.76	6.36	5.12	34.88	52.44	1.20
I_2	45.43	3.02	2.98	17.86	29.87	.84	5.53	5.47	32.73	54.73	1 54
K_2	33.12	4.32	3.34	22.40	35.83	.99	6.47	5.00	33.49	53.57	1.47
B_1	51.72	3.29	3.58	15.52	25.29	.60	6.78	7.40	32.16	52.42	1.24
D_1	42.52	3.86	3.73	19.02	30.09	.78	6.72	6.49	33.09	52.34	1.36
F_1	43.68	4.38	3.66	19.07	28.47	.74	7.79	6.50	33.84	50.55	1.32
B_2	39.87	5.06	4.37	19.36	30.63	.71	8.41	7.27	32.19	50.95	1.18
D_2	44.69	4.36	3.58	17.94	28.69	.74	7.85	6.49	32.46	51.87	1.33
F_2	41.72	4.32	3.79	19.73	29.69	.75	7.41	6.50	33.87	50.94	1.28
H_1	38.62	4.31	4.20	21.27	30.88	.72	7.01	6.81	34.69	50.33	1.16
J_1	31.75	4.33	4.67	23.82	34.52	.91	6.35	6.80	34.92	50.59	1.34
L_1	39.10	3.58	3.57	21.70	31.35	.70	5.86	5.84	35.63	51.52	1.15
H_2	32.49	4.25	3.63	22.24	36.54	.85	6.29	5.37	32.94	54.11	1.29
J_2	36.76	3.76	3.20	21.34	34.06	.88	5.94	5.07	33.75	53.85	1.39
L_2	38.64	4.16	2.85	21.28	32.20	.87	6.79	4.64	34.68	52.49	1.40

ON DETERMINATION OF PHOSPHORIC ACID IN PRESENCE OF IRON AND ALUMINA.

BY S. W. JOHNSON AND T. B. OSBORNE.

In our paper on Determination of Phosphoric Acid in Fertilizers by the "Citrate Method," published in the Annual Report of this Station for 1889, we have stated that while by use of a certain modification of the citrate method satisfactory results were obtained in the analyses of fertilizers containing calcium phosphates, the same method applied to fertilizers containing notable quantities of iron or aluminum, gave varying percentages of phosphoric acid. We also found, in endeavoring to control our work by the rapid molybdic method now "official" in the United States, that it yielded no constant results in presence of iron and aluminum.

To quote from the paper referred, p. 261, "We had intended to give here the data for comparing the citrate method with the molybdic method in case of Thomas-Slag and Keystone Phosphate, but notwithstanding we have made many determinations and have many results by the molybdic method, we are as yet uncertain what is the true percentage of phosphoric acid in these substances and have to defer the consideration of that point to a future publication."

The method now "official" and generally employed in the United States for the determination of phosphoric acid in fertilizers, based on the use of molybdic acid in nitric acid solution, while entirely satisfactory in absence of iron and aluminum gives incorrect and in general too high results when these metals are present in considerable quantities.

In the original molybdic method as elaborated by Sonnenschein the cold solution of the substance in sulphuric or nitric acid is mixed with a large excess of molybdic solution and kept for 4 to

6 hours at a temperature near to but not exceeding 50° C. The yellow precipitate thus formed when washed with diluted molybdic solution, contains all the phosphoric acid and no bases except ammonia.

The method as modified for rapid work and now adopted by the American Association of Official Agricultural Chemists differs from the original mainly in precipitating from *hot* solutions and digesting for one hour at 65° C. When iron and aluminum are in the solution these metals are to some extent carried down with the yellow precipitate, and when this is dissolved in ammonia they are also dissolved and pass into the alkaline filtrate and thence into the magnesium phosphate.

It also easily happens that the conditions are such as to prevent all the phosphoric acid from entering the precipitate. This error is due to excess of nitric acid in the solution of the substance, or to relative deficiency of molybdic acid.

The extent to which iron and aluminum may contaminate the magnesium pyrophosphate is variable according to the acidity of the solution and the temperature at which the yellow molybdic precipitate is formed. The amount of phosphoric acid that may escape precipitation is also subject to variation, as a consequence the results commonly do not agree closely together, even in case of duplicate analyses carried on simultaneously, unless extreme care is taken to keep all the conditions strictly alike.

The amount of error thus occasioned in the hands of skilful analysts is shown by the subjoined figures.

The first results below stated were obtained with a carefully prepared solution containing very exactly 18.93 per cent. of P_2O_5 together with approximately 20 per cent. of Fe_2O_3, 4.72 per cent. of Al_2O_3 and 5.09 per cent. of MnO. These bases were present in the form of sulphates. The phosphoric acid was supplied in a solution of sodium phosphate whose content of P_2O_5 was fixed by repeated determinations with magnesium mixture. The weighed salts were dissolved together to a clear solution with help of nitric acid.

The results marked (O)* were mostly got in our private laboratory and with different reagents and on different solutions from those marked (W) and (C), which were made in the Station Laboratory by Messrs. Winton and Curtiss, respectively.

* By T. B. Osborne.

Comparison of the Original and the "Official" Molybdic Methods for Determining Phosphoric Acid in Presence of Iron and Aluminum.

	Prepared solution (P_2O_5=18.93 p. c.)	Thomas-Slag.	Keystone Concentrated Phosphate.	Grand Cayman Rock.	Bolivian Guano.	Superphosphate. No. 2447.	"Bone." No. 2452.	Prepared mixture of clean bone dust and diluted H_2SO_4.
Sonnenschein's Original Method	18.92, 18.94 (O.)	18.63 (W.) 18.65 (C.) 18.65, 18.65 (O.)	44.86, 44.86, 44.67 (O.) 44.84, 44.86 (O.) 44.84, 44.94 (W.) 45.01, 44.59 (C.)	25.47, 25.54 (O.)	16 96 (O.)	18.56, 18.37 (O.)	18.21 (O.)	22.98, 22.98 (O.)
Official Method now used in U.S.	19.26, 19.26 (O.)	19.26, 19.14 (O.)	46.68, 46.56 (O.) 47.89, 47.48 (C.) 46.19, 46.32 (W.) 45.25 (O.)	26.02 (O.) 26.12, 26.18	17.02 (O.) 17.09, 17.13 17.14, 17.24	19.14 (O.) 18.96, 19.04	18.37 (O.) 18.58, 18.52	22.91, 23.04 (O.)

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