STATE OF CONNECTICUT.

ANNUAL REPORT

OF

The Connecticut Agricultural Experiment Station

For 1891

Printed by Order of the General Assembly.

NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
1892.

OFFICERS AND STAFF FOR 1891.

STATE BOARD OF CONTROL.

	Term expires
Ex-officio.	
HIS EXC. MORGAN G. BULKELEY, *President.*	
Appointed by Connecticut State Agricultural Society:	
HON. E. H. HYDE, Stafford, *Vice-President.*	July 1, 1894
Appointed by Board of Trustees of Wesleyan University:	
PROF. W. N. RICE, Middletown.	1894
Appointed by Governor and Senate:	
EDWIN HOYT, New Canaan.	1892
H. L. DUDLEY, New London.	1893
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Appointed by Board of Agriculture:	
T. S. GOLD, West Cornwall.	1892
Appointed by Governing Board of Sheffield Scientific School:	
W. H. BREWER, New Haven, *Secretary and Treasurer.*	1893
Ex-officio.	
S. W. JOHNSON, New Haven, *Director.*	

Chemists.

E. H. JENKINS, PH.D., *Vice-Director.*
A. L. WINTON, JR., PH.B.
T. B. OSBORNE, PH.D.
A. W. OGDEN, PH.B.
C. G. VOORHEES, PH.B.*

Mycologist.

ROLAND THAXTER, PH.D.†
WILLIAM C. STURGIS, PH.D.‡

Stenographer and Clerk.

MISS F. M. BIGELOW.

In charge of Buildings and Grounds.

CHARLES J. RICE.

Laboratory Helper.

HUGO LANGE.

* From Oct. 1st. † Till Aug. 1. ‡ From Aug. 1

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 immediate 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. The Annual Report made to the Governor contains a *complete* account of all departments of the Station work for the preceding year.

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 street, between Whitney avenue and Prospect street, 1⅝ miles north of City Hall. Suburban street may be reached by the Whitney avenue Horse Cars, which leave the corner of Chapel and Church streets 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 street, or from Peck & Bishop's Office in Union R. R. Depot.

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REPORT OF THE BOARD OF CONTROL.

To His Excellency, the Governor of Connecticut:

The Board of Control herewith submits its Annual Report for the year ending November first, 1891.

In obedience to the "Act Concerning Commercial Fertilizers," the Station has collected through its special deputies, Messrs. Dennis Fenn, of Milford, and F. R. Curtis, of Stratford, as far as possible, samples of all the Commercial Fertilizers selling at ten dollars or more per ton, offered or exposed for sale in Connecticut. These collections have been made in ninety-six towns and many more villages, mostly from the stock on the spring market, and numbered a total of 643 samples, representing one hundred and forty-six distinct brands. On these and on other fertilizing materials and manures have been made 281 analyses, mostly in duplicate. These analyses have been skillfully performed under the immediate charge of Messrs. Winton and Ogden, who have spared no pains to ensure their accuracy.

As in previous years the Station has undertaken to test all the samples of butter, oleomargarine, molasses, and vinegar of which analyses have been desired by the Dairy Commissioners. This work has all been performed by Dr. Jenkins, who has also appeared in court to testify to the results whenever called upon. The number of butter and oleomargarine examinations has amounted to thirty-one.

Various feeding stuffs have been analyzed or are under investigation, either at the request of consumers or with reference to the field and feeding experiments conducted by the Station.

The determination of fat in cream by the Babcock method, and the application of this method to the work of creameries, has been the subject of considerable study, with very favorable results.

The same method has been studied with reference to its use in milk-gathering creameries, and has been already adopted for practical use in one Connecticut creamery of this class.

In response to various requests the practical working of the Babcock method has been exhibited at a number of creameries and at several dairy meetings.

Very large numbers of daily tests of the individual cows in a considerable herd whose milk was sold to consumers, were made during the winter of 1890–91, to study the variations in the daily yields, the value of the different cows for dairy purposes, and the effects of change of ration on the quality and quantity of the milk.

Two field experiments have been carried on at the farm of Mr. J. H. Webb, under Dr. Jenkins' superintendence, viz :

1. On the continuous growth of Indian corn on the same land, both under application of farm manure and of commercial fertilizers.

2. To test the relative yearly yield of potatoes from tubers of different sizes when the selection of tubers is practiced for a course of years.

Mr. J. B. Olcott has devoted much time and labor to the forage gardens, especially to that established by him, with the coöperation of this Station, on his farm at South Manchester, where he now has a most flourishing and instructive exhibit of a number of species and varieties of grasses in the purest possible culture, and on a considerable scale. Mr. Olcott has visited England and France and secured thence valuable or promising additions to his nursery of economic grasses.

Dr. Osborne has devoted himself during the year to a minute study of the albuminoids or proteids of the seeds of the oat, of flax, and of cotton, and is about to reinvestigate the albuminoids of wheat.

The Station corps of chemists has been increased by the appointment of Mr. Clark G. Voorhees, Ph.B., to assist Dr. Osborne in the work on albuminoids.

The results of the careful examination of the albuminoids of Indian corn made during 1889 and 1890 by Professor R. H. Chittenden and Dr. Osborne jointly, are in course of publication in the American Chemical Journal. It is proposed to prepare an abstract of their voluminous paper for publication in the Station report. The expense of this research, so far as materials and Dr. Osborne's time during twelve months, are concerned, was borne by this Station. To the authorities of the Sheffield Scientific School, for the use of their laboratory, and to Prof. Chittenden for his personal devotion to this important investigation, the Board of Control of this Station makes due and hearty acknowledgment.

Dr. Thaxter has severed his connection with the Station to accept a professorship in Harvard University. He will report in detail his work during 1891 with reference to quince blight, potato scab, etc.

The Board of Control takes this occasion to express its appreciation of Dr. Thaxter's distinguished service to the farmers and fruit-growers of this State.

Dr. Wm. C. Sturgis assumed the duties of mycologist to the Station in August and has been giving special attention to the organisms concerned in the fermentations or sweating of tobacco.

Mr. Winton occupied several weeks of the early autumn at Suffield with observations on the curing of tobacco by artificial heat on the "Snow Modern Barn System," and is now engaged in studies upon the composition of the tobacco leaf and the chemical changes suffered in the process of growth and curing.

A detailed account of this and other work of the Station will be given in the Report of the Director, now preparing.

Five bulletins containing seventy-nine octavo pages have been issued during the year and mailed to each newspaper, postmaster, and secretary of a farmer's organization and to all citizens of the State who applied for them.

The accompanying Report of the Treasurer exhibits the financial affairs of the Station for the fiscal year which ended June 30, 1891.

In accordance with a vote of the Board at its annual meeting in January last, preliminary measures have been taken to secure a collection of samples of the varieties of Indian corn which are under cultivation in this State. The accompanying* circular has been mailed to the officers of all the agricultural societies, farmers' clubs, and granges, and to all the newspapers of the State, and to many farmers known to give particular care to their corn crop, in order to invite the sending of samples to the Station. Some responses have already been received.

This collection is primarily intended for permanent preservation in the Station museum, but will be at the service of the proper authorities for exhibition at the Columbian Exposition at Chicago in 1893.

Respectfully submitted,

WILLIAM H. BREWER, *Secretary.*

New Haven, Conn., November, 1891.

* Printed in Report of Director.

Report of the Treasurer.

Wm. H. Brewer, *in account with the Connecticut Agricultural Experiment Station for the fiscal year ending June 30th, 1891.*

Receipts.

From the State Comptroller	$8,000.00	
From the U. S. Treasurer	7,500.00	
Analysis fees due previous fiscal year, collected this year	170.00	
Analysis fees of this fiscal year	2,899.74	
Unclassified Receipts	38.22	
		$18,607.96

Expenditures.

	State Acc't.	U. S. Acc't.	
Salaries	$5,130.00	$6,483.33	$11,613.33
General Laboratory expenses	1,419.78	5.98	1,425.76
Mycological expenses		220.91	220.91
Grass and Forage Investigation	807.10		807.10
Field Experiments		150.80	150.80
Gas	233.10		233.10
Water	147.00		147.00
Coal	484.50		484.50
The Establishment, Grounds, Repairs, etc.	749.36		749.36
Insurance	188.25		188.25
Telephone	100.50		100.50
Printing and Engraving	708.98	638.98	1,347.96
Stationery	119.28		119.28
Postage	94.29		94.29
Library	294.52		294.52
Collecting Fertilizers	388.30		388.30
Expenses of the Board	23.10		23.10
Unclassified Sundries	219.90		219.90
	$11,107.96	$7,500.00	$18,607.96

Memorandum.

The year's accounts were audited July 31st, 1891, by the State Auditor of Public Accounts.

Analysis fees due last year but collected this, are placed to this year's account. The analysis fees of fertilizers known or believed to be on sale since May 1st, 1891, and subject to the law concerning the sale of commercial fertilizers, when collected will be credited to the new account.

WM. H. BREWER, *Treasurer.*

Report of the Director.

The following pages contain a detailed account of the work of this Station during the past year so far as it is sufficiently advanced to justify its publication.

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

THE CONNECTICUT FERTILIZER LAW.

The General Assembly at its session in 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.*
Acme Fertilizer Co., Maspeth, L. I.	Connecticut Potato Fertilizer. Acme Fertilizer No. 2.
Baker, H. J. & Bro., 215 Pearl St., N. Y.	Pelican Bone Fertilizer. A. A. Ammoniated Phosphate. Special Potato Manure. Special Corn Manure. Special Tobacco Manure. Pure Raw Bone, Extra Fine. Castor Pomace.
Bowker Fertilizer Co, 43 Chatham St., Boston, Mass.	Stockbridge Tobacco Manure. " Grain Manure. " Forage Crop Manure. " Vegetable Manure. " Fruit Manure. Bowker's Hill and Drill Phosphate. " Ammoniated Bone Fertilizer. " Fish and Potash. " Pure Dry Fish. " Fresh Ground Bone. " Kainit.
Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Bradley's High Grade Tobacco Manure. " Dry Ground Fish. " Superphosphate. " Potato Manure. " Complete Manure for Potatoes and Vegetables. " for Top Dressing Grass and Grain. " for Corn and Grain. " Pure Fine Bone. " Circle Brand Bone and Potash. " Anchor Brand Fish and Potash. " Triangle A. Brand Fish and Potash. B. D. Sea Fowl Guano. Original Coe's Superphosphate. Farmers' New Method Fertilizer.
Buckingham, C., Southport, Conn.	A1 Fertilizer.
Chemical Co. of Canton, Baltimore, Md.	Special Potato Manure.
Church, Daniel T., Tiverton, R. I.	Pure Dry Ground Menhaden Guano, (A) Church's Special Fertilizer, (B) " Standard Fertilizer, (C) " Fish and Potash, (D) Acid Fish.

Firm.	*Brand of Fertilizer.*
Coe, E. Frank, 16 Burling Slip, N. Y.	Ground Bone and Potash. High Grade Phosphate. Alkaline Bone. Gold Brand Excelsior Guano. Potato Manure.
Collier White Lead & Oil Co., St. Louis, Mo.	Castor Pomace.
Cooper's, Peter, Glue Factory, 17 Burling Slip, N. Y.	Pure Bone Dust.
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Ammoniated Bone Phosphate. Potato, Hop and Tobacco Phosphate. Vegetable Bone Superphosphate. Special Potato Manure. Pure Ground Bone. Niagara Phosphate. Ammoniated Practical Superphosphate. Wheat and Corn Phosphate. New Rival Ammoniated Superphosphate. Buffalo Superphosphate, No. 2. Queen City Phosphate.
Cumberland Bone Co., Portland, Maine.	Cumberland Bone Superphosphate. Cumberland Potato Fertilizer.
Danbury Fertilizer Co., Danbury, Conn.	Ground Bone.
Darling, L. B. Fertilizer Co., Pawtucket, R. I.	Animal Fertilizer. Fine Ground Bone. Extra Bone Phosphate. Potato and Root Crop Manure.
Davidge Fertilizer Co., 121 Front St., N. Y.	Special Favorite Fertilizer.
Downes & Griffin, Birmingham, Conn.	Ground Bone.
Great Eastern Fertilizer Co., Rutland, Vt.	Great Eastern General Fertilizer for Grass and Grain. Great Eastern Vegetable, Vine and Tobacco Fertilizer. Great Eastern General Phosphate for Oats, Buckwheat and Seeding Down.
Hewitt, A. F., Groton, Conn.	Oak Lawn Ground Bone.
Hull, H. C., Meriden, Conn.	Ground Bone.
Kelsey, E. R., Branford, Conn.	Bone, Fish and Potash.
Lister's Agricultural Chemical Works, Newark, N. J.	Ammoniated Dissolved Bone. Potato Fertilizer. Standard Superphosphate of Lime. Celebrated Ground Bone.
Luce Bros., Niantic, Conn.	Ground Acidulated Fish Guano.

Firm.	*Brand of Fertilizer.*
Mapes Formula & Peruvian Guano Co., 143 Liberty St., N. Y.	Potato Manure. Complete Manure for Light Soils. Complete Manure for General Use. Tobacco Manure, Connecticut Brand. Fruit and Vine Manure. Peruvian Guano. Corn Manure. Complete Manure, "A" Brand. Fine Dissolved Bone. Tobacco Manure, Wrapper Brand. Seeding Down Manure. Grass and Grain Spring Top Dressing.
Miles Fertilizer & Oil Co., The, Milford, Conn.	IXL. Ammoniated Bone Superphosphate.
Miller, G. W., Middlefield, Conn.	Pure Ground Bone. Flour of Bone Phosphate.
National Fertilizer Co., Bridgeport, Ct.	Chittenden's Complete Fertilizer. " Ammoniated Bone Phosphate. " Fish and Potash. " Ground Bone.
Nuhn, Frederick, Waterbury, Conn.	Self Recommending Fertilizer.
Olds & Whipple, Hartford, Conn.	Castor Pomace.
Peck Bros., Northfield, Conn.	Ground Bone.
Plumb & Winton, Bridgeport, Conn.	Bone Fertilizer.
Quinnipiac Co., The, 7 Exchange Place, Boston, Mass.	Quinnipiac Phosphate. " Potato Manure. " Phosphate, (Pine Island Brand). " Market Garden Manure. " Fish and Potash, (Crossed Fishes Brand). " Fish & Potash (Plain Brand). " Dry Ground Fish. " Bone Meal. Sulphate of Potash. Muriate of Potash. Blood Bone and Meat Tankage. Nitrate of Soda.
Read Fertilizer Co., Box 3121, N. Y.	Standard Fertilizer. High Grade Farmers' Friend. Fish and Potash. Samson Brand Fertilizer.
Reese, J. S. & Co., 10 South St., Baltimore, Md.	New England Favorite. Mayflower Fertilizer. Pilgrim Fertilizer. Special Potato Fertilizer.
Rogers Mfg. Co., The, Rockfall, Conn.	Ground Bone.

Firm.	*Brand of Fertilizer.*
Rogers & Hubbard Co., Middletown, Ct.	Pure Raw Knuckle Bone Flour.
	Pure Ground AX Bone.
	Soluble Potato Manure.
	Fairchild's Seeding Down Formula.
	" Corn Formula.
Sanderson, L., New Haven, Conn.	Formula A, Mixed.
	Fine Ground Bone.
	Pulverized Bone and Meat.
	Blood, Bone and Meat.
	Nitrate of Soda.
	Sulphate of Ammonia.
	Muriate of Potash.
	Sulphate of Potash.
	Fine Ground Fish.
	Dissolved Bone Black.
Shoemaker, M. L. & Co., Philadelphia, Pa.	Swift Sure Superphosphate.
	Swift Sure Bone Meal.
Stewart, W. D. & Co., Boston, Mass.	Soluble Pacific Guano.
	Special Potato Manure.
Wilcox, Leander, Mystic, Conn.	Ammoniated Bone Phosphate.
	Potato Manure.
	High Grade Fish and Potash.
	Dry Ground Fish Guano.
Williams & Clark Fertilizer Co., 81 Fulton St., N. Y.	Americus Superphosphate.
	" Potato Manure.
	" High Grade Special.
	" Bone Meal.
	Royal Bone Phosphate.
Wilkinson & Co., 52 Williams St., N. Y.	Economical Bone Fertilzer.

ANALYSES OF FERTILIZERS.

During the past year 281 analyses of fertilizers and manurial waste products have been made at this Station. A classified list of them is given on page 26.

Of these a small number were examined for private parties and for other Experiment Stations to compare and test methods of analysis.

The Station has been fortunate in again securing the skillful services of Mr. Dennis Fenn of Milford and Mr. F. R. Curtiss of Stratford as its Agents to collect samples of fertilizers from all parts of the State.

These gentlemen during April and May visited ninety-six towns and a considerably larger number of villages, distributed as follows:

Hartford Co.	19
Tolland Co.	6
Windham Co.	11
New London Co.	10
Middlesex Co.	10
New Haven Co.	18
Fairfield Co.	16
Litchfield Co.	6
	96

Six hundred and forty-three samples were drawn representing one hundred and forty-six different brands.

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

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

As a rule, the Station will not analyze samples—

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

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

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

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

Explanations Concerning the Analysis of Fertilizers and the Valuation of their Active Ingredients.

Revised.

Nitrogen is the most rare, and commercially the most valuable 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 "superphosphates," in the form of free phosphoric acid.

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

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 "pot-ashes" 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 New England, New York and New Jersey markets, are as follows:

THE TRADE-VALUES FOR 1891 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	18½
nitrates	14½
Organic nitrogen in dry and fine ground fish, meat and blood	15½
in cotton seed meal and castor pomace	15
in fine bone and tankage	15
in fine medium bone and tankage	12
in medium bone and tankage	9½
in coarser bone and tankage	7½
in hair, horn shavings and coarse fish scrap	7
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	5½
in medium bone and tankage	4½
in coarser bone and tankage	3
Potash as high-grade Sulphate and in forms free from Muriate (or Chlorides)	5½
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 1891. 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 Superphosphate,
Azotin,	Dry Ground Fish,
Ammonite,	Bone and Tankage,

Ground South 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 2 cents per pound. Potash is rated at $4\frac{1}{2}$ 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 $5\frac{1}{2}$ cents per pound.

In most cases the valuation of the Ingredients in Superphosphates and Specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. 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 1891 the average selling price of Ammoniated Superphosphates, and Guanos was $33.93 per ton, the average valuation was $28.13, and the difference $5.80, an advance of 20.6 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 $38.84, the average valuation $31.64, and the difference $7.20, or 22.8 per cent. advance on the valuation.

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

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

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

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

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

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

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

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

Experience leads to the conclusion that the trade-values adopted at the beginning of 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, 1890, to November 1st, 1891, were as follows:

Raw Materials Commonly Used in Mixed Fertilizers.	
1. *Containing Nitrogen as the Chief Valuable Ingredient.*	
Nitrate of Potash	1
Nitrate of Soda	3
Sulphate of Ammonia	4
Cotton Seed Meal	5
Castor Pomace	6
2. *Containing Phosphoric Acid as the Chief Valuable Ingredient.*	
"Odorless Phosphate"	1
Double Superphosphate	1
Dissolved Bone Black	3
3. *Containing Potash as the Chief Valuable Ingredient.*	
High Grade Sulphate	1
Double Sulphate of Potash and Magnesia	3
Muriate of Potash	3
Krugit	1
4. *Containing Nitrogen and Phosphoric Acid.*	
Bone Manures	33
Tankage	11
Fish	5
Bat Guano	1
Mixed Fertilizers.	
Bone and Potash	5
Nitrogenous Superphosphates and Guanos	73
Special Manures	43
Home-mixed Fertilizers	19
Miscellaneous Fertilizers and Manures.	
Cotton Hull Ashes	34
Unleached Wood Ashes, Canada	12
" " " Connecticut	2
Lime-kiln Ashes	1
Ashes from Brass Works	3
Rag Dust	1
Yard Manure	3
Hen Manure	1
Beef Scraps	1
Muck	1
Total	281

These analyses are discussed in the order above given. In all cases where the contrary is not stated the samples were drawn by agents of the Station from stock in dealers' hands. The regular retail prices are given wherever possible. In many cases the actual cash prices paid by puchasers 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.

3126. Sold by L. Sanderson, New Haven. Sampled by E. F. Thompson, Warehouse Point.

3140. Sold by L. Sanderson, New Haven. Sampled by Station agent.

3214. From Quinnipiac Co., New London. Sold by Olds & Whipple, Hartford. Sampled by Station agent.

Analyses.

	3126	3140	3214
Water	2.32	2.40	1.46
Salt	.51	.66	.32
Sulphate of Soda	.41	.59	.12
Matters insoluble in water	.14	.19	.35
*Pure Nitrate of Soda	96.62	96.16	97.75
	100.00	100.00	100.00
*Containing Nitrogen	15.94	15.87	16.13
Cost per ton	$50.00	$50.00	$50.00
Nitrogen costs per pound in cents	**15.7**	**15.7**	**15.5**

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.

3131. Sold by L. Sanderson, New Haven. Sampled by E. F. Thompson, Warehouse Point.

3137. Sold by L. Sanderson, New Haven. Sampled by Station agent.

3185. From Quinnipiac Co. Sold by Olds & Whipple, Hartford. Sampled by E. F. Thompson, Warehouse Point.

3215. From Quinnipiac Co. Sold by Olds & Whipple, Hartford. Sampled by Station agent.

ANALYSES.

	3131	3137	3185	3215
Nitrogen	20.53	20.70	20.62	20.80
Equivalent ammonia	24.92	25.13	25.03	25.25
Cost per ton	$72.00	$72.00	$72.00	$72.00
Nitrogen costs per pound in cents	17.5	17.4	17.4	17.3

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.

3163 and **3209.** Sold by Olds & Whipple, Hartford. Sampled by Eugene Brown, Poquonock. These samples were of a dark brown color and not thoroughly "decorticated" or freed from hulls, which explains the lower values.

3164. "No. 1 Fort Smith." Sold by Olds & Whipple, Hartford. Sampled by Eugene Brown, Poquonock.

3167. Sold by I. L. Spencer, Suffield. Sampled by Wm. G. Viets, Thompsonville.

ANALYSES.

	3163	3209	3164	3167
Nitrogen	4.36	4.23	7.56	6.64
Phosphoric acid	1.79	1.83	3.26	2.98
Potash	1.53	1.49	2.00	1.86
Cost per ton	$24.50	$24.50	$27.00	$26.50
Nitrogen costs per pound in cents*	23.3	24.0	13.4	15.3

* Allowing 7c. and 5½c. per pound respectively for phosphoric acid and potash.

The two samples of undecorticated meal though costing $2.50 less per ton than the decorticated were very much less economical to purchase. In them nitrogen cost about ten cents more per pound than in the decorticated meal.

CASTOR POMACE.

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

3115. Sold for L. Sanderson, New Haven, by J. C. Eddy, Simsbury. Sampled by C. P. Case.

3150. From Bowker Fertilizer Co., Boston. Sold by A. D. Bridge. Sampled by Thomas J. Stroud, Shaker Station.

3208. Sold by Eli T. Hough, agent, Poquonock. Sampled by A. E. Holcomb, Poquonock.

3218. From H. J. Baker & Co., New York. Sold by W. F. Andross, East Hartford. Sampled by Station agent.

3346. Made by Red Seal Castor Oil Co., St. Louis. Sold by Olds & Whipple, Hartford. Sampled by Station agent.

3352. Made by Collier Castor Oil Co., St. Louis. Sold by F. Ellsworth, Hartford. Sampled by Station agent.

ANALYSES.

	3115	3150	3208	3218	3346	3352
Nitrogen	5.77	4.77	5.26	4.89	5.40	5.37
Phosphoric acid	1.85	2.13	1.69	1.73	1.80	1.54
Potash	1.08	1.07	1.06	1.09	1.00	.88
Cost per ton	$20.00		$19.50	$18.50	$20.00	$20.00
Nitrogen costs per pound in cents*	13.9		15.2	15.2	15.2	15.7

* Allowing 7c. and 5½c. respectively for phosphoric acid and potash.

II. Raw Materials of High Grade containing Phosphoric Acid.

"Odorless Phosphate."

3190. A sample of this material was drawn from stock purchased of Jacob Reese of Phila., by J. H. Ives of Danbury.

Analysis.

Soluble phosphoric acid	None.
"Reverted" phosphoric acid	6.36
Insoluble phosphoric acid	17.01
Total phosphoric acid	23.37
Cost per ton	$25.00

This is Basic Slag from steel works. It will hardly come into use as a fertilizer at the price quoted above.

If Basic Slag could be purchased cheaply enough, it would be well worth the attention of those tobacco growers who endeavor to avoid the use of any but a small quantity of sulphates on their land.

Double Superphosphate.

3406. This material is made by the American Phosphate and Chemical Co. of Baltimore, Md., and the manufacturers state will be introduced into Connecticut the coming season.

The sample sent by the manufacturers as fairly representing the goods is a fine, dry grayish material having the following composition:

	Per cent.
Phosphoric acid, soluble	35.22
Phosphoric acid, reverted	5.91
Phosphoric acid, insoluble	.74
Lime	17.78
Sulphuric acid	5.44
Moisture at 100° C.	5.07
Sand and other insoluble matters	6.37
Combined water and matters undetermined	23.47
	100.00

It will be seen that this material contains nearly two and a half times as much phosphoric acid as dissolved bone black and has comparatively little sulphuric acid. If it can be bought at reasonable rates this double superphosphate will be very acceptable to those tobacco growers who desire a quickly available phosphate but object to the presence of much free sulphuric acid or soluble sulphates in their fertilizers.

Dissolved Bone Black.

A superphosphate made by treating waste and spent bone black from the sugar refineries with oil of vitriol which renders nearly all of the phosphoric acid soluble in water.

3132. Sold by L. Sanderson, New Haven. Sampled by E. F. Thompson, Warehouse Point.

3133. Sold by L. Sanderson, New Haven. Sampled by Station agent.

3184. Sold by Olds & Whipple, Hartford. Sampled by E. F. Thompson, Warehouse Point.

Analyses.

	3132	3133	3184
Soluble phosphoric acid	15.58	16.24	16.40
Reverted phosphoric acid	.06	.10	.23
Insoluble phosphoric acid	.06	.09	none.
Cost per ton	$26.00	$26.00	$26.00
Soluble phosphoric acid costs per pound in cents	8.3	7.95	7.92

III. Raw Materials of High Grade Containing Potash.

Double Sulphate of Potash and Magnesia.

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

3128. Sold by L. Sanderson, New Haven. Sampled by E. F. Thompson, Warehouse Point.

3141. Sold by L. Sanderson, New Haven. Sampled by Station agent.

3187. Sold by Olds & Whipple, Hartford. Sampled by E. F. Thompson, Warehouse Point.

ANALYSES.

	3128	3141	3187
Potash	26.61	25.22	25.46
Equivalent sulphate of potash	49.2	46.7	47.1
Cost per ton	$30.00	$30.00	$30.00
Potash costs per pound in cents	**5.6**	**5.9**	**5.9**

MURIATE OF POTASH.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride), 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water.

It is generally retailed on a guarantee of 80 per cent. muriate, which is equivalent to 50.5 per cent. of actual potash.

3127. Sold by L. Sanderson, New Haven. Sampled by E. F. Thompson, Warehouse Point.

3134. Sold by L. Sanderson, New Haven. Sampled by Station agent.

3217. From Quinnipiac Co., New London. Sold by Olds & Whipple, Hartford. Sampled by Station agent.

ANALYSES.

	3127	3134	3217
Potash	49.60	50.62	52.68
Cost per ton		$42.50	$43.00
Potash costs per pound in cents		**4.2**	**4.1**

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 34 to 36 are tabulated 20 analyses.

The last of these, No. **3199,** Lister's Ground Bone, is a mixture of bone with salt-cake.

The average cost of the other 19 samples is $33.66 and the average valuation $35.58, showing a more satisfactory agreement between cost and valuation than in former years.

Samples **3176** Ground Raw Knuckle Bone, and **3177** Pure Ground A X Bone, both made by the Rogers and Hubbard Co., Middletown, and sampled by Station agent from stocks of the City Coal and Wood Co. of New Britain, and A. E. Kilburn of East Hartford, were analyzed with the results given below.

They are not included in the tables for the reason that the manufacturers objected that the mechanical condition was very different from that which their goods had generally shown, and as the same sieves were used in screening as formerly, they felt sure that some error had been made.

Further samples of the same brands were accordingly drawn and analyzed.

ANALYSES.

Mechanical Analyses.

	3176	3177
Fine, smaller than $\frac{1}{50}$ inch	58	30
Fine medium, smaller than $\frac{1}{25}$ inch	42	30
Medium, smaller than $\frac{1}{12}$ inch	--	25
Coarse, larger than $\frac{1}{12}$ inch	--	15
	100	100

Chemical Analyses.

	3176	3177
Nitrogen	4.06	4.55
Phosphoric acid	25.20	20.89
Valuation per ton	$43.26	$32.84

Bone Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3196	Pure Bone Dust.	Peter Cooper's Glue Factory, N. Y.	Wilson & Burr, Middletown.	$28.00
3198	Fine Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	City Coal & Wood Co., New Britain.	34.00
			W. W. Cooper, Suffield.	38.00
3138	Fine Ground Bone.		L. Sanderson, New Haven.	32.00
3220	Pure Fine Ground Bone.	Bradley Fertilizer Co., 27 Kilby St., Boston.	Strong & Tanner, Winsted.	34.00
			Waterbury & June, Greenwich.	34.00
			R. A. Parker, Warehouse Point.	36.00
			J. A. Lewis, Willimantic.	32.00
			J. E. Holmes, Stratford.	32.00
			W. H. Cheney's Sons, So. Manchester.	38.00
			City Coal & Wood Co., New Britain.	33.00
			Carter & Strong, Manchester.	36.00
3348	Raw Knuckle Bone Flour.	Rogers & Hubbard Co., Middletown.	Manufacturer.	40.00
3182	Ground Bone.	Plumb & Winton, Bridgeport.	Manufacturer.	30.00
3179	Swift Sure Bone Meal.	M. L. Shoemaker & Co., Philadelphia.	J. P. Barstow & Co., Norwich.	38.00
			F. Ellsworth, Hartford.	40.00
3200	Chittenden's Ground Bone.	National Fertilizer Co., Bridgeport.	E. W. Wilson, Ellington.	----
			L. W. Currier, Bridgeport.	35.00
33 19	Fine Ground Bone.	Quinnipiac Co., New London.	G. M. Williams, New London.	35.00
			John Greenwood, Norwalk.	34.00
			Olds & Whipple, Hartford.	35.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3180	Pure Ground Bone.	E. Frank Coe, 16 Burling Slip, N. Y.	I. W. Denison, Mystic.	$35.00
			Wheeler & Howe, Bridgeport.	30.00
			J. P. Barstow & Co., Norwich.	32.00
3181	Pure Ground Bone.	Peck Bros., Northfield.	Strong & Tanner, Winsted.	32.00
			Manufacturer.	28.00
3192	Bone Meal.	Danbury Fertilizer Co., Danbury.	Manufacturer.	32 50
3349	Pure Ground A. X. Bone.	Rogers & Hubbard, Middletown.	Manufacturer.	32.00
3222	Pure Bone Meal.	Williams & Clark Co., 83 Fulton St., N. Y.	D. B. Wilson, Waterbury.	35.00
			Chas. Kingsbury, So. Coventry.	36.00
3194	Ground Bone.	Mapes Formula & Peruvian Guano Co., N. Y.	A. N. Clark, Milford.	34.00
3178	Pure Ground Bone.	Downs & Griffin, Ansonia.	Abbott & Co., Birmingham.	38.00
3195	Fine Ground Bone.	Bowker Fertilizer Co., Boston, Mass.	T. Hallock & Co., Birmingham.	33.00
3347	G. W. Miller's Pure Ground Bone.	G. W. Miller, Middlefield.	Manufacturer.	30.00
3197	Pure Ground Bone.	Crocker Fertilizer Co., Buffalo, N. Y.	F. N. Barton, Watertown.	36.00
			H. C. Aborn, Ellington.	36.00
3199	Lister's Ground Bone.	Lister's Agricultural Chemical Works, Newark, N. J.	J. P. Barstow & Co., Norwich.	30.00

ANALYSES OF BONE MANURES.—SAMPLED BY THE STATION.

Station No.	Name or Brand.	Chemical Analysis. Nitrogen.	Chemical Analysis. Phos. Acid.	Mechanical Analysis. Finer than $\frac{1}{50}$ inch.	Finer than $\frac{1}{25}$ inch.	Finer than $\frac{1}{12}$ inch.	Coarser than $\frac{1}{12}$ inch.	Cost per ton.	Valuation per ton.	Percentage difference between cost and valuation.
										Valuation exceeds cost.
3196	Peter Cooper's Pure Bone Dust	1.64	30.92	42	18	19	21	$28.00	$37.41	25.2
3198	Darling's Fine Bone	2.44	27.31	64	25	10	1	36.00	41.28	12.8
3138	Sanderson's Fine Ground Bone	3.68	24.41	37	22	41	0	32.00	36.47	12.3
3220	Bradley's Pure Ground Bone	3.25	22.50	68	27	5	--	34.00	38.21	11.0
3348	Rogers & Hubbard Co's. Raw Knuckle Bone Flour	3.92	25.39	65	35	--	--	40.00	43.84	8.7
3182	Plumb & Winton's Ground Bone	3.99	21.20	40	21	21	18	30.00	32.58	7.9
3179	Shoemaker's Swift Sure Bone Meal	6.02	21.04	60	32	8	--	40.00	42.97	6.9
3200	National Fertilizer Co's. Ground Bone	3.54	23.18	44	26	18	12	33.00	35.06	5.9
3193	Quinnipiac Co's. Fine Ground Bone	2.88	22.84	66	22	9	3	35.00	37.02	5.4
3180	E. F. Coe's Ground Bone	2.66	22.13†	52	23	13	12	32.00	33.54	4.6
3181	Peck Bro's. Pure Ground Bone	4.32	20.85	13	30	37	20	28.00	29.33	4.5
3192	Danbury Fertilizer Co's. Bone Meal	3.99	22.40	32	28	30	10	32.50	33.70	3.5
3349	Rogers & Hubbard Co's. Pure Ground AX Bone	4.06	22.26	32	23	32	13	32.00	33.17	3.5
3222	Williams, Clark & Co's. Pure Bone Meal	2.52	21.97	72	22	6	--	35.00	35.71	1.9
3194	Mapes' Ground Bone	3.85	25.91	11	36	47	6	34.00	34.56	1.6
										Cost exceeds valuation.
3178	Downs & Griffin's Pure Ground Bone	4.34	21.66	53	22	17	8	38.00	36.81	3.2
3195	Bowker's Fine Ground Bone	4.07	25.46	2	14	84	--	33.00	31.98	3.2
3347	G. W. Miller's Pure Ground Bone	3.79	22.61	21	20	22	37	30.00	29.02	3.4
3197	Crocker's Pure Ground Bone	4.44	23.35	24	34	25	17	36.00	34.30	4.9
3199	Lister's Ground Bone	3.53	13.98	23	22	20	25	30.00	19.54	53.5

† Also contains .94 per cent. of potash.

2. *Manufacturers' Samples.* 3. *Samples drawn by private individuals.*

Here are given analyses of samples sent to the Station by the manufacturers. No samples of these brands were drawn by the sampling agents, and it is therefore necessary,—to meet the requirement of the law which calls for an annual analysis of each brand—to analyze the samples deposited at the Station by manufacturers. With these are the analyses of two samples drawn by private individuals.

3272. A1 Bone, ground by the National Fertilizer Co., Bridgeport, for C. Buckingham, Southport, who is the dealer. Sampled and sent by C. Buckingham.

3280. Oak Lawn Pure Ground Bone made and sampled by A. F. Hewitt, Groton.

3355. Ground Bone, made and sampled by H. C. Hull, Meriden.

3296. Ground Bone, made and sampled by the Rogers Manufacturing Co., Rockfall, Conn.

3116. Fertilizer made by Plumb and Winton. Sampled and sent by Wm. R. Hopson, Bridgeport.

3122. H. J. Baker's Pure Raw Bone, extra fine. Sampled and sent by W. F. Andross, East Hartford.

MECHANICAL ANALYSES.

	3272	3280	3355	3296	3116	3122
Fine, smaller than $\frac{1}{50}$ inch	55	61	5	36	50	47
Fine medium, smaller than $\frac{1}{25}$ inch	38	22	6	32	20	53
Medium, smaller than $\frac{1}{12}$ inch	5	12	9	30	22	0
Coarse, coarser than $\frac{1}{12}$ inch	2	5	80	2	8	0
	100	100	100	100	100	100

CHEMICAL ANALYSES.

	3272	3280	3355	3296	3116	3122
Nitrogen	3.98	2.77	4.16	2.66	5.54	3.72
Phosphoric acid	16.25	27.04	21.40	26.93	13.41	24.65
Valuation per ton	$30.95	40.74	21.87	37.16	31.74	41.34

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.

1. *Sampled by Station Agent.*

3216. Blood Bone and Meat from the Quinnipiac Co. Sampled from stock of the dealer, Olds & Whipple, Hartford.

3135. Blood Bone and Meat. Sampled from stock of L. Sanderson, New Haven.

3139. Pulverized Bone and Meat. Sampled from stock of L. Sanderson.

2. *Manufacturer's Sample and Samples drawn by private individuals.*

3275. Blood and Meat Tankage made by F. S. Andrew & Co., New Haven. Sampled by F. S. Andrew.

3149. Tankage sold by Bowker Fertilizer Co., Boston. Sampled by T. J. Stroud from stock of A. D. Bridge, Hazardville.

3186. Dried Blood and Animal Matter from Quinnipiac Co. Sampled by E. F. Thompson, Warehouse Point, from stock bought of Olds & Whipple, Hartford.

3130. Pulverized Bone and Meat, and **3129** Blood Bone and Meat. Both from L. Sanderson, New Haven. Sampled and sent by E. F. Thompson, Warehouse Point.

3169. Tankage made by Daniel S. Wadsworth, Hartford. Sampled and sent by Aug. Pouleur, Windsor.

3372. Tankage made by Daniel S. Wadsworth, Hartford. Sampled by R. E. Pinney, Suffield.

Analyses of Tankage.

Station No.	Name or Brand.	Chemical Analysis.		Mechanical Analysis.					Cost per ton.	Valuation per ton.
				Finer than				Coarser than		
		Nitrogen.	Phos. acid.	$\frac{1}{50}$ inch.	$\frac{1}{25}$ inch.	$\frac{1}{12}$ inch.	$\frac{1}{6}$ inch.	$\frac{1}{6}$ inch.		
3216	Quinnipiac Co's. Blood, Bone and Meat	4.93	13.61	64	22	13	1	--	$32.00	$32.18
3135	Sanderson's Blood, Bone and Meat	5.80	15.43	61	19	17	3	--	35.00	34.46
3139	Sanderson's Pulverized Bone and Meat	5.14	20.58	84	12	3	11	--	36.00	42.41
3275	F. S. Andrews & Co's. Blood and Meat Tankage	4.02	18.14	15	26	27	32	--	.....	25 22
3149	Bowker's Tankage	6.41	15.33	45	25	21	9	--	.....	33.51
3186	Olds & Whipple's Dried Blood and Animal Matter	5.65	18.04	71	17	12	--	--	.....	38.90
3130	Sanderson's Pulverized Bone and Meat	5.71	19.16	87	10	3	--	--	35.00	42.58
3129	Sanderson's Blood, Bone and Meat	7.93	10.81	61	19	16	4	--	35.00	34.30
3169	D. S. Wadworth's Tankage	3.56	24.26	46	18	20	16	--	25.00	35.79
3372	Wadworth's Tankage	2.79	26.11	28	10	8	54	--	20.00	29.15

Dried and Acidulated Dried Fish.

3351. Bowker's Dry Fish. Sampled by manufacturer, contained 7.93 per cent. of nitrogen, equivalent to 9.63 per cent. of ammonia.

3219. Bowker's Dry Fish. Sampled by Station agent from stock of F. S. Bidwell, Windsor Locks, and Bucklin & Hardin, North Glastonbury. To this analysis the manufacturers object that it does not represent the character of the goods; as all dry fish that has left their factory this year they are very positive is fully up to guarantee. On account of this protest sample **3351** was analyzed and shows one-half of one per cent. more nitrogen. Sample **3219** contains 7.45 per cent. nitrogen, equivalent to 9.05 per cent. ammonia.

3345. Pure Ground Acidulated Fish, made by Luce Bros., Niantic. Sample sent by manufacturers contains 7.19 per cent. nitrogen, equivalent to 8.72 per cent. of ammonia.

MIXED FERTILIZERS.

I. Bone and Potash.

3350. Bone, Meat and Potash, made by F. Nuhn, Waterbury. Sampled by Station agent.

3329. Flour of Bone Phosphate, made by G. W. Miller, Middlefield. Sampled by Station agent.

3343. Fairchild's Bone and Potash for Seeding Down, made by The Rogers & Hubbard Co., Middletown. Sampled by Station agent.

3339. Ground Bone and Potash, made by E. Frank Coe, New York. Manufacturer's sample.

3341. Bone and Potash, Circle Brand, made by Bradley Fertilizer Co., Boston, Mass. Manufacturer's sample.

The sample **3329** is a mixture of bone flour with nitrate of soda and potash salts.

Analyses of Bone and Potash.

Mechanical Analyses.

	3350	3329	3343	3339	3341
Fine, smaller than $\frac{1}{50}$ inch	47	64	63	50	45
Fine medium, smaller than $\frac{1}{25}$ inch	25	29	28	22	38
Medium, smaller than $\frac{1}{12}$ inch	14	7	8	15	16
Coarse, larger than $\frac{1}{12}$ inch	14	0	1	13	1
	100	100	100	100	100

Chemical Analyses.

	3350	3329	3343	3339	3341
Nitrogen as nitrate	----	1.48	----	----	----
Nitrogen as ammonia	.15	.19	----	----	----
Nitrogen, organic	3.93	2.94	2.84	2.22	2.91
Nitrogen, total	4.08	4.61	2.84	2.22	2.91
Phosphoric acid	20.39	13.82	18.75	21.42	16.71
Potash	1.07	5.66	13.42	1.11	2.24
Chlorine	1.24	5.27	13.04	2.64	3.00
Cost per ton	$32.50	35.00	42.50	----	----
Valuation per ton	$34.62	35.96	43.61	31.33	29.94

II. Nitrogenous Superphosphates and Guanos.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid and in most cases potash, which are not designed by their manufacturers for use on any special crop. "Special Manures" are noticed further on. 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 44 to 57 are tabulated the analyses of fifty-seven brands made on samples collected by the Station agents.

The Guarantees.

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

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

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

Of the fifty-seven brands here reported fourteen are below their minimum guarantee in respect of one ingredient, and six in respect of two ingredients. That is, one-third of all the nitrogenous superphosphates in our market contain less of one or of several ingredients than they are claimed to contain.

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

The Actual Chemical Composition.

The different brands differ greatly in composition.

Below are given the highest and lowest percentages of each ingredient and also the average composition of the nitrogenous superphosphates.

The samples of dry ground fish, Peruvian guano and bone treated with oil of vitriol are not included in this table.

Composition of Nitrogenous Superphosphates. Season of 1891.

	Highest.	Lowest.	Average.
Nitrogen as nitrates	1.08	0	.14
" " ammonia	2.55	0	.28
" organic	6.06	.73	2.47
Total Nitrogen	6.06	.73	2.89
Soluble Phosphoric Acid	10.51	1.31	5.71
Reverted " "	8.04	1.19	3.19
Insoluble " "	2.85	.15	1.34
Available Phosphoric Acid	12.97	4.23	8.90
Total " "	14.78	5.19	10.24
Potash	9.95	.93	3.48
Chlorine	7.88	none	3.35
Cost per ton*	$44.00	$25.00	$33.93
Valuation per ton*	$34.18	$19.90	$28.13

* Excluding the last two analyses in the table, in which the cost exceeds valuation by considerably more than 50 per cent.

This table shows that the nitrogen in the nitrogenous superphosphates now in market varies from three-quarters of one per cent. to six per cent., phosphoric acid from five to fourteen and three-quarters per cent., and potash from less than one per cent. to ten.

It is evident that among the various brands there is a great difference in the quantity of actually valuable ingredients per ton and these differences must be studied by any one who would purchase economically.

A comparison of these tables with those of former years will also show that certain brands have about the same composition year after year, while others fluctuate considerably and cannot be depended on to be the same from year to year.

Cost and Valuation.

Cost.

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

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

To each manufacturer is also sent a request that he will notify the Station regarding the probable average cash price at freight centers in Connecticut, of such brands as he sells in the State.

From these data the average prices are computed.

Valuation.

The valuation has been computed in all cases as already described in detail on page 24.

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

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

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

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

The average cost of the nitrogenous superphosphates as already given is $33.93. The average valuation, $28.13 and the percentage difference 20.6.

Last year the corresponding figures were:

Average cost $33.80, Average valuation $28.57, Percentage difference 18.3.

Nitrogenous Superphosphates and Guanos Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3183	Acidulated Fish Guano.	Leander Wilcox, Mystic, Conn.	H. K. Brainard, Thompsonville.	$20.00
3136	Dry Ground Fish.	L. Sanderson, New Haven, Conn.	Manufacturer.	30.00
3344	Pure Fine Dissolved Bone.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes' Branch, Hartford.	32.00
3172	Dry Ground Fish Guano.	Leander Wilcox, Mystic, Conn.	H. K. Brainard, Thompsonville.	33.00
			W. W. Cooper, Suffield.	35.00
			Manufacturer.	30.00
			J. W. Reynolds, Goodspeeds.	30.00
3253	Pure Dry Ground Menhaden Guano, A.	Joseph Church & Co., Tiverton, R. I.	Manufacturer.	34.00
3234	Cumberland Bone Superphosphate.	Cumberland Bone Co., Portland, Me.	L. D. Post, Andover.	30.00
3257	Dry Ground Fish.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	D. W. Spencer, Centerbrook.	32.00
			J. E. Holmes, Stratford.	38.00
			W. F. Andross, E. Hartford.	35.00
			R. A. Parker, Warehouse Point.	34.00
3232	Bone, Fish and Potash.	E. R. Kelsey, Branford, Conn.	Wilson & Burr, Middletown.	28.00
			J. R. Barnes, Cheshire.	25.00
			Manufacturer.	20.00
3320	Sanderson's Formula A.	L. Sanderson, New Haven, Conn.	Manufacturer.	35.00
3213	Dry Ground Fish.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	E. A. Atwater, Cheshire.	36.00
			J. F. Silliman, New Canaan.	36.00
			P. & G. Williams, New London.	40.00
3331	Chittenden's Fish and Potash.	National Fertilizer Co., Bridgeport, Conn.	G. A. & H. B. Williams, E. Hartford.	32.00
			Prindle & Clark, W. Cheshire.	33.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3255	Standard C Brand Fertilizer.	Joseph Church & Co., Tiverton, R. I.	Manufacturer.	$35.00
3254	Special B Brand Fertilizer.	Joseph Church & Co., Tiverton, R. I.	Manufacturer.	37.00
3336	Swift Sure Superphosphate.	M. L. Shoemaker & Co., Philadelphia, Pa.	Wm. H. Filley, Windsor.	40.00
			J. P. Barstow & Co., Norwich.	37.00
			F. Ellsworth, Hartford.	38.00
			Mapes' Conn. Valley Branch, Hartford.	41.00
3321	Genuine Peruvian Guano.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	D. B. Wilson, Waterbury.	36.00
3291	Complete Manure, A Brand.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Birdsey & Foster, Meriden.	36.00
			F. S. Bidwell, Windsor Locks.	36.00
			Quinnebaug Store, Danielsonville.	37.00
			Mapes' Conn. Valley Branch, Hartford.	35.00
			D. Beers, Danbury.	36.00
			Wilson & Burr, Middletown.	36.00
			A. N. Clark, Milford.	37.00
			Southington Lumber & Feed Co., Southington.	35.15
			J. P. Barstow & Co., Norwich.	36.00
			Strong & Backus, Colchester.	34.00
3288	Complete Manure for General Use.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Southington Lumber & Feed Co., Southington.	35.00
			Mapes' Conn. Valley Branch, Hartford.	38.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3324	Chittenden's Ammoniated Bone Phosphate.	National Fertilizer Co., Bridgeport, Conn.	W. L. Currier, Bridgeport.	$35.00
			E. P. Matherson, Promfret.	----
			E. B. Clark, Milford.	30.00
			G. A. & H. B. Williams, E. Hartford.	32.00
			F. L. Leighton & Co., Wallingford.	35.00
			Prindle & Clark, W. Cheshire.	31.00
			C. D. James, Danielsonville.	----
			J. S. Worthington, Gildersleeve.	----
			D. G. Penfield, Danbury.	35.00
			G. W. Eaton, Plainville.	33.00
3248	Bradley's Farmers New Method Fertilizer.	Bradley Fertilizer Co., 127 Kilby St., Boston, Mass.	J. E. Leonard, Jewett City.	32.00
			City Coal & Wood Co., New Britain.	33.00
			W. F. Andross, E. Hartford.	33.00
			D. N. Clark & Sons, Milford.	29.00
			G. W. Carver, Putnam.	29.00
			G. R. Fowler, Central Village.	34.00
			Carter & Strong, Manchester.	34.00
			D. W. Spencer, Centerbrook.	34.00
			J. M. Young, Norwich.	30.00
			R. D. Williams, Collinsville.	32.00
3235	A. A. Ammoniated Superphosphate.	H. J. Baker & Bro., 215 Pearl St., New York.	E. H. Talcott, Torrington.	37.50
			J. H. Ives, Danbury.	37.50
			A. L. Winton, Bridgeport.	37.50
			H. L. Foote, Brookfield Junction.	37.50
			G. W. Walker, Saybrook.	37.50
			E. F. Hawley, Newtown.	37.50
			W. F. Andross, E. Hartford.	37.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3262	Lister's Standard Phosphate.	Lister's Agricultural Chemical Works, Newark, N. J.	W. H. Parmelee, Essex.	$35.00
3174	High Grade Fish and Potash.	Leander Wilcox, Mystic, Conn.	H. K. Brainard, Thompsonville.	32.00
			F. E. Fowler, Montville.	30.00
			Manufacturer.	31.00
			Manufacturer.	31.00
3334	Pilgrim Fertilizer.	J. S. Reese & Co., 10 Broad St., Baltimore, Md.	H. F. Standish, Andover.	27.00
			A. H. Anderson, Putnam.	32.00
3175	Ammoniated Bone Phosphate.	Leander Wilcox, Mystic, Conn.	Manufacturer.	33.00
			J. W. Reynolds, Goodspeeds.	33.00
3312	Animal Fertilizer.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	City Coal & Wood Co., New Britain.	36.00
			W. W. Cooper, Suffield.	38.00
3333	New England Favorite.	J. S. Reese & Co., 10 Broad St., Baltimore, Md.	Montgomery & Co., Groton.	30.00
			H. F. Standish, Andover.	32.00
			A. H. Anderson, Putnam.	35.00
3306	Quinnipiac Phosphate.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	D. N. Medbury, Pomfret.	35.00
			G. B. Whitehead, Green's Farms.	36.00
			J. F. Silliman, New Canaan.	38.00
			Chandler & Morse, Putnam.	35.00
			G. M. Williams, New London.	35.00
			C. A. Young, Danielsonville.	37.00
			J. P. Little, Columbia.	36 00
			Olds & Whipple, Hartford.	38.00
			J. S. Worthington, Gildersleeve.	35.00
			A. J. Martin, Wallingford.	35.00
			D. C. Wood, Stratford.	37.00
			John Greenwood, Norwalk.	38.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3241	Bradley's Superphosphate.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Dix & Wells, Wethersfield.	$35.00
			T. F. Powers, Waterford.	34.00
			Strong & Tanner, Winsted.	35.00
			D. Beers, Danbury.	36.00
			Peck Bros., Northfield.	35.00
			S. A. Billings, Meriden.	38.00
			City Coal & Wood Co., New Britain.	35.00
			Quinnebaug Store, Danielsonville.	36.00
			J. E. Leonard, Jewett City.	36.00
			D. N. Clark, Shelton.	35.00
			Wheeler & Howe, Bridgeport.	37.00
			F. S. Bidwell, Windsor Locks.	34.00
			Burtiss & Mead, New Canaan.	38.00
			Warner, Taylor & Curtiss, Sandy Hook.	36.00
			D. W. Spencer, Centerbrook.	38.00
			J. E. Comstock, New London.	36.00
			A. L. Sternberg, Hartford.	35.00
			Carter & Strong, Manchester.	----
			Waterbury & June, Greenwich.	38.00
			H. C. Aborn & Co., Ellington.	35.00
			G. R. Fowler, Central Village.	34.00
			John Wells, Hebron.	39.00
			R. A. Parker, Warehouse Point.	35.00
3227	Fish and Potash, D Brand.	Joseph Church & Co., Tiverton, R. I.	W. W. Cooper, Suffield.	28.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3325	Americus Brand Ammoniated Bone Superphosphate.	Williams & Clark Fertilizer Co., 83 Fulton St., New York.	D. B. Wilson, Waterbury.	$35.00
			Strong & Backus, Colchester.	33.00
			Geo. Beaumont, Wallingford.	35.00
			C. E. Stagg, Stratford.	34.00
			Daniel Morgan, Mystic.	35.00
			Joseph Roode, Griswold.	36.00
			H. K. Brainard, Thompsonville.	35.00
			John Wells, Hebron.	----
			J. H. Ray & Son, Greenwich.	32.00
			J. P. Little, Columbia.	36.00
			John Bransfield, Portland.	38.00
			Hale, Day & Co., South Manchester.	36.00
			H. L. Vibberts, Manchester.	40.00
			T. C. Greene, Torrington.	37.00
			J. P. Kingsley & Sons, Plainfield.	33.00
3309	Market Garden Phosphate.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	G. B. Whitehead, Green's Farms.	40.00
			E. B. Clark, Milford.	39.00
			J. H. Jennings, Green's Farms.	----
3323	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport, Conn.	E. H. Wilson, Ellington.	----
			C. D. James, Danielsonville.	40.00
			G. H. & H. B. Williams, E. Hartford.	41.00
			D. G. Penfield, Danbury.	45.00
			J. S. Worthington, Gildersleeve.	40.00
			F. L. Leighton & Co., Wallingford.	42.50
			Prindle & Clark, W. Cheshire.	----
			S. D. Woodruff, Orange.	38.00
			David Fitzgerald, Stratford	42.00
			W. W. Cooper, Suffield.	38.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3335	May Flower Fertilizer.	J. S. Reese & Co., 10 Broad St., Baltimore, Md.	Waldo Tillinghast, Plainfield.	$30.00
			H. F. Standish, Andover.	29.00
			H. H. Davenport, Pomfret.	----
			A. H. Anderson, Putnam.	34.00
3228	High Grade Phosphate.	E. Frank Coe, 16 Burling Slip, New York.	C. H. Lounsbury, Seymour.	36.00
			J. Amidon, Wethersfield.	35.00
			Backus Bros., South Windham.	33.00
			Arnold Rudd, New London.	34.00
			W. C. Reynolds, Goodspeeds.	33.00
			D. N. Clark, Shelton.	38.00
			F. H. & F. W. Tillinghast, Central Village.	32.00
			H. L. Vibberts, Manchester.	35.00
			D. G. Penfield, Danbury.	35.00
			J. P. Barstow & Co., Norwich.	32.00
			W. T. Andrew, Orange.	----
			I. W. Denison, Mystic.	32.00
			F. P. Burr & Co., Middletown.	32.00
			H. S. Hall, 2d, Wallingford.	38.00
3233	Pelican Bone Fertilizer.	H. J. Baker & Bro., 215 Pearl St., New York.	Rodgers Bros., New London.	32.50
			E. J. Dickerman, Mt. Carmel.	32.50
3247	Sea Fowl Guano.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	F. S. Bidwell, Windsor Locks.	33.00
3304	Soluble Pacific Guano.	W. D. Stewart & Co., 7 Exchange Place, Boston, Mass.	John Bransfield, Portland.	38.00
			R. H. Tucker, Saybrook.	35.00
			L. J. Grant, South Windsor.	36.00
			Edward Halladay, Suffield.	36.00
			W. F. Andross, E. Hartford.	36.00
			P. J. Bolan, Waterbury.	35.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3318	Ammoniated Bone Fertilizer.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. E. Leonard, Jewett City.	$32.00
			E. M. Brewster, Norwich.	32.00
			N. E. Smith, Woodmont.	30.00
			Waldo Tillinghast, Plainfield.	33.00
			Strong & Backus, Colchester.	31.00
3299	Vegetable Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	J. E. Holmes, Ridgefield.	44.00
3246	Fish and Potash, Triangle A Brand.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	G. W. Grant, South Windsor.	32.00
			R. A. Parker, Warehouse Point.	30.00
			D. N. Clark, Shelton.	40.00
			Carter & Strong, Manchester.	33.00
			J. M. Williams, Manchester.	38.00
3317	Hill and Drill Phosphate.	Bowker Fertilizer Co., Boston, Mass.	M. A. Covell, North Grosvenordale.	34.00
			E. F. Miller, Ellington.	34.00
			City Coal & Wood Co., New Britain.	36.00
			J. H. Fish, Newington.	36.00
			W. F. Andross, E. Hartford.	37.00
			B. Curtiss & Son, Stepney.	37.00
			J. H. Larned, Pomfret.	36.00
			M. McNamara, New Milford.	36.00
			E. M. Brewster, Norwich.	38.00
			F. Hallock & Co., Birmingham.	34.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3297	Ammoniated Bone Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	Prindle & Clark, W. Cheshire.	----
			H. C. Aborn, Ellington.	$34.00
			G. W. Clark, Milford.	----
			F. N. Barton, Watertown.	36.00
			J. P. Little, Columbia.	37.00
			E. W. Peck, Stratford.	38.00
			John Bransfield, Portland.	----
			H. L. Vibberts, Manchester.	37.00
			C. A. Young, Danielsonville.	36.00
3245	Fish and Potash, Anchor Brand.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	J. E. Leonard, Jewett City.	35.00
			H. C. Aborn, Ellington.	30.00
3311	Fish and Potash, Plain Brand.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	A. J. Martin, Wallingford.	27.00
			M. O. Babcock, Branford.	32.00
3264	High Grade Farmer's Friend Fertilizer.	Read Fertilizer Co., Box 3121, New York.	Prior & Tryon, Middletown.	40.00
3229	Alkaline Bone.	E. Frank Coe, 16 Burling Slip, New York.	Howard Ives, Cheshire.	42.00
			Backus Bros., South Windham.	30.00
3308	Pine Island Phosphate.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	C. H. Lounsbury, Seymour.	32.00
			Olin Wheeler, South Windsor.	----
			Olds & Whipple, Hartford.	35.00

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3303	New Rival Phosphate.	Crocker Fertilizer Co., Buffalo, New York.	W. L. L. Spencer, Lebanon.	$32.00
			J. A. Weed, New Canaan.	40.00
			M. A. Covell, North Grosvenordale.	32.00
			F. N. Barton, Watertown.	32.00
3230	Gold Brand Excelsior Guano.	E. Frank Coe, 16 Burling Slip, New York.	D. G. Penfield, Danbury.	40.00
			J. Amidon, Wethersfield.	39.00
			Arnold Rudd, New London.	40.00
3256	Fish and Potash.	Read Fertilizer Co., Box 3121, New York.	Howard Ives, Cheshire.	30.00
			Prior & Tryon, Middletown.	28.00
3263	Standard Phosphate.	Read Fertilizer Co., Box 3121, New York.	Prior & Tryon, Middletown.	30.00
			Howard Ives, Cheshire.	32.00
3330	Special Favorite Fertilizer.	Davidge Fertilizer Co., 121 Front St., New York.	J. M. Burke, South Manchester.	34.00
			Waldo Tillinghast, Plainfield.	37.00
3310	Fish and Potash, Crossed Fishes Brand.	Quinnipiac Co, Boston, Mass.	M. A. Covell, North Grosvenordale.	30.00
			M. O. Babcock, Branford.	36.00
			Olin Wheeler, South Windsor.	----
			J. F. Silliman, New Canaan.	38.00
			Olds & Whipple, Hartford.	36.00
3328	Royal Bone Phosphate.	Williams & Clark Fertilizer Co., 83 Fulton St., New York.	John Bransfield, Portland.	30.00
			Dale, Day & Co., South Manchester.	30.00
3358	Acme Fertilizer, No. 2.	Acme Fertilizer Co., Maspeth, L. I.	D. R. Hubbard, Guilford.	45.00
3237	Economical Bone Fertilizer.	Wilkinson & Co, 81 Fulton St., New York.	W. H. Harris, Woodstock.	32.00
3301	Practical Ammoniated Bone Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	W. L. L. Spencer, Lebanon.	31.00

Analyses of Nitrogenous Superphosphates Sampled by the Station.

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3183	L. Wilcox's Acidulated Fish Guano	----	.80	4.95	5.75	----	1.42	2.58	.63	4.63	----	4.00	----	----	----	----	$20.00	$24.67	*18.9
3136	L. Sanderson's Dry Ground Fish	----	----	8.59	8.59	*6.6*	.75	3.37	2.98	7.10	*6.0*	4.12	----	----	----	----	30.00	34.08	*11.9
3344	Mapes' Pure Fine Dissolved Bone	----	----	2.82	2.82	*2.1*	4.88	12.19	2.36	19.43	----	17.07	*12.0*	----	----	----	32.00	35.79	*10.6
3172	L. Wilcox's Dry Ground Fish Guano	----	----	8.90	8.90	*8.0*	.67	3.43	3.09	7.19	*6.0*	4.10	*4.0*	----	----	----	32.00	35.04	*8.6
3253	Church's Dry Ground Menhaden Guano	----	----	8.68	8.68	*8.2*	.59	3.84	3.10	7.53	*8.0*	4.43	----	----	----	----	34.00	34.85	*2.5
3234	Cumberland Bone Superphosphate	.30	----	2.25	2.55	*2.5*	5.79	7.18	1.81	14.78	----	12.97	*12.0*	2.25	*3.0*	1.29	30.00	30.74	*2.4
3257	Bradley's Dry Ground Fish	----	----	8.57	8.57	*7.4*	.61	3.64	3.36	7.61	*7.0*	4.25	----	----	----	----	34.50	34.36	.4
3232	Kelsey's Bone, Fish and Potash	----	.74	3.41	4.15	*3.3*	3.07	2.10	.38	5.55	*4.0*	5.17	----	3.00	*3.0*	.22	25.00	24.76	1.0
3320	Sanderson's Formula A	1.08	.69	2.43	4.20	*3.3*	6.69	3.48	.15	10.32	*10.0*	10.17	*6.0*	5.54	*6.0*	4.32	35.00	34.18	2.4
3213	Quinnipiac Co.'s Dry Ground Fish	----	.26	8.33	8.59	*7.4*	.48	4.15	2.60	7.23	*7.0*	4.63	*4.0*	----	----	----	36.00	34.82	3.3
3331	Chittenden's Fish and Potash	----	.46	4.38	4.84	*3.3*	3.60	2.79	1.31	7.70	*6.0*	6.39	----	6.13	*5.0*	4.91	32.50	31.27	3.9
3255	Church's Standard C Brand Fertilizer	----	.32	3.70	4.02	*3.3*	6.80	2.64	.92	10.36	*10.0*	9.44	----	4.11	*4.0*	1.68	35.00	31.94	9.6
3254	Church's Special B Brand	----	----	6.06	6.06	*4.9*	3.46	2.91	1.42	7.79	*12.0*	6.37	----	4.93	*6.0*	5.40	37.00	33.71	9.7

* Valuation exceeds cost.

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

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3336	Shoemaker's Swift Sure Superphosphate	.80	----	2.25	3.05	*2.5*	7.38	4.36	2.40	14.14	*14.0*	11.74	*9.0*	4.76	*4.0*	none	$38.00	$33.85	12.2
3321	Mapes' Genuine Peruvian Guano	----	1.83	.97	2.80	*3.3*	3.38	8.92	9.90	22.20	*23.0*	12.30	----	3.09	*3.0*	2.03	41.00	35.39	15.9
3291	Mapes' Complete Manure, A Brand	.64	.60	1.79	3.03	*2.5*	8.48	2.86	1.63	12.97	*12.0*	11.34	*10.0*	3.21	*2.5*	3.04	36.00	31.03	16.0
3288	Mapes' Complete Manure for General Use	.62	1.00	2.06	3.68	*3.3*	6.72	3.54	1.38	11.64	----	10.26	*8.0*	4.42	*4.0*	2.47	38.00	32.70	16.2
3324	Chittenden's Ammoniated Bone Phosphate	----	----	2.52	2.52	*1.7*	6.88	3.75	1.95	12.58	*9.0*	10.63	*7.0*	2.58	*2.0*	1.25	33.00	27.73	19.0
3248	Bradley's Farmers' New Method Fertilizer	----	----	2.38	2.38	*1.7*	7.20	2.97	1.95	12 12	*10.0*	10.17	*8.0*	3.03	*3.0*	2.75	32.00	26.87	19.1
3235	Baker's A.A. Ammoniated Superphosphate	trace	1.85	.96	2.81	*2.5*	10.51	1.27	.38	12.16	*11.0*	11.78	*10.0*	2.83	*2.0*	3.86	37.50	31.25	20.0
3262	Lister's Standard Phosphate	----	.46	2.07	2.53	*2.1*	7.89	1.14	2.45	14.48	*12.0*	12 03	*10.0*	1.09	*1.5*	.23	35.00	29.07	20.4
3174	Wilcox's High Grade Fish and Potash	----	.45	3.45	3.90	*3.3*	3.52	2.17	.73	6.42	*6.0*	5.69	*5.0*	4.63	*4.0*	7.74	31.00	25.70	20.7
3334	Reese's Pilgrim Fertilizer	----	----	1.53	1.53	*1.0*	2.88	8.04	.40	11.32	*7.5*	10.92	*6.5*	2.51	----	2.23	29.00	23.83	21.7
3175	Wilcox's Ammoniated Bone Phosphate	----	.39	3.47	3.86	*3.3*	4.19	2.16	.74	7.09	*7.0*	6.35	*6.0*	5.32	*5.0*	6.21	33.00	27.12	21.7
3312	Darling's Animal Fertilizer	.38	----	3.31	3.69	*3.3*	4.54	3.57	1.54	9.65	*10.0*	8.11	----	5.47	*4.0*	5.30	36.00	29.52	21.9
3333	Reese's New England Favorite	----	----	2.72	2.72	*2.4*	4.03	6.23	.37	10.63	*11.0*	10.26	*9.0*	1.84	*2.0*	2.33	32.00	26.04	22.9
3306	Quinnipiac Phosphate	.08	----	2.97	3.05	*2.5*	6.81	3.73	1.66	12.20	*10.0*	10.54	*9.0*	1.99	*2.0*	1.88	35.00	28.39	23.3
3241	Bradley's Superphosphate	.18	----	2.59	2.77	*2.5*	7.82	3.17	1.36	12.35	*11.0*	10.99	*9.0*	2.20	*2.0*	2.65	35.00	28.34	23.5

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.
3227	Church's Fish and Potash	----	----	4.18	4.18	*3.3*	1.31	2.92	.96	5.19	*5.0*	4.23	----	3.09	*3.0*	5.44	$28.00	$22.60	23.9
3325	Americus Ammoniated Bone Phosphate	.08	----	2.75	2.83	*2.5*	7.28	3.73	.72	11.73	*10.0*	11.01	*9.0*	2.04	*2.0*	1.58	35.00	28.14	24.4
3309	Quinnipiac Market Garden Phosphate	.26	.64	2.48	3.38	*3.3*	6.03	1.95	.50	8.48	*9.0*	7.98	*8.0*	7.83	*7.0*	1.27	40.00	31.86	25.5
3323	Chittenden's Complete Fertilizer	.57	----	2.77	3.34	*3.3*	4.56	5.80	2.56	12.92	*8.0*	10.36	*6.0*	6.22	*6.0*	5.81	41.50	32.86	26.3
3335	Reese's Mayflower Fertilizer	----	----	2.02	2.02	*1.8*	3.25	7.62	.45	11.32	*10.0*	10.87	*8.5*	1.57	*2.3*	3.30	31.00	24.48	26.6
3228	E. F. Coe's High Grade Phosphate	---	.60	1.72	2.32	*2.0*	7.87	2.22	2.05	12.14	*11.0*	10.09	*9.0*	2.41	*3.0*	.40	34.00	26.84	26.7
3233	Baker's Pelican Bone Fertilizer	----	1.27	.91	2.18	*1.8*	8.46	1.19	.26	9.91	*9.0*	9.65	*8.0*	2.85	*2.3*	6.18	32.50	25.53	27.3
3247	Bradley's Sea Fowl Guano	----	----	2.42	2.42	*2.5*	6.90	2.92	1.93	11.75	*11.0*	9.82	*9.0*	2.41	*2.0*	2.22	33.00	25.87	27.5
3304	Stewart's Soluble Pacific Guano	.11	.23	2.44	2.78	*2.3*	7.13	2.69	1.52	11.34	*10.5*	9.82	*8.5*	2.76	*2.0*	2.00	35.00	27.30	28.2
3318	Bowker's Ammoniated Bone Fertilizer	.58	----	1.63	2.21	*2.0*	7.30	2.38	1.62	11.30	*10.0*	9.68	*8.0*	2.05	*2.0*	3.09	32.00	24.48	30.7
3299	Crocker's Vegetable Phosphate	----	.12	4.85	4.97	*5.0*	4.56	2.00	1.13	7.69	*7.0*	6.56	*6.0*	8.24	*6.0*	7.88	44.00	33.65	30.7
3246	Bradley's Fish and Potash, Triangle A Brand	----	----	2.97	2.97	*2.0*	4.50	2.02	1.66	8.18	*6.0*	6.52	*4.0*	3.75	*4.0*	5.10	31.00	23.49	32.0
3317	Bowker's Hill and Drill Phosphate	.87	----	1.97	2.84	*2.5*	8.00	2.48	1.76	12.24	*12.0*	10.48	*8.0*	2.37	*2.0*	2.29	37.00	27.98	32.2
3297	Crocker's Ammoniated Bone Phosphate	----	----	2.88	2.88	*2.9*	5.17	5.07	2.66	12.90	*11.0*	10.24	*10.0*	.93	*1.0*	1.46	35.50	26.71	32.9

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.
3245	Bradley's Fish and Potash, Anchor Brand	----	----	3.53	3.53	*2.2*	2.99	2.97	2.18	8.14	*5.0*	5.96	*3.0*	3.29	*3.0*	5.32	$32.00	$24.01	33.5
3311	Quinnipiac Fish and Potash, Plain Brand	----	----	2.87	2.87	*2.0*	3.23	2.39	1.26	6.88	*6.0*	5.62	*4.0*	3.81	*4.0*	6.40	29.00	21.60	34.2
3264	Read's High Grade Farmer's Friend	----	----	3.22	3.22	*3.3*	4.24	1.90	1.18	7.32	----	6.14	*5.0*	9.95	*10.0*	7.46	40.00	29.05	37.6
3229	E. Frank Coe's Alkaline Bone	----	----	1.07	1.07	*1.0*	7.56	2.99	1.73	12.28	*9.0*	10.55	*9.0*	1.74	*3.0*	.25	31.00	22.44	38.1
3308	Quinnipiac Pine Island Phosphate	----	.23	2.36	2.59	*2.1*	6.02	2.97	1.15	10.14	*10.0*	8.99	*9.0*	1.37	*1.0*	1.39	34.00	23.95	41.9
3303	Crocker's New Rival Phosphate	----	----	1.51	1.51	*1.2*	6.06	3.89	1.82	11.77	*11.0*	9.95	*10.0*	1.41	*1.6*	2.40	32.00	22.22	44.0
3230	E. F. Coe's Excelsior Guano, Gold Brand	----	1.27	1.04	2.31	*2.5*	6.45	2.68	1.94	11.07	*9.0*	9.13	*8.0*	4.75	*6.0*	1.79	40.00	27.79	43.9
3256	Read's Fish and Potash	----	----	2.59	2.59	*2.5*	3.39	1.66	.77	5.82	*6.0*	5.05	*4.0*	4.30	*4.0*	5.86	29.00	20.12	44.1
3263	Read's Standard Phosphate	trace	---	1.13	1.13	*0.8*	7.20	1.40	.51	9.11	*10.0*	8.60	*8.0*	4.23	*4.0*	6.28	31.00	21.14	46.6
3330	Davidge Special Favorite	----	----	1.64	1.64	*1.2*	8.35	2.59	.19	11.13	*11.0*	10.94	*10.0*	1.60	*1.5*	1.52	35.00	23.86	46.7
3310	Quinnipiac Fish and Potash, Crossed Fishes Brand	----	----	3.43	3.43	*3.3*	2.88	2.61	1.79	7.28	*5.0*	5.49	*3.0*	3.64	*3.0*	5.80	34.00	23.16	46.8
3328	Williams & Clark's Royal Bone Phosphate	----	----	1.09	1.09	*1.0*	6.56	2.60	1.15	10.31	*8.0*	9.16	*7.0*	1.71	*2.0*	.85	30.00	19.90	50.8
3358	Acme Fertilizer, No. 2	----	2.55	1.47	4.02	*4.9*	3.92	2.20	2.85	8.97	*8.0*	6.12	----	4.88	*5.0*	4.45	45.00	29.09	54.7
3237	Wilkinson's Economical Bone Fertilizer	----	----	1.07	1.07	*2.1*	4.70	2.15	.67	7.52	*6.0*	6.85	----	2.67	*3.0*	5.60	27.00	16.74	61.5
3301	Crocker's Practical Ammoniated Bone Phosphate	----	----	.73	.73	*0.8*	5.69	3.43	1.95	11.07	*9.0*	9.12	*8.0*	1.41	*1.0*	1.39	31.00	18.56	67.0

Fish and Potash.

On page 59 the different brands of Fish and Potash are tabulated by themselves, though they are also included in the tables of nitrogenous superphosphates on pages 44 to 57.

They contain from 2.6 to 4.8 per cent. of nitrogen, 5.2 to 8.2 per cent. of phosphoric acid and from 3.0 to 6.0 per cent. of potash.

The following two analyses are not included in the tables of superphosphates already given.

3202. Read's Standard Fertilizer. Sample drawn by M. S. Baldwin, Naugatuck, from stock of Frank Truesdell, Naugatuck.

3319. Bristol Fish and Potash. Made by Bowker Fertilizer Co., Boston. Sampled by Station agent from stock of E. M. Brewster, Norwich, and B. Curtiss & Sons, Stepney.

The manufacturers state that not over five tons of this brand—which is totally distinct from their "Bowker's Fish and Potash"—were shipped into Connecticut this year, and that the brand has been withdrawn from the State.

Analyses.

	3202	**3319**
Nitrogen, organic	.97	1.13
Soluble phosphoric acid	6.40	7.54
Reverted " "	2.37	2.24
Insoluble " "	1.21	2.62
Potash	3.88	1.17
Chlorine	6.07	1.59
Cost per ton	$35.00	----
Valuation per ton	$20.78	21.03

2. *Manufacturers' Samples.*

3342. Original Coe's Superphosphate, made by Bradley Fertilizer Co., Boston, Mass.

3375. Buffalo Superphosphate, No. 2, made by Crocker Fertilizer Co., Buffalo, N. Y.

3376. Niagara Phosphate, made by Crocker Fertilizer Co., Buffalo, N. Y.

3377. Queen City Phosphate, made by Crocker Fertilizer Co., Buffalo, N. Y.

3337. Extra Bone Phosphate, made by L. B. Darling Fertilizer Co., Pawtucket, R. I.

Fish and Potash.—Sampled by the Station.

	Kelsey's.	Chittenden's.	Wilcox's.	Church's.	Bradley's Triangle A.	Bradley's Anchor Brand.	Quinnipiac Plain Brand.	Read's.	Quinnipiac Crossed Fishes Brand.
	3232	**3331**	**3174**	**3227**	**3246**	**3245**	**3311**	**3256**	**3310**
Nitrogen as Ammonia	.74	.46	.45	----	----	----	----	----	----
Nitrogen, Organic	3.41	4.38	3.45	4.18	2.97	3.53	2.87	2.59	3.43
Soluble Phosphoric Acid	3.07	3.60	3.52	1.31	4.50	2.99	3.23	3.39	2.88
Reverted Phosphoric Acid	2.10	2.79	2.17	2.92	2.02	2.97	2.39	1.66	2.61
Insoluble Phosphoric Acid	.38	1.31	.73	.96	1.66	2.18	1.26	.77	1.79
Potash	3.00	6.13	4.63	3.09	3.75	3.29	3.81	4.30	3.64
Cost	$25.00	$32.50	$31.00	$28.00	$31.00	$32.00	$29.00	$29.00	$34.00
Valuation	24.76	31.27	25.70	22.60	23.49	24.01	21.60	20.12	23.16

3340. Ammoniated Dissolved Bone Phosphate, made by Lister's Agricultural Chemical Works, Newark, N. J.

3338. IXL Ammoniated Bone Superphosphate, made by the Miles Fertilizer & Oil Co., Milford, Conn.

III. Special Manures.

1. *Sampled by Station Agents.*

For Analyses and Valuations see pages 62 *to* 73.

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

Guarantees.

Eleven brands are below the maker's guarantee in respect of one ingredient, two in respect of two ingredients, and one brand is below in all three.

Actual Composition.

Below are given the highest and lowest percentage of each ingredient found in any special manure as well as their average composition.

Composition of Special Manures.

	Highest.	Lowest.	Average.
Nitrogen as nitrate	5.08	none.	.62
" " ammonia	3.90	none.	.85
" organic	3.90	none.	2.25
Total nitrogen	6.90	1.15	3.72
Soluble Phosphoric Acid	7.65	none.	5.05
Reverted " "	9.16	1.13	2.77
Insoluble " "	7.56	.11	1.57
Readily available Phosph. Acid	10.36	4.38	7.82
Total	16.72	5.36	9.39
Potash	11.66	1.54	6.74
Cost per ton	$50.00	$33.00	$38.84
Valuation per ton	$46.35	$21.42	$31.64

A comparison of the average composition of these special manures with that of the other nitrogenous superphosphates shows the former to contain, on the whole, considerably more nitrogen, nearly twice as much potash and somewhat less phosphoric acid than the latter.

Cost, Valuation and Percentage Difference.

The average cost per ton of the special manures has been $38.84, the average valuation, $31.64 and the percentage difference 22.8, a little higher than in case of the nitrogenous superphosphates.

Last year the corresponding figures were: Average cost $39.18, average valuation $32.90, percentage difference 19.0.

Manufacturer's Samples—Analyses and Valuations.

	3342	3375	3376	3377	3337	3340	3338
Nitrogen as nitrates	----	----	----	----	.58	----	----
Nitrogen as ammonia	----	----	----	----	----	.42	.29
Nitrogen, organic	2.60	----	----	1.98	3.34	2.18	2.03
Total nitrogen found	2.60	----	----	1.98	3.92	2.50	2.32
Nitrogen guaranteed	**2.1**	----	----	**1.7**	----	**1.8**	----
Soluble phosphoric acid	6.91	10.66	10.59	8.70	4.19	7.45	7.92
Reverted phosphoric acid	5.15	2.87	2.90	2.68	4.89	4.14	1.75
Insoluble phosphoric acid	1.61	trace	2.69	.21	1.74	2.64	.03
Total phosphoric acid found	13.65	13.53	16.18	11.59	10.82	14.23	9.70
Phosphoric acid guaranteed	**10.0**	**12.0**	**12.5**	----	----	**11.0**	----
Available phosphoric acid found	12.04	13.53	13.49	11.38	9.08	11.59	9.67
Available phosphoric acid guaranteed	**8.0**	**11.0**	**11.5**	**8.0**	----	**9.0**	----
Potash	1.43	2.78	----	2.03	3.96	1.60	1.72
Potash guaranteed	**1.0**	**1.4**	----	**1.0**	----	**1.5**	----
Chlorine	1.77	3.14	----	1.82	1.11	----	1.64
Valuation per ton	$28.74	23.87	22.37	25.99	30.84	29.27	24.22

Special Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3260	Fairchild's Formula for Corn and General Crops.	Rogers & Hubbard Co., Middletown, Conn.	Strong & Backus, Colchester.	$44.00
3322	Seeding Down Manure.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes' Conn. Valley Branch, Hartford.	37.50
3314	Stockbridge Manure for Tobacco.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	H. K. Brainard, Thompsonville.	50.00
3287	Grass and Grain Spring Top Dressing.	Mapes' Formula & Peruvian Guano Co., New York.	F. S. Bidwell, Windsor Locks.	40.00
			Strong & Backus, Colchester.	39.00
			G. K. Nason, Willimantic.	39.00
			Mapes' Conn. Valley Branch, Hartford.	39.00
			Soule & Staub, New Milford.	41.00
3289	Manure for Fruit and Vines.	Mapes' Formula & Peruvian Guano Co., New York.	Mapes' Conn. Valley Branch, Hartford.	38.00
			E. N. Pierce & Co., Plainville.	40.00
3259	Soluble Potato Manure.	Rogers & Hubbard Co., Middletown, Conn.	A. E. Kilburn, East Hartford.	37.00
			G. L. Foskett, Winsted.	37.00
			City Coal & Wood Co., New Britain.	37.00
			Strong & Backus, Colchester.	36.00
			Daniel Moriarty, South Meriden.	37.00
3292	Complete Manure for Light Soils, or Vegetable Manures.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes' Conn. Valley Branch, Hartford.	42.00
			Wilson & Burr, Middletown.	43.00
			G. K. Nason, Willimantic.	42.00
			Birdsey & Foster, Meriden.	42.00
3173	Potato Manure.	Leander Wilcox, Mystic, Conn.	J. P. Barstow & Co., Norwich.	43.00
			Manufacturer.	*34.00*
			J. M. Young, Norwich.	*35.00*
			W. C. Reynolds, Goodspeeds.	*32.00*
			C. M. Smith, East Hartford.	*36.00*
			J. A. Lewis, Willimantic.	*30.00*

Special Manures Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3171	C. C. C. Special Potato Manure.	Chemical Co. of Canton, Baltimore, Md.	G. L. Foskett, Winsted.	$35.00
3240	High Grade Tobacco Manure.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	A. C. Sternberg, Hartford.	46.00
3261	Lister's Potato Fertilizer.	Lister's Agricultural Chemical Works, Newark, N. J.	E. P. Carroll, East Hartford.	37.00
3332	Concentrated Potato and Corn Manure.	J. S. Reese & Co., 10 Broad St., Baltimore, Md.	H. F. Standish, Andover.	34.00
			Montgomery & Co., Groton.	32.00
3239	Special Tobacco Manure.	H. J. Baker & Bro., 215 Pearl St., New York.	E. F. Hawley, Newtown.	42.00
			L. J. Grant, South Windsor.	40.00
3285	Corn Manure.	Mapes' Formula & Peruvian Guano Co., New York.	F. S. Bidwell, Windsor Locks.	40.00
			W. W. Cooper, Suffield.	41.00
			D. B. Wilson, Watertown.	41.00
			G. K. Nason, Willimantic.	39.00
			W. A. Benton, Guilford.	40.00
			Mapes' Branch, Hartford.	39.00
			W. R. Foote, Branford.	40.00
			Southington Lumber & Feed Co., Southington.	40.00
			E. N. Pierce & Co., Plainville.	40.00
			D. Beers, Danbury.	39.00
3236	Corn Manure.	Mapes' Formula & Peruvian Guano Co., New York.	Mapes' Branch, Hartford.	44.00
3290	Tobacco Manure, Conn. Brand.	Mapes' Formula & Peruvian Guano Co., New York.		

Special Manures Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3243	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., Boston, Mass	J. F. Ellwood, Southport.	$38.00
			R. A. Parker, Warehouse Point.	36.00
			Strong & Tanner, Winsted.	40.00
			J. A. Lewis, Willimantic.	40.00
			W. H. Cheney's Sons, South Manchester.	42.00
			Dix & Welles, Wethersfield.	40.00
			City Coal & Wood Co., New Britain.	41.00
3238	Potato Manure.	H. J. Baker & Bro., 215 Pearl St., New York.	Carter & Strong, Manchester.	42.00
			E. F. Hawley, Newtown.	42.50
			H. L. Foote, Brookfield Junction.	42.00
			J. H. Ives, Danbury.	42.00
			A. L. Winton, Bridgeport.	42.00
			E. H. Talcott, Torrington.	42.00
			Rodgers Bros., New London.	40.50
			W. F. Andross, East Hartford.	40.00
3286	Tobacco Manure, Wrapper Brand.	Mapes' Formula & Peruvian Guano Co., New York.	E. J. Dickerman, Mt. Carmel.	42.50
			Mapes' Branch, Hartford.	48.00
			Southington Lumber & Feed Co., Southington.	47.50
			F. S. Bidwell, Windsor Locks.	49.00
			Soule & Staub, New Milford.	50.00

Special Manures Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3293	Potato Manure.	Mapes' Formula & Peruvian Guano Co., New York.	W. R. Foote, Branford.	$42.00
			F. S. Bidwell, Windsor Locks.	42.00
			Quinnebaug Store, Danielsonville.	43.00
			Wheeler & Howe, Bridgeport.	45.00
			C. W. Beardsley, Milford.	42.00
			Southington Lumber & Feed Co., Southington.	40.50
			E. N. Pierce & Co., Plainville.	42.00
			Wilson & Burr, Middletown.	42.00
			A. N. Clark, Milford.	43.00
			Soule & Staub, New Milford.	43.00
			Mapes' Branch, Hartford.	41.00
			Strong & Backus, Colchester.	41.00
			J. P. Barstow & Co., Norwich.	42.00
			Raymond Bros, South Norwalk.	43.00
			Abbott & Co., Birmingham.	40.00
			D. B. Wilson, Waterbury.	43.00
3313	Potato and Root Crop Manure.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	City Coal & Wood Co., New Britain.	38.00
3327	High Grade Special for Potatoes, Tobacco, Onions and Cabbage.	Williams & Clark Co., 83 Fulton St., New York.	John Bransfield, Portland.	40.00
			Hale, Day & Co., South Manchester.	40.00
			L. J. Grant, South Windsor.	40.00

Special Manures Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3279	Great Eastern Vegetable, Vine and Tobacco Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	W. A. Bonfoey, Higganum.	$35.00
			S. D. Woodruff, Orange.	35.00
			F. W. Goodrich, Portland.	----
			Wm. Burr & Son, Fairfield.	34.00
			Way & Sanderson, Pomfret.	36.00
			G. H. Law, Killingly.	32.00
3315	Stockbridge Manure for Corn	Bowker Fertilizer Co., Boston, Mass.	Waldo Tillinghast, Plainfield.	40.00
			Lewis Browning, New London.	42.50
			E. J. Dickerman, Mt. Carmel.	43.00
			J. A. Lewis, Willimantic.	40.00
			J. A. Paine, Danielsonville.	40.00
			A. H. Anderson, Putnam.	42.00
			H. E. Mead, Ridgefield.	45.00
			E. F. Miller, Ellington.	38.00
			W. A. Beers, Brookfield Junction.	----
			J. H. Larned, Pomfret.	42.00
			City Coal & Wood Co., New Britain.	41.00
			J. M. Williams, Manchester.	40.00
3300	Special Potato Manure.	Crocker Fertilizer Co., Buffalo, N. Y.	F. H. & F. W. Tillinghast, Central Village.	40.00
			H. L. Vibberts, Manchester.	40.00
			Waldo Tillinghast, Plainfield.	37.00
			E. W. Peck, Stratford.	40.00
			G. W. Clark, Milford.	----
			City Coal & Wood Co., New Britain.	39.00
			E. J. Dickerman, Mt. Carmel.	41.00
			Prindle & Clark, West Cheshire.	37.00

Special Manures Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3278	Great Eastern Grain and Grass Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	Wm. Burr & Son, Fairfield.	$33.00
			W. A. Snow, Columbia.	35.00
			G. H. Law, Killingly.	32.00
			Way & Sanderson, Pomfret.	36.00
3244	Complete Manure for Corn and Grain.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Carter & Strong, Manchester.	42.00
			J. E. Holmes, Stratford.	40.00
			D. N. Clark & Sons, Milford.	38.00
3316	Stockbridge Manure for Potatoes and Vegetables.	Bowker Fertilizer Co., Boston, Mass.	F. S. Bidwell, Windsor Locks.	42.00
			Southington Lumber & Feed Co., Southington.	40.50
			A. S. Russell & Co., Meriden.	45.00
			E. B. Clark, Milford.	39.00
			E. J. Dickerman, Mt. Carmel.	43.00
			City Coal & Wood Co., New Britain.	41.00
			N. E. Smith, Woodmont.	40.00

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3298	Potato, Tobacco and Hop Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	H. T. Hart, Burnside.	$36.00
			J. E. Leonard, Jewett City.	35.00
			W. L. L. Spencer, Lebanon.	38.00
			M. H. Aborn & Co., Rockville.	34.00
			E. W. Peck, Stratford.	37.00
			F. N. Barton, Watertown.	36.00
			G. W. Clark, Milford.	----
			W. C. Russell, Orange.	33.00
			J. A. Weed, New Canaan.	37.00
			J. P. Little, Columbia.	38.00
3305	Soluble Pacific Potato Fertilizer.	W. D. Stewart & Co., 7 Exchange Place, Boston, Mass.	P. J. Bolan, Waterbury.	35.00
			R. H. Tucker, Saybrook.	35.00
3357	Potato Fertilizer, Conn. Brand.	Acme Fertilizer Co., Maspeth, L. I.	D. R. Hubbard, Guilford.	38.00
3326	Potato Phosphate.	Williams & Clark Fertilizer Co., New York.	J. P. Kingsley, Plainfield.	33.00
			Chas. Kingsbury, South Coventry.	37.00
			Hale, Day & Co., South Manchester.	36.00
			Geo. Beaumont, Wallingford.	35.00
			Daniel Morgan, Mystic.	35.00
			L. L. Dimmock, Waterford.	36.00
			Joseph Roode, Griswold.	36.00
			T. C. Smith, Torrington.	40.00
			H. L. Vibberts, Manchester.	38.00
			D. B. Wilson, Waterbury.	36.00
			H. K. Brainard, Thompsonville.	38.00
			A. H. Anderson, Putnam.	36.00

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3302	Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer Co., Buffalo, N.Y.	F. N. Barton, Watertown.	$35.00
			M. H. Aborn & Co., Rockville.	34.00
			J. E. Leonard, Jewett City.	32.00
			Henry Davis, Durham.	32.00
			W. C. Russell, Orange.	33.00
			J. E. Holmes, Ridgefield.	35.00
			Prindle & Clark, West Cheshire.	----
			Waldo Tillinghast, Plainfield.	33.00
			G. W. Clark, Milford.	----
			F. H. & F. W. Tillinghast, Central Village.	34.00
			H. L. Vibberts, Manchester.	35.00
			W. L. L. Spencer, Lebanon.	36.00
			E. W. Peck, Stratford.	36.00
3307	Potato Manure.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	D. N. Medbury, Pomfret.	36.00
			F. S. Bidwell, Windsor Locks.	36.00
			M. A. Covell, North Grosvernordale.	34.00
			A. J. Martin, Wallingford.	35.00
			C. E. Young, Killingly.	35.00
			C. A. Young, Danielsonville.	38.00
			G. M. Williams, New London.	35.00
			Olds & Whipple, Hartford.	40.00
			J. S. Worthington, Gildersleeve.	----
			D. C. Wood, Stratford.	38.00

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3242	Potato Manure.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Warner, Taylor & Curtiss, Sandy Hook.	$36.00
			J. S. Wells, Hebron.	39.00
			G. W. Carver, Putnam.	34.00
			H. C. Aborn, Ellington.	36.00
			A. C. Sternberg, Hartford.	36.00
			F. S. Bidwell, Windsor Locks.	36.00
			D. W. Spencer, Centerbrook.	38.00
			D. N. Clark, Shelton.	40.00
			J. E. Leonard, Jewett City.	37.00
			Samuel Stevens, North Glastonbury.	----
			City Coal & Wood Co., New Britain.	37.00
			Strong & Tanner, Winsted.	36.00
			W. F. Andross, Hartford.	36.00
			T. F. Powers, Waterford.	35.00
			Dix & Welles, Wethersfield.	35.00
			J. E. Holmes, Stratford.	38.00
			D. N. Clark & Sons, Milford.	34.00
			R. A. Parker, Warehouse Point.	35.00
3276	Samson Fertilizer for Vegetables and Potatoes.	Read Fertilizer Co., Box 3121, New York.	Howard Ives, Cheshire.	40.00
3258	Complete Manure for Top Dressing Grass and Grain.	Bradley Fertilizer Co., Boston, Mass.	G. W. Grant, South Windsor.	40.00
3277	Great Eastern Fertilizer for Oats, Buckwheat and Seeding Down.	Great Eastern Fertilizer Co., Rutland, Vt.	W. A. Snow, Columbia.	35.00
			Way & Sanderson, Pomfret.	34.00
			J. E. Comstock, New London.	32.00

ANALYSES OF SPECIAL MANURES SAMPLED BY THE STATION.

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3260	Fairchild's Formula for Corn and General Crops	3.70	----	1.91	5.61	*5.5*	----	----	----	12.28	*12.0*	----	----	13.46	*12.0*	11.75	$44.00	†44.80	*1.8
3322	Mapes' Manure for Seeding Down	.83	----	2.76	3.59	*2.5*	----	9.16	7.56	16.72	*18.0*	9.16	----	11.43	*10.0*	10.35	37.50	38.03	1.4
3314	Stockbridge Manure for Tobacco	----	3.57	3.47	6 90	*5.7*	----	5.37	3.97	9.34	*5.0*	5.37	*4.0*	11.66	*10.0*	.39	50.00	46.35	7.8
3287	Mapes' Grass and Grain Spring Top Dressing	.99	1.52	2.60	5.11	*4.1*	6.45	2.36	.58	9.39	*7.0*	8.81	*7.0*	6.14	*5.0*	5.12	39.00	36.17	7.8
3289	Mapes' Manure for Fruit and Vines	.45	.89	1.63	2.97	*1.7*	5.65	2.41	1.15	9.21	*7.0*	8.06	*7.0*	11.45	*10.0*	.64	38.00	35.20	7.9
3259	Rogers & Hubbard's Soluble Potato Manure	1.57	----	3.90	5.47	*5.0*	1.14	5 68	3.32	10.14	*10.0*	6.82	----	5.17	*5.0*	.58	37.00	33.84	9.3
3292	Mapes' Complete Manure for Light Soils	1.44	1.65	2.15	5.24	*4.9*	6.27	2.57	.64	9.48	*8.0*	8.84	*7.0*	7.11	*6.0*	6.26	42.00	37.51	11.9
3173	Leander Wilcox's Potato Manure	.67	.25	2 63	3.55	*3.2*	6.19	1.16	.11	7.46	*8.0*	7.35	*7.0*	5.97	*6.0*	1.71	33.00	28.83	14.4
3171	C. C. C. Special Potato Manure	.58	----	2.27	2 85	*2.7*	6.08	1.22	.75	8.05	----	7.30	*6.0*	11.03	*9.0*	14.14	35.00	30.51	14.7
3240	Bradley's High Grade Tobacco Manure	----	3.53	2.53	6.06	*5 8*	2.03	2.35	1.38	5.76	*4.0*	4.38	----	11.02	*10.8*	1.30	46.00	40.01	15.0
3261	Lister's Potato Fertilizer	1.03	.74	2.25	4.02	*3.7*	6.61	1.34	.52	8.47	----	7.95	*7.5*	6.99	*7.0*	4.43	37.00	32.01	15.6
3332	Reese's Concentrated Potato and Corn Manure	trace	----	3.17	3.17	*3.0*	4.28	4.13	.29	8.70	*7.0*	8.41	*6.0*	6.14	*7.5*	6.48	33.00	28.53	15.7
3239	Baker's Special Tobacco Manure	----	3.90	.87	4.77	*4.5*	3.41	1.13	.82	5.36	----	4.54	*4.0*	9.87	*10.0*	.76	41.00	35.27	16.2

* Valuation exceeds cost

† A mixture of bone flour and chemicals. Phosphoric acid valued as in bone of same fineness.

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

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.	Percentage Difference between Cost and Valuation.
3285	Mapes' Corn Manure	.84	.95	1.99	3.78	3.7	6.43	3.46	1.35	11.24	10.0	9.89	8.0	6.62	6.0	6.15	$40.00	$34.10	17.3
3236	Mapes' Corn Manure	.99	1.06	1.86	3.91	3.7	6.27	3.49	1.41	11.17	10.0	9.76	8.0	6.30	6.0	5.80	40.00	34.06	17.5
3290	Mapes' Tobacco Manure, Conn. Brand	.60	1.65	2.49	4.74	4.7	5.23	2.95	.67	8.85	....	8.18	7.8	8.08	7.7	1.00	44.00	37.28	18.0
3243	Bradley's Complete Manure for Potatoes and Vegetables	.33	1.23	2.20	3.76	3.7	7.01	1.90	1.45	10.36	9.0	8.91	8.0	5.36	6.0	5.95	38.00	31.78	19.5
3238	Baker's Potato Manure	.41	2.63	.88	3.92	3.3	4.91	1.62	.89	7.42	....	6.53	5.0	10.73	10.0	4.40	42.50	34.93	21.7
3286	Mapes' Tobacco Manure, Wrapper Brand	1.13	3.45	1.47	6.05	6.2	.72	3.96	1.75	6.43	4.5	4.68	4.5	10.36	10.5	1.31	48.00	39.44	21.7
3293	Mapes' Potato Manure	.89	.87	2.24	4.00	3.3	5.52	2.79	1.28	9.59	8.0	8.31	8.0	7.45	6.0	.54	42.00	34.32	22.4
3313	Darling's Potato and Root Crop Manure	.41	.34	3.16	3.81	2.9	2.85	4.80	2.78	10.43	....	7.65	10.0	6.46	7.0	5.25	38.00	30.93	22.9
3327	Williams & Clark's High Grade Special for Potatoes, Tobacco, Onions and Cabbage	.46	.85	2.30	3.61	3.7	5.60	3.35	1.92	10.87	8.0	8.95	7.0	6.63	7.0	6.79	40.00	32.34	23.7
3279	Great Eastern Vegetable, Vine and Tobacco Fertilizer	.17	....	2.08	2.25	2.1	6.40	1.97	1.16	9.53	9.0	8.37	8.0	6.29	6.0	6.00	34.00	26.26	29.4
3315	Bowker's Stockbridge Manure for Corn	1.37	....	1.95	3.32	3.3	7.52	2.49	1.50	11.51	9.0	10.01	8.0	4.31	7.0	4.03	40.00	30.27	32.1
3300	Crocker's Special Potato Manure	....	.19	3.27	3.46	3.7	6.59	1.16	1.14	8.89	9.0	7.75	8.0	6.47	5.5	6.16	39.00	29.40	32.7
3278	Great Eastern Grain and Grass Fertilizer	.23	....	2.78	3.01	2.9	6.88	1.78	.74	9.40	9.0	8.66	8.0	2.22	2.0	3.32	34.00	25.57	32.9

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

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.	Percentage Difference between Cost and Valuation.
3244	Bradley's Complete Manure for Corn and Grain	.23	.49	2.35	3.07	2.9	7.65	2.71	1.03	11.39	9.0	10.36	8.0	3.71	3.0	3.93	$40.00	$29.83	34.1
3316	Stockbridge Manure for Potatoes and Vegetables	1.97	....	1.80	3.77	3.3	4.61	2.17	2.75	9.53	8.0	6.78	7.0	6.99	5.0	5.19	40.00	29.34	36.3
3298	Crocker's Potatoes, Tobacco and Hop Phosphate	....	....	2.25	2.25	2.0	6.80	2.93	1.87	11.60	11.0	9.73	10.0	3.41	3.5	3.80	36.00	26.08	38.0
3305	Stewart's Soluble Pacific Potato Fertilizer	....	....	2.82	2.82	2.5	4.75	2.35	1.92	9.02	7.0	7.10	5.0	5.23	5.0	4.92	35.00	25.35	38.0
3357	Acme Fertilizer Co's Conn. Brand for Potatoes	....	1.52	1.41	2.93	3.3	4.19	1.83	2.59	8.61	7.0	6.02	....	7.80	7.0	7.15	38.00	27.50	38.1
3326	Williams & Clark Fertilizer Co's Potato Phosphate	trace	....	2.87	2.87	2.5	5.23	2.48	1.12	8.83	7.0	7.71	6.0	5.02	5.0	3.81	36.00	25.96	38.7
3302	Crocker Ammoniated Wheat and Corn Phosphate	.05	....	2.10	2.15	2.0	7.15	2.81	1.92	11.88	11.0	9.96	10.0	1.54	1.7	2.45	34.00	24.48	38.9
3307	Quinnipiac Potato Manure	....	....	2.84	2.84	2.5	4.85	2.51	1.28	8.64	7.0	7.36	6.0	5.27	5.0	4.33	36.00	25.58	40.7
3242	Bradley's Potato Manure	.20	....	2.62	2.82	2.5	4.74	2.50	1.72	8.96	8.0	7.24	6.0	4.94	5.0	4.82	36.00	25.17	43.0
3276	Read's Samson Fertilizer for Vegetables and Potatoes	....	....	2.25	2.25	2.5	7.09	1.70	.67	9.46	9.0	8.79	8.0	6.84	5.0	6.28	40.00	27.30	46.5
3258	Bradley's Complete Manure for Top Dressing Grass and Grain	5.08	....	....	5.08	5.0	2.69	2.36	1.42	6.47	6.0	5.05	5.0	3.03	2.5	.40	40.00	26.37	51.6
3277	Great Eastern Fertilizer for Oats, Buckwheat and Seeding Down	trace	....	1.15	1.15	.8	7.20	1.44	.65	9.29	9.0	8.64	8.0	4.34	4.0	5.78	33.00	21.42	54.1

E. F. Coe's Potato Manure.

Below, No. **3231**, is given an analysis of this brand made on a mixture of equal parts of six samples drawn by our agents from stock of the following dealers: I. W. Denison, Mystic; W. C. Reynolds, Goodspeeds; H. L. Vibberts, Manchester; J. Amidon, Wethersfield; J. O. Fox & Co., Putnam; D. G. Penfield, Danbury.

The manufacturer objected that this analysis did not represent the quality of the goods shipped into Connecticut, and for this reason the analysis is here specially noted and not tabulated with the others. The sample is well above the manufacturer's guarantee in nitrogen and phosphoric acid but below in potash. The manufacturer claimed that it should show 6 per cent. actual potash, and believed that the sample might have been drawn by mistake from some other brand. It is inconceivable that the same mistake should have been made in six different places, but in order to see if the samples taken from the different dealers were nearly alike, nitrogen determinations were made separately in the six different samples.

The results in per cents. were as follows: 3.05, 2.05, 2.42, 2.18, 1.52, 2.05. A new mixture was now made, excluding the sample which had the lowest per cent. of nitrogen, 1.52, and analyzed with the results given under **3231A**.

	3231	3231A
Nitrogen in ammonia	.68	.74
Nitrogen, organic	1.58	1.70
Total nitrogen	2.26	2.44
Soluble phosphoric acid	6.75	6.40
Reverted " "	2.76	2.79
Insoluble " "	1.69	2.20
Total " "	11.20	11.39
Potash	4.09	3.80
Chlorine	1.38	.96

IV. Home Mixed Fertilizers.

Many farmers prefer to buy fertilizer-chemicals and mix them according to their own ideas of the requirements of their land and crops, and with the conviction that in the present state of the fertilizer trade they can buy nitrogen, phosphoric acid and potash more economically in this way than in any other.

The formulas of such home-mixtures as have been received at the Station and also the analyses are given in the tables on pages 76 to 80.

Since, in most cases, the stocks from which the chemicals were bought have been sampled and analyzed by the Station it is easy to calculate what the composition of the mixtures would have been if the goods had been perfectly uniform and the weighing and mixing accurate and thorough, without loss or gain of moisture.

This *calculated* composition is likewise given in the table.

The cost of the materials, *unmixed*, delivered at the purchaser's freight station is also given so far as could be ascertained.

The regular cash retail price of the materials is stated in nearly every case. Special and considerably reduced rates were obtained in a number of cases.

The valuations were calculated as in the preceding tables.

Calculated and Actual Composition.

The calculated nitrogen in most cases agrees fairly well with the amount actually found. There are greater discrepancies in phosphoric acid and potash; in most cases the actual phosphoric acid is less than calculated, and the potash more than calculated.

Average Composition of Home Mixtures.

	Highest.	Lowest.	Average.
Nitrogen as nitrate	2.95	none.	.82
" " ammonia	1.97	none.	.65
" organic	4.85	1.61	2.78
Total nitrogen	6.51	3.23	4.25
Soluble phosphoric acid	10.25	.16	4.72
Reverted " "	6.33	1.53	3.83
Insoluble " "	5.11	.55	2.53
Total " "	15.11	6.09	11.08
Potash	15.85	2.08	6.57
Cost of materials per ton unmixed	$39.60	$26.43	$34.82
Valuation per ton	$38.27	$30.28	$34.57

In the above table only those mixtures are regarded whose formulas are known.

Comparing the Home Mixtures with the Special Manures it is seen that the former contain on the average (fourteen analyses) half of a per cent. more nitrogen, over one and a half per cent. more phosphoric acid and slightly more of potash than the latter.

Cost, Valuation and Percentage Difference.

The average cost of the materials of which these mixtures were made, delivered, without the special discounts which were obtained in some cases, was $34.47. To this must be added the cost of screening and mixing which is necessarily variable and is estimated by those who have had experience, at from one to two dollars per ton.

If the average cost of the *mixed* materials is placed at $37.00 per ton it will probably fully cover all expense in every case.

On this basis

the average cost of the Home Mixtures has been $37.00, the average valuation $34.47 and the percentage difference 7.3.

Formulas of the Home Mixtures.

3125. Mixture made by S. E. Curtiss, Stratford.

Formula.

3,200	pounds Dissolved Bone Black,	costing	$41.60
600	" Double Sulphate of Potash,	"	9.00
600	" Muriate of Potash,	"	12.75
800	" Nitrate of Soda,	"	20.00
2,800	" Tankage,	"	49.00
8,000			$132.35

3153. Mixture for general use made by N. D. Platt, Milford.

Formula.

1,335	pounds Tankage,	costing	$24.03
1,333	" Dissolved Bone Black,	"	17.32
333	" Bone,	"	5.32
333	" Sulphate of Ammonia,	"	11.98
333	" Double Sulphate of Potash,	"	5.00
333	" Muriate of Potash,	"	7.09
4,000			$70.74

Cost of materials $36.37 per ton delivered at Milford.

3154. Mixture for Potatoes made by Geo. F. Platt, Milford.

Formula.

800	pounds Tankage,	costing	$14.40
400	" Bone,	"	6.40
550	" Dissolved Bone Black,	"	7.15
50	" Sulphate of Ammonia,	"	1.80
100	" Nitrate of Soda,	"	2.50
50	" Double Sulphate of Potash,	"	.75
50	" Muriate of Potash,	"	1.07
2,000			$34.07

Cost of materials $35.07 delivered at Milford.

3155. Mixture for Potatoes made by R. M. Treat, Woodmont.

Formula.

450	pounds Tankage,	costing	$ 8.10
170	" Sulphate of Ammonia,	"	6.12
1,000	" Dissolved Bone Black,	"	13.00
280	" Muriate of Potash,	"	5.96
100	" Double Sulphate of Potash,	"	1.50
2,000			$34.68

Cost of materials $35.68 delivered at Woodmont.

3156. Mixture for Potatoes, made by Dennis Fenn, Milford.

Formula.

350	pounds Muriate of Potash,	costing	$ 7.45
900	" Dissolved Bone Black,	"	11.70
1,400	" Tankage,	"	25.20
350	" Nitrate of Soda,	"	8.80
3,000			$53.15

Materials cost $36.43 delivered at Milford.

3160. Mixture for general use made by W. L. and S. T. Merwin, Milford.

Formula.

700	pounds Muriate of Potash,	costing	$14.91
3,400	" Dissolved Bone Black,	"	44.20
500	" Tankage,	"	9.00
700	" Sulphate of Ammonia,	"	2.52
500	" Bone,	"	8.00
2,200	" Fish containing some potash,	"	24.20
8,000			$102.83

Materials cost $26.43 delivered at Milford.

3188. Mixture for Oats, made by T. J. Stroud, Shaker Station.

FORMULA.

800	pounds	Tankage.
700	"	Castor Pomace.
400	"	Nitrate of Soda.
200	"	Muriate of Potash.
100	"	Dissolved Bone Black.
100	"	Plaster.
2,300		

3189. Mixture for Potatoes, made by T. J. Stroud, Shaker Station.

FORMULA.

700	pounds	Tankage.
500	"	Castor Pomace.
50	"	Nitrate of Soda.
400	"	Muriate of Potash.
250	"	Double Sulphate of Potash.
100	"	Dissolved Bone Black.
100	"	Plaster.
2,100		

3191. Made by Dennis Fenn, Milford. It contains tankage, dissolved bone black, nitrate of soda and ashes. Exact proportions not known.

3205. Mixture made by H. S. Frye, Poquonock.

FORMULA.

4,000	pounds	Cotton Seed Meal,	costing	$49.00
1,200	"	Dissolved Bone Black,	"	15.60
900	"	Double Sulphate of Potash,	"	13.50
300	"	Sulphate of Ammonia,	"	10.80
1,600	"	Tankage,	"	28.80
8,000				$117.70

Materials cost $29.42 per ton delivered at Windsor.

3207. Mixture for Tobacco, made by A. E. Holcomb, Poquonock.

FORMULA.

150	pounds	Sulphate of Ammonia,	costing	$ 5.40
800	"	Tankage,	"	14.40
600	"	Dissolved Bone Black,	"	7.80
450	"	Double Sulphate of Potash,	"	6.75
2,000				$34.35

Materials cost $36.15 per ton delivered at Poquonock.

3226. Mixture for Corn, made by Dennis Fenn, Milford.

FORMULA.

500	pounds	Bone,	costing	$ 8.00
200	"	Muriate of Potash,	"	4.26
600	"	Dissolved Bone Black,	"	7.80
500	"	Tankage,	"	9.00
200	"	Nitrate of Soda,	"	5.00
2,000				$34.06

Materials cost $35.06 per ton delivered at Milford.

3267 and **3268.** Mixtures made by J. M. Brown, Poquonock, formulas not given.

3273. Mixture for Corn, made by T. J. Stroud, Shaker Station.

FORMULA.

800	pounds	Castor Pomace.
900	"	Tankage.
200	"	Muriate of Potash.
100	"	Dissolved Bone Black.
100	"	Nitrate of Soda.
100	"	Plaster.
2,200		

3281. Mixture made by E. J. Wells, East Windsor Hill.

FORMULA.

150	pounds	Sulphate of Ammonia.
700	"	Dissolved Bone Black.
700	"	Tankage.
245	"	High Grade Sulphate of Potash.
1,795		

Materials cost $34.50 delivered at East Windsor Hill.

3282. Mixture made by E. J. Wells, East Windsor Hill.

FORMULA.

262	pounds	Muriate of Potash.
800	"	Dissolved Bone Black.
700	"	Tankage.
266	"	Nitrate of Soda.
2,028		

Materials cost $31.50 per ton delivered at East Windsor Hill.

3283 and **3284.** Mixtures for general use made by H. G. Osborne, East Windsor Hill.

Home Mixed Fertilizers.—Analyses and Valuations.

Station No.	Name.	Nitrogen.					Phosphoric Acid.					Potash.		Chlorine.	Valuation per Ton.	Cost of Raw Material per Ton, Delivered.
		As Nitrates.	As Ammonia.	Organic.	Total Found.	Total Calculated.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Calculated.	Found.	Calculated.			
3125	S. E. Curtiss, Home Mixture	1.75	----	1.85	3.60	*3.9*	6.40	2.32	1.32	10.04	*10.9*	5.84	*5.7*	3.79	$30.48	$34.09
3153	N. D. Platt, Mixture for General Use	----	1.64	2.32	3.96	*3.9*	7.02	3.16	2.34	12.52	*13.9*	6.35	*6.3*	4.05	36.06	36.37
3154	G. F. Platt, Mixture for Potatoes	.74	.60	3.22	4.56	*4.3*	5.39	4.61	5.11	15.11	*17.3*	2.08	*1.9*	.41	34.11	35.07
3155	R. M. Treat, Mixture for Potatoes	----	1.60	1.63	3.23	*3.0*	10.25	1.53	.56	12.34	*12.5*	6.53	*8.4*	6.14	35.77	35.68
3156	Dennis Fenn, Mixture for Potatoes	1.71	----	3.06	4.77	*4.5*	5.79	3.29	2.68	11.76	*13.9*	5.79	*5.9*	5.46	34.91	36.43
3160	W. L. & S. T. Merwin, Home Mixture	----	1.97	1.61	3.58	*3.6*	7.95	1.77	.55	10.27	*10.7*	5.42	*5.1*	5.19	32.76	26.43
3188	T. J. Stroud, Mixture for Oats	2.95	----	3.56	6.51	*6.2*	.86	3.84	2.04	6.74	*7.9*	6.08	*4.7*	----	33.02	----
3189	T. J. Stroud, Mixture for Potatoes	.32	----	3.00	3.32	*3.4*	.83	3.49	1.77	6.09	*7.6*	15.85	*13.1*	9.70	32.38	----
3191	Dennis Fenn, Mixture for Potatoes	.94	----	2.36	3.30	----	1.31	3.51	5.07	9.89	----	6.36	----	.54	26.30	----
3205	H. S. Frye, Home Mixture	----	.74	4.85	5.59	*5.4*	2.40	3.01	2.13	7.54	*7.8*	6.82	*4.0*	2.37	33.84	29.42
3207	A. E. Holcomb, Home Mixture	----	1.06	2.20	3.26	*3.6*	5.81	4.17	2.75	12.73	*13.2*	5.90	*5.6*	----	33.89	36.15
3226	Dennis Fenn, Home Mixture	1.45	----	2.78	4.23	*3.9*	5.60	4.72	4.14	14.46	*15.8*	5.32	*5.2*	4.23	35.32	35.06
3267	J. M. Brown, Home Mixture	----	2.69	2.32	5.01	----	5.66	6.34	2.47	14.47	----	3.10	----	.32	40.03	35.00
3268	J. M. Brown, Home Mixture	----	.34	1.92	2.26	----	4.34	5.53	2.22	12.09	----	17.22	----	.68	42.10	35.00
3273	T. J. Stroud, Mixture for Corn	.97	----	4.35	5.32	*4.9*	.16	5.32	1.88	7.36	*9.2*	5.54	*5.0*	5.21	30.28	----
3281	E. J. Wells, Home Mixture	----	1.55	2.41	3.96	*3.9*	4.16	6.33	4.03	14.52	*13.5*	6.76	*6.8*	.54	38.27	34.50
3282	E. J. Wells, Home Mixture	1.63	----	2.14	3.77	*4.1*	3.57	6.12	4.21	13.90	*12.7*	7.67	*6.7*	6.79	34.84	31.50
3283	H. G Osborne, Home Mixture	----	1.20	1.71	2.91	----	5.02	3.83	1.92	10.77	----	11.01	----	.93	36.15	----
3284	H. G. Osborne, Home Mixture	.99	----	2.28	3.27	----	6.83	3.38	.69	10.90	----	8.70	----	5.19	34.41	----

Miscellaneous Fertilizers and Manures.

Cotton-Hull Ashes.

The analyses of 33 samples of this material are tabulated on page 82.

Samples numbered **3098** and **3104** represent the same stock. The analysis of the first sample being unsatisfactory, showing less potash than was guaranteed, and the amount of ashes represented being very considerable, a second sample, No. **3104**, was drawn by a Station agent which showed a much higher per cent. of potash than the first sample.

By reference to the last column of the tables it is seen that actual potash in these samples has cost from 3.2 cents to 8.9 cents per pound.

The ashes selling for $40.00 per ton, we are informed, are screened ashes, free from the large lumps which the cheaper ashes contain. The analyses show that these ashes selling at the higher price have contained on the average more potash than the "cheaper" ashes and the potash in them has cost less per pound; 4.3 cents on the average as against 4.7 cents.

The highest per cent. of water-soluble potash found in any of these samples is 35.23, the lowest 15.50 and the average percentage 25.41.

Canada Unleached Wood Ashes.

All the analyses of Canada ashes made during the year are tabulated on page 86. The first two analyses, Nos. **3361** and **3379**, were made on samples drawn by a Station agent experienced in the work. The other samples were drawn by dealers or consumers. As the following data show, some of them certainly did not at all represent the goods whose value they were intended to fix, but the analyses are published to emphasize the need of great care in drawing and bottling the samples and of sending us full particulars regarding them.

No. **3361**, sampled by a Station agent, was guaranteed to contain 5½ per cent. potash and 1½ per cent. phosphoric acid. When the dealer was informed of the result of the analysis he promptly remitted to the purchaser a sum sufficient to fully cover the discrepancy between the guaranteed and actual composition. Subsequent investigation by the dealer convinced him that the poor

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.
3097	H. K. Brainard, Thompsonville.	Arthur Sikes, Suffield.	2.45	5.83	1.35	24.70	$33.00	$40.38*	4.0
3098	R. E. Pinney, Suffield.	W. H. Prout, Suffield.	.16	6.81	.19	28.57	40.00	41.98*	5.1
3099	W. W. Cooper, Suffield.	O. C. Rose, W. Suffield.	.64	6 34	1.23	22.30	35.00	35.55*	5.4
3102	J. E. Soper & Co., Boston, Mass.	A. E. Holcomb, Poquonock.	1.60	5.50	2.20	17.44	30.00	30.87*	5.2
3104	R. E. Pinney, Suffield.	Station Agent.	.18	7.49	.22	35.23	40.00	48.15*	4.2
3109	From Texas Oil Mills.	S. L. Smith, Poquonock.	.46	4.36	1.36	21.42	28.00	31.38*	4.7
3111	I. L. Spencer, Suffield.	J. A. Hemenway, Suffield.	.64	7.38	3.26	23.00	32.00	38.69*	4.0
3114	I. L. Spencer, Suffield.	Robert Obram, Thompsonville.	.67	7.47	2.17	22.70	32.00	38.11*	4.1
3121	National Oil Co., Galveston, Texas.	Alfred Spencer, Suffield.	1.02	6.73	1.21	24.64	28.00	39.31	3.2
3123	Unknown.	B. F. Case, Canton Center.	.83	5.48	2.03	21.15	34.00	33.63	5.5
3144	Edward Austin, Suffield.	Frederick Clark, Suffield.	.83	5.93	1.30	26.98	33.00	40.43	4.1
3151	R. A. Parker, Warehouse Point.	Station Agent.	1.92	7.49	.75	31.26	40.00	48.99	4.0
3152	Olds & Whipple, Hartford.	A. H. Clark, Poquonock.	2.94	7.21	.71	30.98	40.00	49.86	3.9
3157	R. E. Pinney, Suffield.	C. H. Wells, Suffield.	1.97	9.44	.94	28.42	40.00	48.95	3.9
3158	Olds & Whipple, Hartford.	L. L. Bedortha, Windsor.	.58	7.35	.35	29.72	40.00	44.78	4.7
3159	Olds & Whipple, Hartford.	L. L. Bedortha, Windsor.	2.37	9.21	1.60	29.00	40.00	50.14	3.7
3161	Olds & Whipple, Hartford.	A. A. Viets, Bloomfield.	1.12	8.40	3.82	16.66	35.00	34.24	5.8
3165	R. E. Pinney, Suffield.	C. H. Wells, Suffield.	1.71	8.71	.52	30.22	40.00	49.26	3.9
3166	R. E. Pinney, Suffield.	C. H. Wells, Suffield.	1.73	8.88	.84	28.82	40.00	48.13	4.1
3168	James Van Gelder, W. Suffield.	F. C. Root, Suffield.	.69	7.26	1.52	22.55	----	37.40	--
3201	R. E. Pinney, Suffield.	D. L. Brockett, Suffield.	2.91	7.01	2.72	27.34	----	46.33	--
3203	F. W. Muck, Agent.	H. S. Frye, Poquonock.	1.92	5.64	1.11	8.56	----	21.39	--
3204	F. W. Muck, Agent.	H. S. Frye, Poquonock.	.06	6.12	.57	29.10	----	41.50	--
3210	R. E. Pinney, Suffield.	H. H. Austin, Suffield.	1.47	7.46	.64	30.40	40.00	47.24	4.3
3211	R. E. Pinney, Suffield.	H. H. Austin, Suffield.	1.82	8.93	1.06	27.17	40.00	46.62	4.2
3225	T. Soule & Co., New Milford.	E. A. Wildman, New Milford.	1.04	6.23	2.26	25.12	35.00	39.53	4.6
3249	Edwin Copley, W. Suffield, bought of W. F. Fletcher, Southwick, Mass.	F. C. Root, Suffield.	.38	6.89	2.04	18.99	35.00	32.65	6.1
3250	H. N. Loomis, W. Suffield.	F. C. Root, Suffield.	2.45	7.05	2.10	27.58	40.00	45.68	4.5
3252	F. W. Rising, W. Suffield.	F. C. Root, Suffield.	1.79	8.11	2.38	26.18	40.00	44.78	4 6
3270	F. W. Culver, W. Suffield.	F. C. Root, Suffield.	1.07	8.65	2.15	24.72	40.00	42.74	4 9
3294	H. M. Rose, W. Suffield.	F. C. Root, Suffield.	2.00	8.25	2.75	25.98	40.00	45.26	4.5
3295	C. L. Austin, W. Suffield.	F. C. Root, Suffield.	2.30	7.03	2.38	26.48	40.00	44.31	4.7
3364	H. K. Brainard, Thompsonville, from American Oil Co.	R. C. Gaines, Thompsonville.	trace.	3.30	1.13	15.50	33.00	22.45	8.9

quality of the ashes was due to their being put in hired storage, before shipment, which storage did not fully protect them from wetting.

The two samples, **3362** and **3378**, are instructive, as it is alleged that both were taken from the same lot. No. **3362** was sent with a letter from which it was fairly inferred that a number of purchasers had joined in a purchase and in drawing and sending the sample. After the analysis was reported and inquiry made the purchaser wrote, "It was drawn by the dealer and some other gentlemen who assured me that it was a fair sample of the cargo [boat load]. I did not see the drawing. I have ten tons of the same ashes and will very carefully take a sample."

Regarding the second sample, **3378**, he writes, "I send you a carefully drawn sample of those ashes. I got it by digging three holes in different sides of the pile not too near the bottom and taking out of each and mixing thoroughly together." The second sample was taken sometime after the first one. In the meantime the ashes had lain in a pile on the ground but the purchaser thinks had not been rained on.

It will be seen that the first sample drawn by the dealer contained 11.14 per cent. of water-soluble potash. The second sample, drawn by the purchaser, contained 5.01 per cent. of potash, less than half as much.

The purchaser of the sample **3360**, wrote when sending it, "The car load was purchased by me from Canada, price $12.00 per ton delivered here. I think them very fine if they show up as well as they look." Later, after the analysis was made, he wrote replying to inquiry: "I had ordered a car of ashes from Canada and requested the dealer to send me a sample of them by mail when loaded. I used what I wished to" (of the sample) "then sent them to you. On receiving your report I wrote to the seller who states that he was not there when the car was loaded and he thinks *his man sent me that sample from another lot* of ashes made entirely from elm wood!"

It should not need to be said that a sample drawn at random by the hired man of a dealer in Canada has little worth in fixing the value of a car load of ashes delivered here in Connecticut.

When the car load arrived the purchaser drew a sample himself and sent it to the Station properly authenticated. This is No. **3368** in the table. The sample drawn in Canada by the dealer's "man" showed 14.49 per cent. of potash, the one drawn from the goods delivered showed 4.10 per cent.—less than one-third as much.

Samples **3367** and **3384**, representing a lot originally consisting of $15\frac{1}{2}$ tons, were sent from Darien, Ct. The analysis of **3367** was so unsatisfactory to the seller living in Ontario, Canada—he having guaranteed 5 per cent. or over of potash—that he desired another analysis from a fresh sample. This is stated to have been drawn from the remaining ashes in the manner requested by him, from the center of the parcel. A noticeable difference between the two samples is the 8.4 per cent. less moisture contained in the latter. **3367** was sent to the Station, Sept. 10th, and **3384** Oct. 16th. Both were sent in small paper boxes and loss or gain of moisture may have easily occurred.

When the analyses are recalculated, after deducting the variable moisture, we have in the *dry ashes* the following percentages:

	3367.	3384.
Potash, soluble in water	3.54	4.03
Phosphoric acid	1.18	1.55
Carbonate of lime	73.98	77.66
Sand and silica	9.06	10.34

A more complete analysis of **3384** serves to show the amounts of the other ingredients in these ashes.

Potash, soluble in water	4.00
Soda, " "	.50
Lime, soluble in hydrochloric acid	42.74
Magnesia " " "	4.03
Sulphuric acid, soluble in hydrochloric acid	.82
Phosphoric acid, " " "	1.53
Carbonic acid	24.49
Sand and silica, insoluble in acid	10.17
Charcoal	2.09
Moisture	1.73
Alumina, oxides of iron, and manganese, and undetermined matters of no fertilizing value	7.90
	100.00

In view of the experience of the past season, the Station declines to analyze, at public expense, any samples of wood or cotton hull ashes which are not drawn in accordance with its directions and *fully* described on a blank form which will be sent to any one in the State on application.

Substitutes for Unleached Ashes.

Very considerable quantities of ashes are annually brought into the State from Canada. There is no way of learning the total quantity, but we are informed that in Westport, Southport and near-lying towns alone about 800 tons have been sold the last season. In view of the fact that the quality of the "Canada ashes" sold in Connecticut has deteriorated of late it is worth considering whether a substitute as serviceable and considerably cheaper may not be found. A ton of unleached Canada ashes of good quality contains:

Sand, earth and coal	260	pounds.
Water	240	"
Oxide of iron, alumina, carbonate of soda, etc.	131	"
Actual potash	110	"
Phosphoric acid	39	"
Carbonate with some hydrate of lime and magnesia	1220	"
	2000	

The agricultural value of ashes consists largely in the finely divided carbonate of lime which they contain, which is of great account in many cases as an amendment and in promoting the processes of decay and nitrification within the soil.

It is safe to say that the carbonates and phosphates of potash, magnesia and lime constitute the entire agricultural value of ashes. Can we then provide 110 pounds of potash, 39 of phosphoric acid and 1220 of carbonate of lime in fine condition in some other form cheaper than ashes?

An application in the late fall of 20 bushels of burned oyster shell lime (40 pounds to the bushel), at 12 cents per bushel would supply as much lime as a ton of ashes at a cost $2.40, 500 pounds of cotton hull ashes in addition would cost $8.75 and supply as much or more potash than a ton of Canada ashes and very considerably more phosphoric acid. The weight of these two things would be 1300 pounds as against 2000 pounds of Canada ashes which involves a saving in cartage—the cost $11.15, a little less than Canada ashes cost on the average.

The comparison is here made with ashes of excellent quality. With ashes of lower grade which are more common in our markets to-day, the showing for the substitute would be much more favorable.

Or if cotton hull ashes are not available, for them may be used 220 pounds of high grade sulphate of potash and 150 pounds of

ANALYSES OF UNLEACHED CANADA ASHES.

	3361	3362	3378	3360	3368	3385	3396	3397	3380	3395	3379	3367	3384
Potash, soluble in water	2.92	11.14	5.01	14.49	4.10	3.93	4.74	4.42	7.17	8.75	4.65	3.19	4.00
Phosphoric acid	1.28	1.27	1.50	1.13	1.44	1.22	1.42	1.34	1.34	.96	1.48	1.06	1.53
Carbonate of lime*	56.40	....	50.60	63.20	57.50	46.90	53.60	45.80	56.10	59.60	57.20	66.50	76.32
Sand and silica	13.97	6.39	12.83	6.08	10.80	24.20	20.24	27.08	14.75	19.33	10.65	8.15	10.17
Water, expelled at 212°	15.92	....	17.80	9.00	16.00	11.40	4.45	7.35	6.42	3.45	15.05	10.12	1.73
Cost per ton	$12.00	10.00	10.00	12.00	12.00	10.50	12.00	10.50	12.00	15.00			

* Equivalent to the total calcium oxide (CaO) found soluble in hydrochloric acid.

some cheap steamed bone like Peter Cooper's Bone, and 800 pounds of oyster shell lime, the three costing $11.10.

The above named mixtures would be close imitations of superior wood ashes not only as respects the kinds and proportions of fertilizing elements, but also as to the forms or combinations of those elements. Still cheaper and in most cases probably no less effective, would be a mixture of 800 pounds (20 bushels) of burned oyster shell lime with 150 pounds of Peter Cooper's Bone and 220 pounds of muriate of potash—the total weighing 1170 pounds and costing $9.45.

The oyster shell lime being caustic should be put on in the late fall or early spring and being fine and pulverulent it will soon be converted into carbonate.

Stone lime could be used instead of oyster shell lime but being in hard lumps would require slacking before being sown. The sulphate or muriate of potash and bone are best applied in spring.

It is hoped that our farmers may make thorough trial of these substitutes which are considerably cheaper than the average of Canada ashes, quality as well as price being taken account of.

ASHES FROM HOUSEHOLD FIRES IN CONNECTICUT AND FROM FACTORIES.

3399. Sample of ashes gathered from house to house in Torrington.

3400. Sample of ashes gathered from a single house. Both of the above sent by H. Von Tobel, Harwinton.

3402. Ashes from The Coe Co. Brass Works, Torrington. Sampled and sent by the Echo Farm Co.

ANALYSES.

	3399	3400	3402
Potash	5.53	4.11	2.83
Phosphoric acid	3.18	4.00	2.18
Cost per bushel	18 cents.		12 cents.

LIME KILN ASHES.

3398. Sent by D. C. Spencer, Saybrook.

3403 and **3404** sent by S. A. Eddy, Canaan, from the Canaan Lime Co.; **3403** was from a pile which had been exposed to the weather for some time; **3404** was from a pile on which fresh ashes were being dumped.

ANALYSES.

	3398	3403	3404
Potash	.33	.44	.41
Phosphoric acid	.10	----	----
Lime	62.05	26.87	30.66
Insoluble in acid	----	2.41	1.54
Moisture	----	29.54	18.16

These "ashes" contain about a tenth of one per cent. of phosphoric acid and less than a half of one per cent. of potash. They will be useful as a cheap form of lime for "liming" land where that is desirable.

RAG DUST.

3374. A sample of the dust from Egyptian rags, which is one of the wastes from the Windsor Locks paper mill, was sent to the Station by R. E. Pinney, Suffield. It contains .96 per cent. of ammonia and only traces of phosphoric acid, but is said to have greatly increased the crops on land to which it was applied very liberally. Its action on the soil must be largely mechanical.

HEN MANURE.

3145. A sample of "fresh hen manure" from stock of E. M. Spalding, Suffield. Sampled by J. S. Gardner, Suffield.

ANALYSIS.

Moisture	34.87
Organic and volatile matter	20.28
Ash	44.85
	100.00
The organic matter contains: Nitrogen	.56
The ash contains: Sand and earth	9.41
Phosphoric acid	.35
Potash	.36

BEEF SCRAP.

3146. Sampled and sent by E. N. Spalding, Suffield. This consisted of lumps of dried meat and raw bones. It contained 7.44 per cent. of nitrogen and 5.14 per cent. of phosphoric acid. It also contained 11.07 per cent. of moisture and 23.14 per cent. of grease.

The material could probably be best used in the compost heap. At the price charged, $1.75 per hundred or $35.00 per ton, it would be poor economy to buy it for a fertilizer.

MUCK.

3223. A sample sent by G. H. Bartlett of North Guilford, who writes regarding it: "The sample is from a swamp of twenty-five acres. Bottom is a very hard gravel—looks like drift. Thickness of muck 5 to 10 feet. This sample came from where it was five feet deep. The first two feet were rejected because contaminated with leaves, sticks, etc. The sample therefore represents the layer between the second and fifth foot."

ANALYSIS.

	As received.	Water-free.
Water	87.22	----
Organic and volatile matters	11.66	91.23
Ash	1.12	8.77
	100.00	100.00
Nitrogen	.31	2.45
Phosphoric acid	.017	.13

Over nine-tenths of this material is vegetable matter. It has much less sand and earth mixed with it than most of the samples which we have examined.

The nitrogen of muck or peat is usually in a very inert condition, but as an amendment peat is very valuable on some soils.

REVIEW OF THE FERTILIZER MARKET.

For the Twelve Months ending December 31, 1891.

Nitrogen.

Nitric Nitrogen.

The *wholesale* quotation of nitrogen in nitrates has fluctuated greatly during the last year on account of the political disturbances in Chili. The agreement of the producers to limit the output of nitrate of soda, so as to maintain prices was suspended by the seizure of the mines by the Congressional party who sold all the nitrate possible to obtain means for carrying on the war with Balmaceda. The Balmaceda government however, began proceedings to exact an export duty in this country, on nitrate which had already paid a duty to the Congressional party. Finally when the Balmaceda party collapsed, the original agreement as to limiting the output is stated to have been put in force again.

The nitrogen of nitrate of soda cost in New York at *wholesale* in January, 1891, 10.9 cents per pound. It rose rapidly till April when it cost 14.4 cents, fell again to 11.3 cents in August and then rose to 13.6 in October, and was quoted at 13.3 in December.

The average wholesale cost for the year 1890 was 11.5 cents per pound; for the year 1891, 12.9 cents per pound.

The *retail* price of nitrogen in nitrate of soda in this State during the last season has been about 15.7 cents per pound. See page 27.

Ammonic Nitrogen.

The *wholesale* price of nitrogen in sulphate of ammonia has fallen somewhat during the year. It was 16.5 cents per pound in January, 1891, began falling in May to 16 cents, in October to 14.7 cents, at which price it was quoted till the end of the year.

The average wholesale price of nitrogen in this form in 1890 was 16 cents per pound, in 1891, 15.6 cents.

The *retail* price of nitrogen in sulphate of ammonia in this State during the last season was about 17½ cents per pound. See page 28.

Organic Nitrogen.

The wholesale price of nitrogen in Dried Blood has been somewhat higher in 1891 than 1890. It has fluctuated between 11.0 cents per pound in January and 12.6 cents in November, while the average price for the year for nitrogen in red blood has been 12.3 cents per pound; for nitrogen in black blood 11.7 cents. In 1890 these average prices were 11.8 cents per pound in red blood and 11.3 cents in black blood.

Nitrogen in Azotin has been quoted through the year at 11.5 cents per pound at *wholesale*, this being somewhat lower than the average for the previous year.

Dried Fish Scrap which is considerably used in mixed fertilizers has risen in price during the year from $19.25 per ton in January to $19.75 in April, $20 in June, $21 in July, $21.35 in August, $21.75 in September, and $23.75 in December.

Acidulated Fish has also risen from $9.50 per ton in January, 1891, to $13.25 in November and December.

As has been shown by the analyses and quotations given on previous pages, Organic Nitrogen has *retailed* this year in Connecticut at the following prices:

In Castor Pomace----- 13.9 to 15.7 cents per pound—see page 29.
In Cotton Seed Meal-- 13.4 to 15.3 cents per pound—see page 29.

Dried Blood is not sold in any quantity in the State at retail, organic nitrogen being purchased either in cotton seed meal, castor pomace, bone or tankage.

Phosphatic Materials.

Refuse Bone Black has remained steady through the year at $18.50 per ton.

Rough Bone and Ground Bone have been steady at $21.50 and $26.50 respectively.

Bone Meal, quoted at $22.75 in April has risen to $23.25.

Ground Charleston Rock, quoted at $9.75 till June has been quoted since then at $9.25 per ton.

Acid Phosphate, 14 per cent. available, has been quoted throughout the year at 73¾c. per unit which is equivalent to 3.7 cents per pound for available phosphoric acid.

The *retail* price of available phosphoric acid in dissolved bone black, which is the only form of plain superphosphate in our market at present has been about 8 cents per pound in Connecticut. See page 31.

POTASH.

Muriate of Potash.

The *wholesale* price of actual potash in this form has advanced during the year from 3.58 to 3.68 cents per pound.

Actual potash in this form has been sold at *retail* in Connecticut the past year for 4.2 cents per pound. See page 32.

Double Sulphate of Potash and Magnesia.

The *wholesale* quotation has remained constant through the year at 4.53 cents per pound for actual potash till December, when it was quoted at 4.63 cents.

Potash in this form has cost at *retail* in Connecticut from 5.6 to 5.9 cents per pound. See page 32.

High Grade Sulphate of Potash.

This material contains about the same per cent. of potash as the muriate but is entirely free from chlorides.

The *wholesale* quotations have made actual potash cost 4.33 cents per pound during the whole year till December when it rose to 4.41 cents.

It has not, to our knowledge, been retailed in Connecticut this year.

Kainit.

Kainit has sold at *wholesale* from $8.75 to $10.00 per ton during the year, the average price being $9.25, at which price the actual potash of kainit would cost about 3.8 cents per pound *wholesale.*

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 16.0 per cent. of nitrogen.

If quoted at	3.0	cents per lb.	Nitrogen	costs	18.8	cents	per lb.
"	2.9	"	"	"	18.2		"
"	2.8	"	"	"	17.5		"
"	2.7	"	"	"	16.9		"
"	2.6	"	"	"	16.2		"
"	2.5	"	"	"	15.6		"
"	2.4	"	"	"	15.0		"
"	2.3	"	"	"	14.4		"
"	2.2	"	"	"	13.8		"
"	2.1	"	"	"	13.2		"
"	2.0	"	"	"	12.5		"
"	1.9	"	"	"	11.9		"
"	1.8	"	"	"	11.3		"
"	1.7	"	"	"	10.6		"

Commercial Muriate of Potash and also High Grade, 98 per cent., Sulphate of Potash usually contains $50\frac{1}{2}$ 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 $26\frac{1}{2}$ per cent. of actual potash.

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

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since January, 1889. The price given for each month is 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 $50\frac{1}{2}$ per cent. of actual potash or 80 per cent. of the pure salt.

WHOLESALE PRICES OF FERTILIZING MATERIALS.

		Dried Blood.		Cost of Nitrogen at wholesale in			Cost of Potash at wholesale in			
		Red. Cents per pound.	Black or low grade. 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.
1889.	January	16.5	16.1	16.6	15.1	16.6	3.66	4 63	5.00	4.30
	February	16.6	16.2	17.0	15.0	16.6	3.66	4.44	5.01	4.37
	March	16.6	16.2	17.1	15.2	16.6	3.66	4.48	4.88	4.20
	April	16.0	16.0	16.1	14.6	16.2	3.57	4.44	4.85	4.10
	May	15.2	14.9	15.2	13.8	15.7	3.64	4.49	4.65	4.06
	June	15.0	14.6	14.6	12.8	15.2	3.64	4.53	4.60	4.06
	July	14.8	14.3	14.2	12.5	15.1	3.64	4.53	4.56	4.06
	August	14.3	13.8	14.2	11.9	15.0	3.64	4.53	4.56	4 06
	September	14.0	13.7	14.2	12.1	15.0	3.64	4.44	4.66	4.06
	October	13.8	13.2	13.7	12.2	15.0	3.64	4.44	4.67	4.06
	November	13.6	12.9	13.6	12.3	15.4	3.64	4.44	4.75	4.06
	December	12.6	12.2	13.3	12.4	15,4	3.64	4.44	4.98	4.06
1890.	January	12.4	11.9	12.7	12.1	15.4	3.64	4.44	4.97	4.06
	February	12.4	11.8	12.5	12.0	15.4	3.64	4.44	4.97	4.06
	March	12.1	11.8	12.2	11.9	15.4	3.64	4.44	4.89	4.06
	April	12.0	11.7	12.2	11.2	15.4	3.64	4.42	4.77	4.06
	May	11.9	11.3	12.2	11.2	15.3	3.62	4.42	4.77	4.05
	June	11.9	11.4	12.1	11.2	15.8	3.62	4.42	4.77	4.00
	July	11.9	11.4	12.0	11.2	16.6	3.62	4.42	4.77	3.69
	August	11.6	11.0	11.5	11.0	16.6	3.62	4.42	4.77	3.69
	September	11.3	10.7	11.3	11.1	16.6	3.62	4.42	4.77	3.69
	October	11.4	10.8	11.7	11.6	16.5	3.62	4.42	4.17	3.69
	November	11.5	10.9	11.4	11.6	16.5	3.55	4.27	4.06	3.69
	December	11.5	10.9	11.4	11.6	16.5	3.62	4.53	4.31	3.69
1891.	January	11.0	10.5	11.5	10.9	16.5	3.58	4.53	4.33	3.69
	February	12.0	11.0	11.5	12.5	16.5	3.58	4.53	4.33	8 69
	March	12.5	11.9	11.5	14.3	16.5	3.68	4.53	4.33	3.69
	April	12.4	12.0	11.5	14.4	16.5	3.68	4.53	4.33	3.69
	May	12.3	11.7	11.5	13.6	16.0	3.68	4.53	4.33	3.69
	June	12.3	11.7	11.5	13.2	15.5	3.68	4.53	4.33	3.69
	July	12.2	11.6	11.5	12.2	15.4	3.68	4.53	4.33	3.69
	August	12.3	11.8	11.5	11.3	15.4	3.68	4.53	4.33	3.69
	September	12.3	12.0	11.5	12.2	14.8	3.68	4.53	4.33	3.69
	October	12.3	12.0	11.5	13.6	14.7	3.68	4.53	4.33	3.69
	November	12.6	12.3	11.5	13.5	14.7	3.68	4.53	4.23	3.69
	December	12.4	12.1	11.5	13.3	14.7	3.63	4.63	4.41	3.69

OBSERVATIONS ON A HERD OF MILK COWS.

The work below described is not a rigidly conducted experiment, but rather a somewhat careful observation carried on for about five months, of the rations fed, milk produced, difference in the yield of individual cows, etc., in a herd kept on a large and well-managed farm near New Haven. The object was to gather data of general interest to milk producers, which might also suggest future experiments or methods of producing milk at less cost. All the observations, determinations of fat and calculations here cited are made without the help of laboratory appliances and can be made as well by any practical feeder who has the publications of the Station at command.

At the farm referred to is a herd of about sixty milk cows. The milk produced is sold in New Haven, partly at wholesale to hotels and restaurants, partly at retail to families on two milk routes.

The herd is wholly of "natives." There were at the time no cows in the herd which even approached pure breed as far as could be learned.

It has been the practice to buy in cows from any source as needed, and turn them off to the butcher when they were judged to be unprofitable milkers.

This herd was well housed. The temperature of the stables during the winter never went below 37° and only on one day below 40°. On one day it rose to 64°, but except on that one day never rose over 58°.

The cows had fresh running water always before them in their stalls, having an average temperature of about 33°.

They were turned out to exercise for half an hour daily, except in stormy weather.

The following observations were made on the cows standing in one section of the stable, nineteen in number, and representing, as far as could be judged, the average of the herd.

It was not possible to learn how long each cow had been in milk or the average time of the herd since calving. A record is kept of the date when each cow is due to calve, but the record of dates of last calving was not in such shape that it could be fully depended on, and some of the cows were not with calf till some months after the time of last calving.

An extreme instance is No. 9, which was served every month, from September to March, and so went without calf for six months.

About half the herd was due the following September and one-third of the herd in August.

Judging from all the data at hand, it is likely that the herd on the average was about two or three months in milk at the beginning and six or seven months in milk at the end of the test. No cow calved or dried off during the time of the observation.

The time of milking was very regularly kept at five o'clock, both morning and afternoon, and the cows were milked daily in nearly the same order, so the milkings of each cow were at very regular intervals of twelve hours.

The milk of each of the nineteen cows was accurately weighed by Mr. A. W. Ogden, chemist of this Station, morning and evening and a sample taken, in which the butter fat was regularly determined and the other ingredients in some cases.

This was done from late in November till early in April, with such omissions as pressure of other work and accidents made unavoidable. The weights were recorded on 92 days out of 133.

A record was also kept of the kind and quantity of feed used through the winter.

From the records of these observations the following statements are compiled :

I. Average Yield per Day and Head of Milk and Fat, and Per Cent. of Fat.

By Months.

Herd of Nineteen Cows.

	Pounds of Milk.	Equivalent Quarts of Milk.	Ounces of Butter Fat.	Per cent. of Fat in the Milk.
In November	19 lbs. 8 oz.	9.1	13.2	4.24
December	19 " 13 "	9.2	13.4	4.22
January	22 " 12 "	10.6	13.9	3.80
February	21 " 15 "	10.2	13.1	3.73
March	21 " 2 "	9.8	13.7	4.08
April	19 " 2 "	8.9	13.0	4.23
Average of the months Dec., Jan., Feb., March	**21 " 6 "**	**9.95**	**13.5**	**3.95**

Observations were made on the last seven days only of November and the first nine days of April, so that these two months are excluded in the average statement.

It appears that in four months out of the six, the per cent. of butter fat was above 4.0, but in February it fell to 3.7. The cause of the somewhat sudden decrease of fat in February in connection with its rise again in March does not appear.

The average yield of fat per day and cow, 13½ ounces, if separated as perfectly as possible by the centrifugal and churned with only a usual loss of fat in the butter-milk, would give less than a pound of butter per day. But the most important feature with a herd whose milk is sold to consumers is the yield of milk.

About ten quarts per day and head is the average for this herd, during the time when the cows were between three months and seven months in milk.

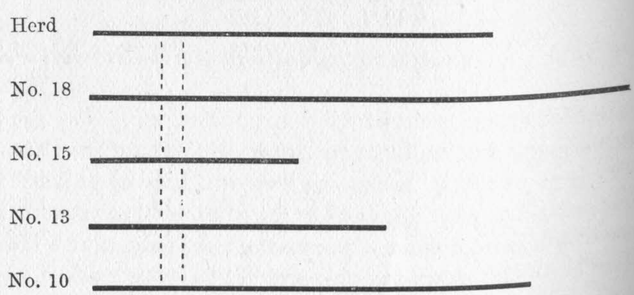
The next table shows the average yield of the whole herd of nineteen cows for the *six* months, and in comparison the yield of some individual cows in the herd.

II. Average Yields per Day and Head of Milk and of Butter-fat from Individual Cows for Six Months.

	Whole Herd.	No. 18. Giving the most milk.	No. 15. Giving the least milk.	Two Cows about equally old in milk. No. 13.	No. 10.
Quarts of Milk	9.6	13.1	4.8	7.0	10.4
Ounces of Fat	13.4	19.4	10.0	10.9	14.8
Per cent. of Fat	4.05	4.35	6.03	4.54	4.13

The comparative yields of milk are represented by the lengths of the lines below.

Comparative Yield of Milk.



The herd as has been said, was about two months in milk at the beginning of the test.

No. 18, the best milker, slipped her calf at seven months just as the test began and was in full milk during the whole of the test. She gave per day three and a half quarts more milk than the average of the herd, and three-eighths of a pound more of butter-fat; her milk contained three-tenths per cent. more of fat than that of the herd.

No. 15 was due to calve early in July and did not calve later than August, 1890. She was probably older in milk than the most of the herd. She gave only half as much milk as the average cow in the herd, four and four-fifths quarts per day, nearly three and a half ounces less of fat, but the per cent. of fat was very high, 6.03. Of course a comparison between two cows, one of which is near the beginning of lactation and the other near the end, is unfair, though so great a difference as there is between the yield of No. 18 and No. 15 cannot be explained in this case by the period of lactation.

The last two columns of the table show the yields of two cows which are comparable in respect to being about equally old in milk. No. 10, the larger milker of the two calved in May, 1890, two months earlier than No. 13, and both were due to calve August, 1891.

Here are two cows, costing the same for feeding and care, the better of the two is two months older in milk than the poorer and while the one gives 10.4 quarts a day for the six months, the other gives only 7 quarts, a difference of 3.4 quarts per day, or for the six months, of 615.4 quarts or more than $40 worth of milk.

Roughly figured the difference in the yield of fat would make a difference of 50 pounds of butter in the six months.

III. The Feed of the Cows.

Total quantity of feed eaten.

The ration was changed somewhat several times during the observations, partly to make it cheaper without making it less nutritious and partly because of the difficulty of getting a full supply of brewers' grains. No marked or sudden change in the yield of milk or butter-fat was noticed in consequence of these changes. During four months—121 days,—(and at the same rate during the whole period of observation) the herd consumed *per head*:

	In 4 Months.	Per Day.
Hay	1240 pounds.	10¼ pounds.
Stover or corn-stalks	1283 "	10⅝ "
Turnips	302 "	2½ quarts.
Brewers' grains	1578 "	13 pounds.
Corn meal	21 "	0.17 "
Bran	70 "	0.57 "
Corn and cob meal	273 "	2.2 "
Sugar feed	228 "	1.9 "

The second column represents the *average* ration per day. No cow on any one day received all of the feeds named. The ration was changed several times as already said, and the second column is obtained by dividing the total quantity of food eaten by each cow in four months by the total number of days, viz: 121.

Gross Cost of the Feed.

To determine this with accuracy is impossible. The cost of production on any farm varies from year to year with the season, efficiency of farm help and superintendence, etc., and in any case many of the factors in the cost cannot be ascertained with accuracy. But the following figures have been assumed with the belief that so far as they relate to feed raised on the farm they will fully cover actual cost of production, and are too high rather than low. In calculating the cost of producing milk, of course the feed raised at home should be put into the account, not at its selling price, but at cost of production.

Hay is valued at $10.00 per ton, corn-stalks at $3.00, turnips at 15 cents per bushel, corn-meal at $19.00 per ton, corn and cob meal at $17.00.

Of the boughten feed bran cost $25.00, sugar feed $23.50, and brewers' grains 10 cents per bushel of 60 pounds.

Reckoned on this basis the *gross* cost of the feed *per head* for 121 days was $18.21.

Manurial Value and Net Cost of the Feed.

The *net* cost of the feed will be found by deducting from the gross cost the manure value of the feed.

Basing calculation on the average composition of the feed used the quantities of nitrogen, phosphoric acid and potash fed to each cow during the four months will be as given in the table below.

In this time the cows gave on the average 2,586 pounds or 1,202 quarts of milk.

The quantities of nitrogen, phosphoric acid and potash contained in this milk, supposing it to be of average quality, are also given in the table. It will be seen that nearly a third of both the nitrogen and phosphoric acid of the feed may go in the milk.

The third column of the table gives the quantity of the three ingredients which are to be credited to the manure account, and the last column their valuation. In this calculation phosphoric acid and potash are valued as in commercial fertilizers at 7 and 4½ cents per pound respectively, but nitrogen is valued at only 8 cents per pound. This is done in order to be on the safe side, and in view of the losses of nitrogen from the manure pile both by its escape as nitrogen gas, and in the leaching and drainage, and also in view of the more inert condition of the nitrogen of manure as compared with that of the high grade nitrogenous fertilizers like nitrate of soda, sulphate of ammonia, dried blood, cotton-seed meal, etc.

Pounds of Nitrogen, Phosphoric Acid and Potash in the Feed, Milk and Manure of one Cow in Four Months.

	In the Feed.	In the Milk.	In the Manure.	Valuation of that in the Manure.
Nitrogen	46.6	15.5	31.1	$2.49
Phosphoric acid	18.3	5.8	12.5	.88
Potash	38.8	3.3	35.5	1.60
				$4.97

Deducting this from the gross cost of the feed, $18.21 there remains $13.24, which may be called the net cost of the feed of one cow for four months, or 121 days. For a single day then, on the average, a single cow's feed costs 15.05 cents gross or 10.94 cents net.

If milk is selling at 7 cents a quart, 2.15 quarts of each cow's milk must go to pay the gross cost of her feed or 1.56 quarts to pay the net cost of it.

Applying these figures to those given on page 98 under II, it appears that on the average, 16 per cent. of the milk of the herd was needed to cover the net cost of their feed. Less than 12 per cent. of her milk paid for the feed of the best milker, while 32½ per cent., nearly one-third, of the milk of the smallest milker was needed to cover the cost of her feed.

This proportion is also shown by the dotted transverse lines in the diagram on page 98. The space to the left of the lines represents the part of the total yield of milk which was needed to cover the gross and net cost of the feed.

The Digestible Matter of the Feed.

As has been already said the ration was changed a number of times. But if the total quantity of feed of all kinds used in the four months had been evenly divided per day and head, it would have given a ration like that which follows. Assuming 875 pounds as the average weight of a cow, this digestible matter is calculated to 1000 pounds live weight in order to compare it with the "standard."

By the aid of the published tables of the average composition and digestibility of feeds it is possible to calculate, somewhat roughly, the quantity of digestible food, i. e. of actual nutriment that each cow daily received in this ration. The results of this calculation are as follows:

DIGESTIBLE MATTER IN THE RATION PER DAY AND HEAD.

	Dry Organic Matter.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
Hay, 10½ pounds contain	8.13	.37	1.78	2.61	.10
Stover, 10⅗* pounds contain	6.39	.27	1.26	2.24	.06
Turnips, 4.7 pounds contain	.41	.03	----	.28	---
Brewer's Grains, 13.0 lbs. contain	2.85	.54	.17	.96	.14
Corn Meal, .2 pounds contain	.15	.01	----	.11	.01
Bran, .6 pounds contain	.49	.07	.02	.25	.02
Corn and Cob Meal, 2.2 lbs. cont'n	1.84	.15	.09	1.30	.07
Sugar Feed, 1.9 pounds contain	1.66	.33	.06	.88	.15
	21.92	1.77	3.38	8.63	.55

	Organic Matter.	Albuminoids.	"Carbohydrates." Fiber and Nitrogen-free Extract.	Fat.
Per 1000 pounds live weight	25.04	2.02	13.72	.63
"Standard"	**24.0**	**2.5**	**12.5**	**.4**

The terms here employed scarcely need explanation to our stock feeders. A somewhat extended discussion of their meaning and use will be found on pages 89–111 of the Station Report for 1886.

* The digestible matter is reckoned on nine pounds of stalks, as it was found by trial that the cows left 1⅗ pounds uneaten, and that the uneaten portion had approximately the same composition as the rest.

It should be specially noted in this connection that the albuminoids, sometimes called "flesh-formers," are essential to the growth of all the tissues of the body, and therefore are particularly concerned in the production of milk, which is not a mere secretion, but rather a liquefied tissue; and if albuminoids are deficient in the food one of two things must happen: either the milk yield will shrink or the animal will consume other tissues, i. e. its own flesh and blood to produce it. The albuminoids also, rather than the fat or the starch of the feed, are most largely concerned in the production of the butter fat of milk.

The food-ingredients of each feed consists of two parts, the digestible portion which alone is real nutriment and the ballast or waste portion which goes directly through the animal into the dung and does not nourish the body at all. The proportion of these two parts in different feeds varies greatly.

For instance only about 56 per cent. of the albuminoids of good meadow hay is digestible, but 87 per cent. of that of linseed meal is digestible.

For these reasons in comparing feeds we need to calculate, not the total quantity of the albuminoids, but the quantity which is digestible and actually useful to the animals.

The "standard" represents about what a cow weighing one thousand pounds needs per day of the several food ingredients, to keep her body from waste and maintain a full flow of milk.

The standard itself is the result of a number of very accurately made tests, in each of which the weight of the animal was determined as well as the daily weight and composition of the feed, the excrement and the milk.

In comparing the average ration of the herd with the standard it appears that the cows have had an abundance of food, 25 pounds per day of organic matter as against 24 of the standard, but it also appears that while they have had 1.2 pounds more "carbohydrates" (starch, sugar, fiber, etc.), and one-fifth of a pound more fat than the standard requires, there has been half a pound less per day of the albuminoids, or "flesh-formers;" only four-fifths of the quantity required by the standard.

Of course the feeding standard is a general statement, represents an average and is not to be too literally taken. It is only a general guide, but the above comparison suggests the inquiry whether the ration fed was not seriously deficient in albuminoids and wasteful of the "carbohydrates."

NOTES ON THE ABOVE OBSERVATIONS.

1. *Ventilation.*—During these observations there was on certain days a sudden and large shrinkage in the quantity of milk; in one extreme case the loss amounted to over 15 quarts in a day from 19 cows. There was no irregularity in the time of milking or in the temperature of the stables, and no reason could be discovered for the shrinkage, except the fact that a brisk cold wind was followed the next day by warm still air. While this made no particular difference in the temperature of the stable it made a very noticeable difference in the quality of the air. The stable became close with a strong odor and at the same time the milk fell off greatly, but increased again when conditions changed.

While connection between milk yield and ventilation could not be proved in these cases it appeared highly probable. Pure air is as essential as warm air and where the herd is large and housed with great economy of space it is harder to secure under all conditions of weather.

2. *Yield of Milk and Fat from the Herd and from Individual Cows.*—It is believed that this herd was better fed, housed and tended than the general average of Connecticut herds of native stock, that the stock was as good as the average, and their yield of milk fully as good and probably above the average.

It was not far from ten quarts per day and head for the winter months.

No one wishes to be content with average efficiency but aims to secure the highest yield possible.

How then can the efficiency of the herd be increased?

Looking first at the cows themselves it appears that certain ones gave 3½ quarts a day more than the average, while others gave almost 5 quarts less than the average; that some were profitable cows to keep, while others were an expense all the time to their owners.

To find out which are the unprofitable ones is not a difficult matter. An observant man who is at the milking every day will know them well enough. But if the herd is large and hired men milk, the owner is not likely to know surely unless he will go to the trouble, which is small compared to the advantage gained, of making tests for at least three or four days in the month.

With a spring balance and a couple of pails whose weight has been brought to even pounds, by soldering on a piece of lead if necessary, it is only half a minute's work to pour each cow's milk

as brought by the milker into one of these pails, hook it on the scale and read and record the weight. It is much quicker and more accurate than to measure. But pounds of milk may be readily reduced to quarts by dividing by 2.15.

A few such tests made monthly will show what each cow is doing from the time of calving till she dries off, and to judge of her merits or demerits one needs to know this. If cream rather than milk is sold, the Babcock milk tester should be used in connection with the test of milk yield and can readily be used on the farm as well as in the laboratory.

Having fixed on the unprofitable cows of the herd the next step is to get rid of them and at the same time substitute something better. This is not easy.

If it be granted, as is claimed by breeders of pure stock, that thoroughbreds are more profitable for milk men than "scrubs," this knowledge is small help to a man who has from five to forty natives in his herd and very limited uninvested capital. He cannot turn off one herd to a butcher or to some less thrifty neighbor and buy a new thoroughbred herd.

If he turns off the poorest cows and buys in other natives as he can pick them up, he very soon finds, as was remarked in a recent dairy meeting, that the seller is also engaged in improving his herd and the buyer is likely to be no better off than he was before. The very best cows are never for sale; the very poorest cows are always for sale.

A third way which finds more favor among patrons of creameries than among those who sell whole milk is the raising of calves for one's own herd.

Most cattle keepers can afford to get and keep a thoroughbred bull which comes from stock with good milk records. This establishes the foundation for a good herd. His get, even from the "scrub" cows, are likely to be much better milkers than the average native cows which are "picked up" in emergencies here and there. And at any time when a few thoroughbred cows can be introduced, the improvement of the herd will go on more rapidly. The raising of calves looks more formidable where skim milk from the creamery is not available for feed, but in the long run may be the cheapest means of improving the herd and so lessening the cost of producing milk. Only good cows will make it pay to produce milk. The producer has got to raise them himself or pay to have some one else do it for him. The former course will often be the best.

3. *Quality of the Feed.*—In 1881 the Station examined the rations fed on several good farms in this State and found in general more carbohydrates and less albuminoids in the rations than is given in the standard. The same thing appears in the ration which has been discussed and probably it is generally true of the feeding in this State.

It is quite likely that a pound or a pound and a half or even more per day and head of either linseed meal, gluten meal or cottonseed meal, with a corresponding diminution of the more starchy feed, corn meal, bran, etc., would have noticeably improved this ration and will improve the rations of other feeders in this State. In some cases it may happen that the flow of milk will not be noticeably increased, but that nevertheless the milk will be made from the feed instead of the cow's flesh and in consequence she will come out better in the spring.

An excess of albuminoids in the feed is not wholly wasted for the undigested portion enriches the manure. An excess of carbohydrates is less perfectly digested than where a proper proportion of albuminoids is present, and what goes into the manure is dead loss, having no manurial value.

THE BABCOCK METHOD OF DETERMINING FAT IN MILK.

The following statements on this subject, most of which were made in Bulletin No. 106, it seems best to record here in view of the great interest which is taken in the matter and the frequent inquiries about it.

Of the various quick methods for determining fat in milk and cream which have been proposed of late, the Babcock method has been most widely adopted and to us seems the safest, most convenient and rapid.

Description of the Method.—The principle of the method is this; to a carefully measured quantity of the milk in a flask provided with a narrow accurately graduated neck, made for the purpose, is added a definite quantity of strong oil of vitriol which dissolves all the solid matters of the milk except the fat. The flasks thus charged, are rapidly whirled in a centrifugal apparatus by which all the fat is brought to the surface of the mixture in a few minutes. Hot water is then added to raise this layer of melted fat into the graduated neck of the flask. The length of the fat layer, as read off on the graduation, gives at once the per cent. of fat. It may be of advantage to any one who gets this Tester to see it at the Station and learn some particulars of manipulation that can be better appreciated by seeing than by reading of them. Any one can, however, get perfectly satisfactory results for himself without further instruction than is given in the directions which accompany the machine.

The apparatus which has been used by the Station lately at the meeting of the Dairymen's Association and at farmers' institutes is made by Porter Blanchard's Sons, Nashua, N. H. A convenient apparatus is also made by the Vermont Farm Machine Co., Bellows Falls, Vt.

Rapidity of the Test.—This depends largely on the skill and activity of the operator. In the Station laboratory, a person skilled in handling such apparatus, but who has worked with this method only a few times has made determinations of fat in 40 samples of milk in an hour and forty-eight minutes.

This included time spent in mixing the milk in the sample bottles, measuring milk, acid and fat, labelling and cleaning all the flasks and apparatus used, recording the results, and leaving everything in perfect order for the next use; in short *every* thing involved in any way with the operation. This is more than twice as rapid work as we were able to do at first and is made possible simply by having the apparatus conveniently arranged for the work.

Accuracy of the method.—The accuracy of this method of determining the quantity of butter-fat in whole milk has been fully tested at several stations and is settled beyond dispute.

Our own tests have given the following results. The average difference between the quantity of fat shown by this method and that shown by the standard method used in chemical laboratories, was less than one one-hundredth of one per cent. in 32 comparative tests. The greatest difference in any single case was .18 per cent. In six cases the difference exceeded .10 per cent. and in 18 cases it was .05 or less.

In 17 cases the standard method gave a lower result than the Babcock method, in 15 cases a higher result.

That is, on the average where 100 pounds of butter-fat were actually present, the Babcock test showed $99\frac{99}{100}$ pounds.

The widest discrepancy in any single case was $\frac{18}{100}$ pound or about three ounces of fat in 100 pounds.

In the majority of cases the discrepancy was $\frac{1}{8}$ of an ounce or less in 100 pounds of fat.

Accuracy of sampling indispensible.—To get a perfectly fair sample of each patron's milk is the most critical thing of all. As soon and as often as milk stands at rest, its constituents begin to separate, the cream rising to the surface. The contents of a forty quart can may be thoroughly mixed with a long handled dipper *if time and pains are taken to do it*, but it will require more time than one who has not tried it would suppose, to thoroughly mix the whole so that different samples from the same can will show the same quantity of fat when tested. The most thorough mixing is done by pouring the whole quantity of milk from one can into another.

For sampling large quantities of milk, the Vermont Station, Bulletin No. 21, recommends a sampling tube. This is simply a piece of brass tube of suitable length and an inch in diameter, having an iron wire running through it, centered by a wire loop within the tube near each end. One end of this wire is bent to form a handle, the other bears a disc of sheet iron with a rubber

packing over it. The tube is passed vertically downwards in the milk, the disc being kept away from the tube allowing it to fill as it goes down. Then the wire is drawn up, thus closing the bottom of the tube, and the tube is withdrawn, bringing with it a core or section of milk, which should represent accurately the whole quantity of milk.

This "milk thief" we have found very convenient in sampling either milk or cream.

Where the method is used by milk-gathering creameries it is very desirable to sample the milk daily, but to make the tests less frequently, perhaps once a week. To do this fairly a sample of each day's milk from each patron is put into a suitable bottle or jar, of which as many are required as there are patrons. Each jar contains an antiseptic powder which will keep the milk sweet till the end of the week when the fat in each so-called "composite sample" is determined, and the patrons are credited with the butter-fat they have supplied.

Any creamery wishing particulars of this process would do well to apply to the Iowa Experiment Station, Ames, Iowa, for Bulletins No. 9 and No. 11, and for the "Relative Value Table." The chemist of that Station, Prof. Patrick, has originated and carefully worked out the details.

The creamery of J. B. Sandford in Redding, in this State, is now paying for milk according to the butter-fat in it as shown by the Babcock test. The results are understood to be very satisfactory alike to owner and patron while the system of paying for pounds of "milk" supplied, was extremely unfair both to the proprietor and to a part of the patrons, as was shown by tests made at the creamery.

That this must be so in all cases the following considerations show.

The average per cent. of fat in 206 samples of the milk of herds carefully drawn at creameries in this State and analyzed at this Station, was 3.98, or in round numbers four per cent.

That is, if this whole quantity of milk had been mixed thoroughly together, a hundred weight of it would have contained four pounds of butter-fat.

But as was to be expected the milk from the individual dairies was of various quality. The milk of one herd contained 5.25 per cent. of fat, that of another 3.28 per cent. of fat, and while the percentage varied somewhat from day to day yet the milk of certain herds was *uniformly* rich in fat while that of other herds was as *uniformly* poor.

These figures mean that a hundred pounds of milk, furnished by one patron, brought to the creamery five and a quarter pounds of fat, but a hundred pounds of milk from his neighbor's herd brought only three and a quarter pounds. This is an extreme case. If for illustration we assume that the milk of A's herd contains 5 per cent. of fat and that of B's herd 3.5 per cent. we have a difference between the herds which is not by any means extreme in Connecticut to-day.

A and B we will suppose produce the same quantity of milk per week, 1500 pounds, and are paid at the rate of $1.10 per hundred or about $2\frac{35}{100}$ cents per quart. (The actual price paid by different creameries is not known). Their receipts are therefore the same, $16.50 per week.

For this, A furnishes to the creamery 75 pounds ($1500 \times \frac{5}{100}$) of butter-fat and B furnishes $52\frac{1}{2}$ pounds.

That is, crediting nothing to the skimmed milk of which each patron supplied the same quantity; A, the patron who produces the richer milk, who has the better cows or who feeds more rationally, gets 22 cents a pound for butter-fat, and B the patron whose milk is the poorest, whose herd is poor or feeding injudicious, gets 31.4 cents a pound. This is a premium of 10 cents per pound of fat on thin milk, or poor stock and feeding, or on judicious watering of the milk.

It presents little inducement to better the herd or to feed for quality rather than quantity of milk.

It is obviously very unfair to all the parties concerned and bears heardest on A who has an exceptionally good herd or who feeds exceptionally well.

Now suppose this creamery changes its policy and offers as before $1.10 per hundred for "standard" milk containing four per cent. of fat but allows $2\frac{3}{4}$ cents per hundred additional for every "unit" or tenth of a per cent. of fat more than four in the milk and deducts $2\frac{3}{4}$ cents per hundred for every "unit" or tenth per cent. under four.

The two accounts will stand as follows:

Patron A. Milk contains 5 per cent. of fat.

15 hundred weight of milk, @ $1.10	$16.50
Add for 10 units per hundred, or 150 units of fat @ $2\frac{3}{4}$ cents	4.13
	$20.63

Patron B. Milk contains 3.5 per cent. of fat.

15 hundred weight of milk, @ $1.10	$16.50
Deduct for 5 units per hundred, or 75 units of fat @ $2\frac{3}{4}$ cents	2.07
	$14.43

Under this arrangement A has received $20.63 for his 1500 pounds of milk and has furnished 75 pounds of butter-fat. He has therefore received $27\frac{1}{2}$ cents per pound for the butter-fat.

B has received $14.43 for $52\frac{1}{2}$ pounds of butter-fat, and for each pound $27\frac{1}{2}$ cents, the same that his neighbors receive for a like amount of butter-fat.

Neither A nor B can increase his receipts by watering or skimming milk nor by increasing the flow of milk at the expense of quality.

These particular prices are for nothing more than to illustrate the point. The actual rate to be paid must depend of course on what it costs the creamery to make and sell the butter.

The appearance of the Tester itself at a creamery, and of some one making tests on each patron's milk, has had in some cases a marked effect on the quality of the milk furnished thereafter.

For instance, in one case a Station chemist with the tester examined at a creamery the milk of each patron as he brought it. The milk of the previous week had made 270 pounds of butter. The following week the milk brought to the creamery fell off 590 quarts, but the butter made was 269 pounds, only a pound less than the week before.

It is believed that the practice of paying for butter-fat rather than for milk—which is rendered practicable by the methods referred to above—will gradually reduce the cost of producing butter, will increase the profits of the honest and intelligent patrons and offer more inducement than there now is for improving herds and feeding liberally for quality rather than quantity of milk.

It must be borne in mind that the Tester shows the percentage of *pure butter-fat* in the milk, not of "cream" or of butter. "Cream" varies much in composition and may contain as low as 16 per cent. of pure butter-fat or as high as 30 per cent. or even higher. Butter contains from 75 to 87 per cent. of pure butter-fat. More or less of the butter-fat of the milk however is lost in butter making, chiefly in the skimmed milk and in the butter milk.

MISCELLANEOUS NOTES ON MILK.

Solids and Fat in the Milk of Herds.

The following data on this subject have accumulated during the year. The figures refer to the milk of patrons as received at creameries.

	Feb. 19.	Feb. 20.	Mar. 7.	Mar. 12.			May 10.	Nov. 1.
No. of patrons	35	36	33	31	50	15	24	27
Solids, average per cent.	----	----	----	----	13.60	12.14	12.73	13.48
" maximum	----	----	----	----	14.93	13.38	14.44	14.93
" minimum	----	----	----	----	11.90	10.91	11.79	11.90
Fat, average per cent.	3.85	3.95	4.05	4.0	4.5	3.91	3.87	*4.52
" maximum	4.4	4.8	5.0	4.6	5.25	4.39	4.94	5.25
" minimum	3.1	3.2	3.3	3.6	3.38	3.31	3.28	3.38

Following are the results of examination of the milk of a herd of "three full blood Holsteins and nine common cows." A creamery superintendent witnessed the milking and took the sample which was drawn on March 20th:

	March 12.	March 20.
Specific gravity at 15° C.	1.030	1.032
Total solids	11.28	11.51
Fat	3.47	3.48

Effect of Sickness on the Yield and Composition of Milk.

During the observations on a herd of milk cows, described on pages 96 to 106, two cows at different times were "off their feed" for a few days. The cause and nature of the trouble, which did not appear very serious, is not known. Neither cow was in heat at the time.

The effects on the yield and composition of the milk are interesting.

Cow No. 10 for a week previous had been giving on the average 22½ pounds of milk per day, 16 ounces of butter fat, while the per cent. of fat in the morning's and night's milk ranged from 3.5 to 4.3.

On the 23rd of February it was noticed that she did not eat well. Her yield of milk and of butter fat for the next few days were as follows:

* Twelve patrons.

	Pounds of Milk.	Ounces of Fat.
Feb. 23	18½	---
" 24	15⅕	13.2
" 25	12	11.3
" 26	15	10.4
" 27	17⅓	11.4

Her daily yield was not up to what it was before her sickness till March 7.

A full analysis of her milk when she was sickest is given in the table which follows.

Cow No. 9 was seen to be off her feed on December 9.

Her record just before and during her sickness is as follows:

	Pounds of Milk.	Ounces of Fat.	Per cent. of Fat in morning's and night's Milk.
Dec. 6	21	12.6	3.9, 3.6
" 8	20¼	12.3	3.9, 3.7
" 9	22⅜	14.4	4.2, 3.9
" 10	16	8.0	2.2, 3.9
" 11	7½	7.5	4.0, 7.0
" 12	$11\frac{15}{16}$	12.5	6.0, 7.0
" 13	$13\frac{13}{16}$	10.0	4.3, 4.8
" 15	15⅞	10.1	4.1, 3.9

On the 22d her yield had risen to $19\frac{7}{16}$ pounds, which was about her average before her sickness.

In both these cases there was a large shrinkage both of milk and of butter fat, while the per cent. of fat rose noticeably, showing that the shrinkage of fat was less than that of the milk. Analyses of this milk appear in the following table:

Composition of Milk from Sick Cows.

	No. 10.				No. 9.	
	Feb. 23, night.	Feb. 24, morning.	Feb. 24, night.	Feb. 25, morning.	Dec. 11, night.	Dec. 12, morning.
Casein or curd *	3.44	2.97	3.18	3.13	2.55	2.49
Butter fat	5.77	4.83	5.24	6.49	7.02	6.02
Sugar †	4.51	4.90	4.50	4.44	4.69	4.53
Ash	.85	.72	.79	.71	.63	.66
Total solids	14.57	13.42	13.71	14.77	14.89	13.70
Water	85.43	86.58	86.29	85.23	85.11	86.30
	100.00	100.00	100.00	100.00	100.00	100.00

* Nitrogen × 6¼. † By difference.

Composition of the Milk Solids.

Casein or curd	23.61	22.13	23.19	21.19	17.13	18.18
Butter fat	39.61	35.99	38.22	43.94	47.15	43.94
Sugar	30.95	36.51	32.82	30.06	31.49	33.07
Ash	5.83	5.37	5.77	4.81	4.23	4.81
	100.00	100.00	100.00	100.00	100.00	100.00

Fat in the First of the Milking and in the Strippings.

The samples **A** to **D** were drawn by Mr. W. I. Bartholomew of Putnam, and tested at a dairy institute in April, 1891. **E** is from a registered Jersey cow. The figures given are the per cents of butter fat.

	A.	B.	C.	D.	E.
First milk drawn from the udder	2.8	1.6	3.4	1.5	1.6
Last " " " "	6.1	7.5	9.8	7.2	6.2

On the Determination of Solids in Milk by Drying the Milk Alone.

The following tests, made by Mr. Winton, were to show whether the drying of milk by itself gave results practically identical with those obtained by the so-called "Sand Method."

The quantities of milk given below were heated on a water bath in a porcelain guano capsule with 10–15 grams of dry quartz sand, with frequent stirring, till most of the water was expelled and then in the drying oven at about 98° C. till the weight was constant.

For comparison, the quantities of milk given in the table below were brought into flat bottomed nickel dishes, having a diameter at the bottom of 2 inches and a height of ⅝ inch. The drying was precisely as by the sand method, but without any stirring.

Weight of Milk used.	By Sand Method.	Dried in nickel dish.	The Sand Method gave more (+) or less (–).
2 grams	12.47	12.65	–.18
"	9.27	9.29	–.02
"	13.30	13.36	–.06
"	12.21	12.33	–.12
"	12.19	12.27	–.08
4.3 grams.	12.87	13.04	–.17
"	12.03	12.07	–.04
"	12.35	12.59	–.14
"	11.32	11.32	.00
"	10.91	10.88	+.03
	13.38	13.39	–.01
3.3 grams.	11.82	11.89	–.07
"	11.36	11.49	–.13

In thirteen tests the extreme difference between the results by the two methods was .17 per cent.; the average difference was .08 per cent., and in eleven out of thirteen cases the sand method gave a lower result.

ON THE DETERMINATION OF THE FAT IN CREAM BY THE BABCOCK METHOD.

Most of the creameries in this State gather cream rather than milk and the cream is usually raised by deep setting in submerged cans at low temperatures. Inasmuch as cream raised by this method naturally varies considerably in its content of actual butter-fat and may easily be made to vary much more by fraud on the part of the creamery patron, a rapid, accurate and practicable method of determining fat in cream, for use in creameries, is particularly desirable here.

The Babcock method applied to cream has been thoroughly tested by Mr. Winton, chemist of the Station, with a view to its use by cream gathering creameries.

The same apparatus, bottles, acid and method have been employed as are recommended by Dr. Babcock with a single exception.

Mr. Winton has made and used in all the tests given below a pipette for measuring the cream which delivers 6 grams of cream quite accurately, *provided the cream was raised as above described.* The reading from the tube multiplied by three gives the per cent. of fat in the cream without further correction.

The pipette.—The pipette, made by Mr. Winton, is 6¼ inches long, narrow at each end, the internal diameter at one end being about ⅛ of an inch and at the other $\frac{1}{16}$ inch.

It is designed to deliver 6 grams of cream, as the milk pipette is designed to deliver 18 grams of milk. The actual quantity delivered in several preliminary trials was 5.97–5.95–6.00 and 5.93 grams.

The number of grams of water delivered (15° C.) by this pipette in a number of trials was

6.035
6.038
6.028
6.053
6.045
6.035

Average 6.039

The *volume* of cream delivered will be less than that of water because a larger proportion of the cream will adhere to the sides of the pipette.

Method of using the pipette.—The cream is very thoroughly mixed by moderate agitation,—violent shaking may churn it partially or beat it full of small bubbles which are very slow to rise,—and the pipette, with one end well below the surface of the cream is sucked full, a little escaping into the mouth. The upper end is closed with the tongue, and the pipette withdrawn, its tip introduced into the neck of the flask and on removing the tongue the cream flows out. *As soon as it has run out*, the adhering drop is blown out and the pipette withdrawn.

The reason for making the pipette to be completely filled with cream rather than to be filled to a mark on its stem is that it is more difficult to observe in a tube the height of cream than of milk, as the former coats the walls of the tube more thickly. By filling the tube full moreover, any bubbles on the cream surface will be removed by the mouth.

Having measured the cream into the testing flasks it is only necessary to add to each, 12 centimeters of water, from a pipette made for the purpose, and then proceed exactly as in the case of milk only multiplying the per cent. of fat, as read from the graduations, by three.

Following is a complete account of the experiments thus far made with this method, with the exception of the first ten samples examined which were quite sour when tested and had not been raised by a uniform method.

The "gravimetric method" referred to below or the laboratory analytical method, which is the standard, consisted in weighing the cream accurately on asbestus fiber in a tube, drying at the heat of boiling water till the weight was constant, and then extracting the fat completely from the tube and asbestus with absolute, alcohol-free ether, evaporating the ether, drying at the temperature of boiling water and weighing the residual fat.

Creamery No. Collected Feb. 10th, 1891.	Solids.	Fat. Babcock Method.	Fat. Gravimetric Method.	Babcock method gave more (+) or less (–) than Gravimetric Method.
3	----	21.3	21.16	+ .14
6	----	21.6	21.30	+ .30
9	----	18.9	18.64	+ .26
11	----	18.2	17.90	+ .30
19	----	20.25	20.34	+ .09
21	----	20.4	20.36	+ .04
22	----	17.7	17.76	— .06
23	----	20.25	20.17	+ 0.8
25	----	18.45	18.67	— .22
29	----	20.55	20.57	— .02
30	----	22.5	22.90	— .40

Collected Feb. 20, 1891.				
2	27.40	20.4	20.16	+ .24
3	30.14	22.7	22.51	+ .19
4	25.69	18.6	18.49	+ .11
5	27.87	21.0	20.80	+ .20
6	27.40	21.9	22.09	— .19
7	27.52	19.8	19.66	+ .14
8	25.50	18.0	17.72	+ .28
9	28.36	21.0	21.02	— .02
11	31.18	23.9	23.54	+ .36
12	27.77	20.5	20.64	— .14
13	26.15	19.0	18.96	+ .04
14	28.70	21.9	21.94	— .04
15	26.38	19.9	19.64	+ .26
16	26.46	20.1	19.79	+ .31
17	26.91	19.8	19.66	+ .14
18	26.57	19.5	19.15	+ .35
19	27.45	20.4	20.23	+ .17
20	27.13	20.4	20.58	— .18
Collected March 27, 1891.				
1	----	19.8 19.8	20.14	— .34
2	----	20.7 20.7	20.98 20.99	— .28
3	----	21.0 21.3	21.37 21.39	— .22
4	----	19.2 19.5	19.76 19.66	— .36
5	----	20.7 20.4	20.27 20.45	+ .19
6	----	22.8 23.1	22.66 23.08	+ .08
7	----	21.0 21.0	20.94 21.00	+ .03
8	----	18.3 18.3	18.25 18.26	+ .04
9	----	18.3 18.3	18.21 18.46	— .03
10	----	20.4 20.4	20.57 20.58	— .17
Collected April 23d, 1891.				
1	27.15	20.4 20.7	20.51	+ .04
4	26.77	20.1 20.4	20.35	— .10
5	26.74	20.7	20.74	— .04
6	27.67	22.2	22.26	— .04

Collected April 23d, 1891.

7	29.71	23.4 23.4	23.81	— .41
8	28·53	21.3 21.6	21.60	— .15
9	26.48	19.8	20.36	— .56
10	28.78	21.9	22.16	— .26
11	27.91	20.7 20.1	20.42	— .02
13	27.42	21.0	20.80	+ .20
14	27.77	21.0	20.97	+ .03

Results.—The average quantity of fat as determined in the fifty tests above given, by the Babcock method was 20.46 per cent. and by the gravimetric or standard method was the same, 20.46 per cent.

In 26 cases the former gave a higher result than the latter, in 24 cases the reverse was true.

In 18 cases the variation of the two methods was a tenth of one per cent. or less; in 35 cases the variation was less than a quarter of one per cent.; in 7 cases the difference exceeded a third of one per cent. and the extreme difference was .56 per cent. The same facts may be expressed as follows:

In 36 per cent. of the tests the variation from the standard method was not more than one-tenth of a per cent.

In 70 per cent. of the tests the variation from the standard method was not more than a quarter of a per cent.

In 86 per cent. of the tests the variation from the standard method was not more than a third of a per cent.

In 98 per cent. of the tests the variation from the standard method was not more than a half of a per cent.

In considering these figures and the accuracy of the method it must be borne in mind that the per cent. of fat is from four to six times as great in cream as in milk and hence a larger difference in the percentage of fat found in cream by the two methods may not involve any larger proportion of the total quantity of butter fat than a much smaller difference in the per cent. of fat found in milk by the two methods involves in the total quantity of the fat of milk.

To illustrate. If a sample of milk contains 4 per cent. of fat and the Babcock method shows 3.92, the agreement is all that could be desired. The per cent. difference is only .08. That is out of 4 pounds of fat .08 of a pound or 2 per cent. is missing. Now if a sample of cream contains 20 per cent. of fat and the Babcock method shows 19.60, the per cent. difference is .40 which is five times as large as in the case of milk. Yet *proportionally* no more fat is lost than in milk, i. e., two per cent.

In more than four-fifths of the cases above cited the error is considerably less than this.

The results above given lead us to believe that the Babcock method may be made of very great value to cream-gathering creameries. It offers to them a practicable and accurate method of ascertaining the actual quantity of butter fat which each patron furnishes so that payments may be based not on volume of cream supplied but on *actual butter fat*, which is the raw material that the creamery manufactures. This is obviously the most satisfactory method of payment. For this purpose each patron's cream should be weighed and sampled and the fat in it determined by the method described.

Since the work above described was done, Mr. J. M. Bartlett of the Maine Experiment Station, has published * a description of two new forms of testing bottles for cream, graduated from 0–25 and from 0–35 per cent. respectively. He also finds that the pipette used for milk can be used as well for cream if graduated to 18 cc.

The result of 19 tests made by him showed very good agreement with the gravimetric test.

The use of a pipette, in which the cream is drawn to a mark on the stem rather than to fill the pipette, is a very great advantage and renders possible the use of antiseptics with the cream where necessary.

A few experiments made in the laboratory of this Station with the 18 cc. pipette and flasks of the same size and shape as the flask used for milk tests,—*except that the graduated portion, while of the same length had three times the capacity of the graduated part of the ordinary flasks*—have given the following results: In column A are percentages found by the use of apparatus described on page 115, in column B the percentages found in the same samples, using for the determinations an 18 cc. pipette and the flasks just described with the larger graduated part.

A.	B.
18.00	17.95
21.90	21.70
18.60	19.00
21.60	21.40
20.40	20.80
22.20	22.60

* Me. Expt. Station, Bull. 3, Second Series, Sept. 1, 1891.

The accuracy of the determination of fat in cream by the Babcock method is beyond any doubt.

The questions which remain to be settled are, first, can cream in considerable quantity be accurately sampled, secondly, can composite samples of cream be kept for a week at any season of the year and the fat accurately determined at the end of that time, and thirdly, is it necessary each day to take a portion of the cream for the composite sample which shall bear relation to the total quantity of cream it represents, or is it sufficiently accurate to take each day for the composite sample, the same quantity of each patron's cream.

The Station began experiments on these points as promised in Bulletin 105, but the work has been necessarily interrupted for a time.

On Variations in the Composition of Cream Raised by Deep Setting at Low Temperatures.

The following observations were made on cream collected from creamery patrons who set their milk in deep submerged cans where it stood from 12 to 24 hours before collection by the cream-gatherer. The samples were drawn from mixtures of the cream of morning and evening setting.

SOLIDS.—Thirty-seven tests made at two creameries gave an average of 27.55 per cent. of solids. The highest per cent. found was 31.18, the lowest 25.18.

BUTTER FAT.—One hundred and sixty-five tests made at three creameries in different parts of the State gave for the average 19.85 per cent. of fat. The highest per cent. found was 24.9, the lowest 13.8 per cent.

The widest variations in the per cent. of fat in the cream furnished by individual patrons of one creamery on the same day were 13.8–21 per cent. and in another case 18.3–24.9 per cent. The smallest daily variations at any one creamery were 19.0–21.9 per cent.

The Composition of Cream and Butter-milk and the Loss of Butter-Fat in Churning.

Through the courtesy of the superintendent of one of the creameries in the State the following test was made:

All the work of making the butter was done in the usual way by the butter-maker; the station chemists weighed the cream and products of the churning and analyzed them.

There went into the churn 467.5 pounds of ripened cream and 12 pounds of water. After churning there were added in two different portions 116.5 pounds of water for washing the butter. The two washings were separately weighed and analyzed.

ANALYSES OF THE CREAM AND PRODUCTS OF CHURNING.

	Cream.*	Butter-milk.	First washing.	Second washing.	Butter.
Ash	.60	.67	.24	.21	5.22†
Albuminoids	2.75	3.31	2.56	1.14	1.62
Fat	18.33	.20	.10	.07	79.81
Sugar	3.80	4.35	3.90	1.90	----
Water	74.52	91.47	93.20	96.68	15.35
	100.00	100.00	100.00	100.00	100.00

The next table shows the number of pounds of each of these ingredients which went into the churn and the quantity of each that went into the butter, the butter-milk and the washings.

CHURNING ACCOUNT.

Taken out of the Churn.	Ash. Pounds.	Albuminoids. Pounds.	Fat. Pounds.	Sugar. Pounds.	Water. Pounds.
Butter-milk 238 pounds	1.59	7.88	.48	10.35	217.70
First washing, 167½ pounds	.40	4.29	.17	6.53	156.11
Second washing, 68½ pounds	.14	.78	.05	1.30	66.23
Butter [salted], 108½ pounds	3.49	1.76	86.59	----	16.65
Water lost in working butter	----	----	----	----	17.11
	5.62	14.71	87.29	18.11	456.69
Put into the churn, cream and water	2.88	13.19	87.89	18.22	473.8

The excess of "ash" in the products of the butter, 2.74 pounds, is the salt added in working. The 1.52 pounds of albuminoids appearing as taken out of the churn in excess of what was put in is to be charged to errors and losses in weighing.

There is a loss of .11 pounds of sugar to be explained in the same way. Of the 87.89 pounds of butter-fat put into the churn, .60 pounds were lost in the butter-milk and washings. This amounts to .68 of one per cent. of the total quantity of fat.

* Includes the 12 pounds of water added before churning. † Salt.

BUTTER ANALYSES.

In a following table are given the analyses of eleven samples of butter from private dairies and six samples of creamery butter. These butters were entered in the exhibit at the Connecticut Dairymen's Association which met in Hartford, January 20–22, 1891. The score of points for each butter is also given. The method of making award was as follows: Number of possible points, 100. Minimum number allowed in awarding premiums 85. Divide the total premium by the total number of points scored above the minimum. The quotient is the amount to be awarded for each point scored above the minimum.

To illustrate: Of the creamery butters,

No. 9 scored 14 points above the minimum.
" 7 " 14 " "
" 4 " 10 " "
" 1 " 4 " "
" 5 " 3 " "
" 6 " 0 " "

Total points scored........ 45. Total premium to be divided, $70.00. Each point scoring above the minimum therefore gets $\frac{70}{45}$ = $1.555 and the premiums awarded are as follows:—

No. 9 and No. 7, each $21.78, No. 4, $15.55, No. 1, $6.22 and No. 5, $4.67.

PRIVATE DAIRY BUTTER.

Scale of Points.

	Perfect.	No. 5.	No. 11.	No. 4.	No. 6.	No. 7.	No. 2.	No. 1.	No. 8.	No. 9.	No. 3.	No. 10.
Flavor	50	48	45	46	44	40	47	30	21	20	20	15
Grain	25	23	23	23	22	23	22	24	17	15	15	5
Color	15	15	15	12	12	12	6	15	14	13	13	3
Salt	5	5	4	4	5	3	3	4	4	3	1	1
Package	5	5	4	5	5	5	1	5	0	4	3	0
Total	100	96	91	90	86	83	79	78	56	55	52	24

Analyses.

	No. 5.	No. 11.	No. 4.	No. 6.	No. 7.	No. 2.	No. 1.	No. 8.	No. 9.	No. 3.	No. 10.
Water	10.86	11.01	12.27	8.59	12.74	11.54	10.09	10.99	10.04	9.37	11.38
Curd	1.32	1.28	.91	1.44	1.42	2.00	1.83	2.53	.94	1.24	1.11
Salt	1.86	5.23	1.18	2.32	2.76	4.11	4.22	3.47	2.44	7.83	6.78
Fat	85.96	82.48	85.64	87.65	83.08	82.35	83.86	82.01	86.58	81.56	80.73
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Specific gravity of the butter-fat at 100° C.	.8666	.8644	.8667	.8646	.8646	.8657	.8640	.8642	.8652	.8650	.8662

CREAMERY BUTTER.

Scale of Points.

	Perfect.	No. 9.	No. 7.	No. 4.	No. 1.	No. 5.	No. 6.
Flavor	50	49	50	48	46	49	44
Grain	25	25	25	23	22	21	21
Color	15	15	14	15	13	10	9
Salt	5	5	5	4	3	3	3
Package	5	5	5	5	5	5	5
Total	100	99	99	95	89	88	82

Analyses.

	No. 9.	No. 7.	No. 4.	No. 1.	No. 5.	No. 6.
Water	11.38	8.89	11.38	7.97	8.35	6.54
Curd	.96	.94	1.18	.90	1.00	1.58
Salt	2.65	2.14	3.17	2.88	2.30	3.96
Fat	85.01	88.03	84.27	88.25	88.35	87.92
	100.0	100.0	100.0	100.0	100.0	100.0
Specific gravity of the butter-fat at 100° C.	.8644	.8648	.8647	.8644	.8645	.8646

The judge of the creamery butter was Mr. H. K. House of the Allyn House, Hartford; of the private dairy butter, Mrs. Thomas Fairclough, of Waterbury. Tunxis Creamery, Robertsville, and Green's Farms Creamery, Westport, took first premiums.

The average composition of the creamery and private dairy butters and the range of percentage of each ingredient are as follows:

	Creamery Butter.		Private Dairy Butter.	
	Range of percentage.	Average composition.	Range of percentage.	Average composition.
Water	6.5–11.4	**9.1**	8.6–12.7	**10.8**
Curd	.9– 1.6	**1.1**	.9– 2.5	**1.5**
Salt	2.1– 4.0	**2.9**	1.2– 7.8	**3.8**
Fat	84.3–88.4	**86.9**	80.7–87.7	**83.9**
		100.0		**100.0**

The private dairy butters which received the lowest grading for flavor, grain and salt were ones which had the very abnormally high per cents. of salt (6.78 and 7.83).

It is somewhat surprising that No. 11, with 5.23 per cent. of salt, should have scored as high as it did.

The creamery butter as a rule carried 3 per cent. more of actual butter-fat than the private dairy butter.

PROTEIDS OR ALBUMINOIDS OF THE OAT-KERNEL.

SECOND PAPER.*

BY THOMAS B. OSBORNE, PH.D.

I. PREPARATION OF A GLOBULIN FROM THE SO-CALLED ALBUMINATE.

In a paper on the proteids of the oat-kernel published in the Report of this Station for 1890, the writer described a globulin obtained from the oat-kernel by extraction with a ten per cent. sodium chloride brine heated to 65° C. [Preparation **20**]. It was shown that this globulin differs from that extracted by the same brine at 20° C. both in properties and composition and that on cooling the warm saturated solution of this body in dilute sodium chloride brine, crystals were several times obtained; once in the form of rhombohedra and at other times in the form of octahedra.

This globulin has been further investigated and the results obtained are the main subject of this paper.

When the oat-proteids brought into solution in cold brine† are precipitated by saturating the extract with ammonium sulphate, a considerable part of this precipitate is always found to have lost its solubility in the salt-solution, by conversion into a form called by Weyl "an albuminate" [**15, 16**]. In this state it is soluble in a one per cent. solution of sodium carbonate.

On treating ten pounds of freshly ground oats with brine, precipitating the filtered solution by saturating with ammonium sulphate and extracting the precipitate thus obtained with brine, it was found that a very large part of the globulin originally dissolved was converted into the so-called "albuminate." After washing this latter thoroughly with brine, to free it completely from the unchanged globulin, it was dissolved in a one per cent. sodium carbonate solution. About two-thirds of this solution was then treated with carbon dioxide for three hours, whereby a heavy white precipitate settled out. This precipitate was collected on a filter and allowed to drain over night. The next morning it was found to have become transparent and gummy about the edges.

This precipitate was now completely soluble in salt-solution and had all the properties of the globulin [**20**] formerly obtained from the hot sodium chloride extract. The entire precipitate was then dissolved in one liter of brine and dialyzed for four days, during which time all but a trace of the substance separated out. The thus precipitated proteid was seen under the microscope to consist of spheroids of about one-tenth of a millimeter diameter or less, similar to those obtained by cooling a warm solution of the globulin, as described in my former paper. After filtering off, washing with alcohol, ether and absolute alcohol, twenty-one grams of air-dried material were obtained. This substance was completely soluble in brine and was precipitated therefrom by diluting with water or saturating with sodium chloride, or by adding minute quantities of hydrochloric, nitric or acetic acids.

In the entire absence of salts, extremely small amounts of the just named acids dissolved the proteid instantly and completely, but the addition of a little sodium chloride precipitated it from this solution, the extent of the precipitation depending on the relative quantities of the acid and salt present. The precipitation was complete when certain proportions of salt and acid were used. Addition of strong soda-lye to the solution of the proteid in dilute acid, gave a heavy precipitate, which dissolved but slowly in excess of soda, although the final mixture contained over twenty-five per cent. of sodium hydrate. Addition of copper sulphate to this alkaline solution gave the biuret violet. With Millon's reagent and with nitric acid the usual proteid reactions were obtained. Alcohol containing a minute amount of free acid dissolved the substance completely. Its composition was found to be as follows:

* Read at the meeting of the National Academy of Sciences in New York Nov. 10, 1891.

† Unless otherwise specified "brine" and "salt-solution" are to be understood in this paper to signify aqueous solutions of very pure sodium chloride containing ten per cent. of NaCl, used at common temperatures.

OAT PROTEID.—*Derived from Sodium Carbonate Solution of the "Albuminate."*

PREPARATION 21.

	I.	II.	Ash-free. I.	Ash-free. II.
Carbon	52.28	----	52.30	----
Hydrogen	6.98	----	6.98	----
Nitrogen	17.86	17.73	17.86	17.73
Sulphur	0.69	----	0.69	----
Oxygen	----	----	22.17	----
Ash	0.03	----	----	----
			100.00	

Ash.—0.6759 gram substance dried at 110° C. gave 0.0002 gram of ash =0.03 per cent.

Carbon and hydrogen.—0.4610 gram dried substance gave 0.8837 gram CO_2= 52.28 per cent. C., and 0.3220 gram H_2O=6.98 per cent. H.

Nitrogen.—I. [Dumas method].—0.3474 gram dried substance gave 52.15 cc. N, at 13° C. [barometer 768.2 mm. at 23° C.] = 17.86 per cent. N.

II.—Kjeldahl method].—1.0108 gram dried substance gave ammonia = 21. 8cc. HCl sol. [1 cc.=0.00822 gram N.] = 17.73 per cent. N.

Sulphur.—0.7695 gram dried substance gave 0.0380 gram $BaSO_4$=0.0052 grams S =0.69 per cent.

In all respects save one this substance behaved exactly like the globulin obtained by extracting ground oats with hot sodium chloride solution. The latter proteid dissolved to a turbid solution in cold, and to a perfectly clear solution, in hot distilled water. So far as the usual methods of analysis show, the two bodies are identical in composition as is seen from the following figures:

	GLOBULIN.—Extracted from oats by hot sodium chloride solution. Average of two analyses. Preparation 20.	GLOBULIN.—Derived from sodium carbonate solution of the "Albuminate." Preparation 21.
Carbon	52.22	52.30
Hydrogen	6.98	6.98
Nitrogen	17.82	17.86
Sulphur	0.77	0.69
Oxygen	22.21	22.17
	100.00	100.00
Ash	0.19	0.03

Another preparation of this substance was made by dissolving a second portion of the "albuminate" in two per cent. sodium carbonate solution, precipitating with carbon dioxide, washing thoroughly with water, dissolving in brine and diluting the solution with a large amount of water. The final snow-white precipitate was filtered off and, after washing with alcohol and ether, weighed eleven grams. Its properties are exactly the same as those of 20 except that it is slightly soluble in hot distilled water. Its composition, as determined by analysis, here follows:

OAT PROTEID.—*Derived from Sodium Carbonate Solution of the "Albuminate."*

PREPARATION 22.

		Ash-free.
Carbon	51.98	52.05
Hydrogen	6.92	6.93
Nitrogen	17.83	17.85
Sulphur } Oxygen }	----	23.17
Ash	0.13	----
		100.00

Ash.—0.5437 gram substance dried at 110° C. gave 0.0007 gram ash =0.13 per cent.

Carbon and hydrogen.—0.5789 gram dried substance gave 1.1030 gram CO_2= 51.98 per cent. C and 0.3609 gram H_2O=6.92 per cent. H.

Nitrogen.—0.4230 gram dried substance gave 63 cc. N at 13° C. [barometer 773 mm. at 23° C.] = 17.83 per cent. N.

The filtrate from the precipitate produced by carbon dioxide in the preparation of the preceding substance [22] was diluted with an equal volume of water, further treated with carbon dioxide for about three hours and allowed to stand over night. The resulting precipitate was filtered off and washed with water, alcohol and ether. Five grams of substance having the same properties as preparations 21 and 22 were thus obtained. Analysis of this preparation gave the following results:

OAT-PROTEID.—*Derived from Sodium Carbonate Solution of the "Albuminate."*

PREPARATION 23.

		Ash-free.
Carbon	52.16	52.35
Hydrogen	7.00	7.02
Nitrogen	17.68	17.73
Sulphur	0.73	0.73
Oxygen	----	22.17
Ash	0.36	----
		100.00

Ash.—0.5500 gram substance dried at 110° C., gave 0.0020 gram of ash = 0.36 per cent.

Carbon and hydrogen.—0.4388 gave dried substance gave 0.8393 gram CO_2 = 52.16 per cent. C., and 0.2766 gram H_2O = 7.00 per cent. H.

Nitrogen.—0.3659 gram dried substance gave 54.36 cc. N, at 13° C. [barometer 767.6 mm. at 22° C.] = 17.68 per cent. N.

Sulphur.—0.9135 gram of dried substance gave 0.0484 gram $BaSO_4$ = 0.0066 gram S = 0.73 per cent. S.

II. Crystalization of the Globulin obtained from the so-called Albuminate.

Three hundred cubic centimeters of one per cent. sodium chloride solution were heated to 70° C. with 5 grams, i. e. an excess, of preparation **21**, and filtered on a steam-jacketed funnel. On cooling, the filtrate rapidly deposited a large crop of rhombohedral crystals. The residue undissolved by the hot one per cent. brine was washed with the same weak brine heated to 70°. On cooling, the washings deposited octahedral crystals. This process was repeated several times with other portions of preparation **21**. In most cases the filtrate deposited rhombohedral and the washings octahedral crystals. The residues which had been filtered out were dissolved and crystallized as far as possible from one per cent. brine, yielding either octahedral crystals or mixtures of octahedra and rhombohedra. The different crops of crystals were collected on separate filters according as they were wholly rhombohedra or octahedra or mixtures of the two. Three preparations, **24, 25, 26,** were obtained in this way, which were, as usual, washed with water, alcohol and ether and dried at 110° for analysis. Thus prepared, they retained their crystalline form entirely unchanged and had in all respects the same properties as the mother substance, **21**.

Prof. S. L. Penfield kindly examined these crystals and states that they appear to be rhombohedra and octahedra although the former have no action on polarized light. He suggests that the apparent rhombohedra may be octahedra with but six faces developed, such crystals occurring in nature. As they were too small for measurement [less than one-tenth of a millimeter long], this point could not be definitely determined. Analyses of the three preparations gave the following results :

Crystallized Oat-Proteid, *derived from* 21.

Preparation 24.

		Ash-free.
Carbon	52.14	52.17
Hydrogen	6.96	6.96
Nitrogen	17.92	17.93
Sulphur	0.53	0.53
Oxygen	----	22.41
Ash	0.06	----
		100.00

Ash.—0.4600 gram substance dried at 110° C. gave 0.0003 gram of ash = 0.06 per cent.

Carbon and hydrogen.—0.4463 gram dried substance gave 0.8835 gram CO_2 = 52.14 per cent. C., and 0.2795 gram H_2O = 6.96 per cent. H.

Nitrogen.—0.4042 gram dried substance gave 63.0 cc. N. at 17° C. [barometer 756.3 mm. at 21° C.] = 17.92 per cent. N.

Sulphur.—0.6345 gram dried substance gave 0.0242 gram $BaSO_4$ = 0.0033 gram S = 0.53 per cent.

Crystallized Oat-Proteid, *derived from* 21.

Preparation 25.

		Ash-free.
Carbon	52.00	52.11
Hydrogen	7.09	7.10
Nitrogen	17.91	17.94
Sulphur	----	} 22.85
Oxygen	----	
Ash	0.20	----
		100.00

Ash.—0.2035 gram substance dried at 110° C. gave 0.0004 gram ash = 0.20 per cent.

Carbon and hydrogen.—0.2562 gram dried substance gave 0.4885 gram CO_2 = 52.00 per cent C., and 0.1635 gram H_2O = 7.09 per cent. H.

Nitrogen.—0.3935 gram dried substance gave 61.3 cc. N. at 17° C. [barometer 756.5 mm. at 21° C.] = 17.91 per cent. N.

Crystallized Oat-Proteid, *derived from* 21.

Preparation 26.

		Ash-free.
Carbon	52.23	52.25
Hydrogen	7.08	7.08
Nitrogen	17.81	17.82
Sulphur	0.52	0.52
Oxygen	----	22.33
Ash	0.05	----
		100.00

Ash.—0.3974 gram substance dried at 110° C. gave 0.0002 gram of ash = 0.05 per cent.

Carbon and hydrogen.—0.2866 gram dried substance gave 0.5489 gram CO_2 = 52.23 per cent. C., and 0.1828 gram H_2O = 7.08 per cent. H.

Nitrogen.—0.3123 gram dried substance gave 48.31 cc. N. at 17° C. [barometer 757.0 mm. at 21° C] = 17.82 per cent. N.

Sulphur.—0.3598 gram dried substance gave 0.0135 gram $BaSO_4$ = 0.0018 gram S = 0.52 per cent.

CRYSTALLIZED OAT-GLOBULIN *derived from* **21.**

	24. Rhombohedra.	**25.** Rhomboheda and Octahedra.	**26.** Octahedra.
Carbon	52.17	52.11	52.25
Hydrogen	6.96	7.10	7.08
Nitrogen	17.93	17.94	17.82
Sulphur	0.53 }	22.85	0.52
Oxygen	22.41 }		22.33
	100.00	100.00	100.00
Ash	0.06	0.20	0.05

No chlorine could be detected in these crystals. It is thus shown that the crystallized globulin, except for its slightly lower content of sulphur, has the same composition as the mother-substance and agrees in all respects with the globulin obtained directly from ground oats by extraction with hot salt solution and described in my former paper, except that it is not soluble in water and contains a little less sulphur.

It is further to be noted that the methods of preparation were suited to fractionally separate the substance into its component parts had it been a mixture of two or more globulins. It seems improbable that the sodium chloride which Grübler found in his crystallized globulin from squash seed was anything more than an accidental impurity. The ash of Grübler's preparations contained traces of the various salts present in the solutions from which they separated, and since the content of total mineral matters is variable and, as in my preparations **24** and **26**, sometimes amounts to but .05 per cent. of the proteid, there appears to be no good ground for Grübler's assumption that crystallized proteids are definite compounds of globulin with sodium chloride or with other inorganic bodies.

III. GLOBULIN OBTAINED FROM GROUND OATS BY DIRECT EXTRACTION WITH SODIUM CARBONATE SOLUTION.

One hundred grams of ground oats were digested with a one per cent. sodium carbonate solution, the extract was filtered clear and the sodium carbonate converted into bicarbonate by treatment with carbon dioxide. The solution was then saturated with ammonium sulphate and the heavy precipitate filtered off. This precipitate was washed with a saturated solution of ammonium sulphate until the washings no longer reacted alkaline. The precipitate was then extracted thoroughly with salt solution and this extract dialyzed. After removal of the salts, by dialysis, the proteid, which had separated, was filtered off and washed with alcohol and ether. It weighed, air-dry, one and a half grams, being, therefore, about one and a half per cent. of the oat kernel. Dried at 110° for analysis it was found to have the following composition:

OAT PROTEID.—*Extracted from ground oats by Sodium Carbonate Solution and Soluble in Sodium Chloride Solution.*

PREPARATION **27.**

	I.	II.	Ash-free. I.	Ash-free. II.
Carbon	51.68	----	51.82	----
Hydrogen	6.91	----	6.93	----
Nitrogen	17.92	17.91	17.95	17.94
Sulphur	----	---- }	23.30	----
Oxygen	----			----
Ash	0.26		----	----
			100.00	

Ash.—0.2652 gram substance dried at 110° C. gave 0.0007 gram ash = 0.26 per cent.

Carbon and Hydrogen.—0.2296 gram dried substance gave 0.4350 gram CO_2 = 51.68 per cent. C and 0.1429 gram H_2O = 6.91 per cent. H.

Nitrogen, I.—0.3441 gram dried substance gave 52.15 cc. N at 13° C. [barometer 764.0 mm. at 25° C.]=17.92 per cent. N.

II.—0.3294 gram dried substance gave 50.14 cc. N at 14° C. [barometer 762.0 mm. at 23° C.=17.91 per cent. N.

From this analysis it is seen that this body is the same as that obtained from the oats by direct extraction with hot salt-solution, as well as from the "albuminate" by the methods just described.

IV. SUMMARY OF ANALYSES OF OAT-GLOBULIN.

The agreement of the analyses of the different preparations of the Oat-Globulin may be seen from the following table:

	20	21	22	23	24	25	26	27
Carbon	52.22	52.30	52.05	52.35	52.17	52.11	52.25	51.82
Hydrogen	6.98	6.98	6.93	7.02	6.96	7.10	7.08	6.93
Nitrogen	17.82	17.86	17.85	17.73	17.93	17.94	17.82	17.95
Sulphur	0.76	0.69 }	23.17	0.73	0.53 }	22.85	0.52 }	23.30
Oxygen	22.22	22.17 }		22.17	22.41 }		22.33 }	
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The writer has found nowhere any description of a vegetable proteid like this. Although its proportion of carbon is the same as that of the globulin extracted from oats by cold salt-solution, its nitrogen-content is one per cent. greater. It contains nearly a per cent. less of nitrogen, about one half per cent. more of carbon and but one-half as much sulphur as Chittenden & Hartwell* found in the globulin or "vegetable vitellin" of squash-seed.

Barbieri's analysis of squash-seed globulin agrees fairly well with these analyses of the crystallized oat-globulin, but carbon and sulphur are somewhat lower, nitrogen higher and as regards sulphur and nitrogen his analysis differs materially from the later ones of Chittenden & Hartwell.

Grübler's earlier analyses of squash-seed globulin which gave 53.21 per cent. of carbon and 19.22 per cent. of nitrogen were evidently incorrect, and in a recent publication† this chemist states the composition of crystallized proteid from squash-seed as given below, where the various analyses of vegetable globulin, except the earlier ones of Grübler, are tabulated.

I have obtained from flax-seed a crystallized globulin whose composition agrees quite nearly with that of the squash-seed vitellin.

The following table gives the composition of crystallizable globulin from various seeds:

COMPOSITION OF CRYSTALLIZABLE VEGETABLE GLOBULIN.

	Ritthausen.		Barbieri.	Ritth.	Chittenden & Hartwell.			Grübler	Osborne.	
	Hemp cryst.	Castor bean cryst.	Squash-seed. am'ph.	Squash-seed. cryst.	Squash-seed. cryst.	Squash-seed. spheroid.	Squash-seed. am'ph.	Squash-seed. cryst.	Flax seed cryst.	Oats cryst.
C	50.98	50.88	51.88	51.61	51.60	52.03	51.81	51.48	51.36	52.18
H	6.92	6.98	7.51	7.00	6.97	6.93	6.94	6.76	6.94	7.05
N	18.73	18.58	18.08	----	18.80	19.08	18.71	18.14	18.66	17.90
S	0.82	0.77	0.60	----	1.01	1.04	1.01	0.96	0.82	0.53
O	22.55	22.79	21.93	----	21.62	20.92	21.53	22.66	22.22	22.34
	100.00	100.00	100.00	----	100.00	100.00	100.00	100.00	100.00	100.00
Ash		----	1.11	----	0.30	0.36	----	0.18	----	----

* Journal of Physiology, **XI**, pp. 437–440. † Jour. für prak. Chemie, **XLIV**, 369.

V. Proteid extracted from ground Oats by direct Treatment with Alkali Carbonate.

The precipitate produced by saturating with ammonium sulphate the sodium carbonate extract of the oats from which the globulin 27 had been extracted, was next washed with warm eighty per cent. alcohol until all the proteid soluble in that liquid was removed. The residue was then found to be insoluble in one per cent. sodium carbonate solution and was therefore dissolved in two-tenths per cent. caustic potash solution, filtered and the dissolved proteid completely precipitated by neutralizing with dilute acetic acid. After washing the latter with water, alcohol and ether and drying at 110° its composition was as follows:

OAT PROTEID.—*Extracted from ground Oats by Sodium Carbonate Solution.*

PREPARATION 28.

	I.	II.	Ash-free. I.	Ash-free. II.
Carbon	53.25	----	53.63	----
Hydrogen	7.13	----	7.18	----
Nitrogen	15.99	15.89	16.11	16.01
Sulphur	0.81	----	0.82	----
Oxygen	----	----	22.26	----
Ash	0.72	----	----	----
			100.00	

Ash.—0.5661 gram substance dried at 110° C. gave 0.0041 gram ash = 0.72 per cent. ash.

Carbon and hydrogen.—0.3269 gram dried substance gave 0.6383 gram CO_2 = 53.25 per cent. C, and 0.2096 gram H_2O = 7.13 per cent. H.

Nitrogen.—I. 0.3637 gram dried substance gave 49.33 cc. N at 13° C. (barometer 761.5 mm. at 25° C.) = 15.99 per cent. N.

II. 0.3916 gram dried substance gave 52.95 cc. N at 13° C. (barometer 759.2 mm. at 23° C.) = 15.89 per cent. N.

Sulphur.—0.5000 gram dried substance gave 0.0295 gram $BaSO_4$ = 0.0041 gram S = 0.81 per cent. S.

If this analysis is compared with that of preparation 17, which was obtained from ground oats by direct extraction with two-tenths per cent. potash solution, it will be seen that the two agree quite closely.

	28.	17.
Carbon	53.63	53.49
Hydrogen	7.18	7.01
Nitrogen	16.11	16.39
Sulphur	0.81	0.99
Oxygen	22.27	22.12
	100.00	100.00
Ash	0.72	1.00

These two bodies are thus shown to be essentially the same in composition and the results of direct extraction with alkali given in the previous paper are confirmed.

VI. Conclusions.

The proteids of the oat kernel undergo great change in contact with water or sodium chloride solution. The body extracted by direct treatment of ground oats with alcohol differs much in properties and composition from that extracted by alcohol after the ground oats have had contact for some time with water or sodium chloride solution.

Direct treatment with sodium carbonate solution yields the same globulin as that obtained by direct treatment with hot sodium chloride solution, but a different globulin from that obtained by direct treatment with cold sodium chloride solution. Sodium carbonate solution also extracts another proteid the same as that yielded by direct extraction with dilute potash-lye which, again, is distinct in composition from that obtained after the oats have been in contact with water. It is remarkable that all these transformations are the result of the use of water or salt-solution as contrasted with the use of three agents known to suspend or destroy ferment-action, viz: alcohol, alkali or heat.

The fact that the globulin extracted after treatment of the ground oats with alcohol has the same composition as that obtained by direct treatment with sodium chloride, would indicate that alcohol temporarily suspends a ferment-action which is induced by water or solutions of neutral salts.

It is probable that the primary proteids originally contained in the oat-kernel are the three following bodies:

Primary Oat-Proteids.

	Alcohol-soluble Proteid. Average of five analyses.	Salt-soluble Proteid or Globulin. Average of nine analyses.	Alkali-soluble Proteid. Average of two analyses.
Carbon	53.01	52.19	53.56
Hydrogen	6.91	7.00	7.09
Nitrogen	16.43	17.86	16.20
Sulphur	2.26	0.65	0.90
Oxygen	21.39	22.30	22.25
	100.00	100.00	100.00

Of the above substances the alcohol-soluble proteid forms about one and a quarter per cent., the globulin about one and a half

per cent., and the alkali-soluble body the remainder of the proteids contained in the oat-kernel, with the possible exception of extremely small amounts of proteose and acid-albumin. The two latter substances are quite probably the results of change occurring during extraction; the evidence, however, on this point is not conclusive.

Three other proteids are obtained evidently by the alteration of the primary proteids, and probably through ferment-action, when the ground-oats are subjected to contact with water or solutions of neutral salts. The composition of these derived or secondary proteids is as follows:

Secondary Oat-Proteids.

	Alcohol-soluble Proteid. Average of four analyses.	Salt-soluble Proteid or Globulin. Average of four analyses.	Alkali-soluble Proteid. Average of two analyses.
Carbon	53.70	52.34	52.49
Hydrogen	7.00	7.21	7.10
Nitrogen	15.71	16.88	17.11
Sulphur	1.76	0.88	0.80
Oxygen	21.83	22.69	22.50
	100.00	100.00	100.00

It would appear that none of the proteids from the oat-kernel have been obtained and analyzed in a state of purity by previous investigators. The author therefore reserves the right to revise the nomenclature of these bodies, after further progress in his researches on the other vegetable proteids, with which he is now engaged.

THE PROTEIDS OF THE MAIZE KERNEL.*

By Professor R. H. Chittenden and Dr. Thomas B. Osborne.

1. The maize kernel contains several distinct proteids well characterized in reactions and composition. Of these there are three globulins, and one or more albumins, all occurring in small proportion and an alcohol-soluble proteid which is relatively abundant.

2. The substance obtainable from the maize kernel by extraction with 10 per cent. solution of sodium chloride and separation by dialysis, or by precipitation with ammonium sulphate, followed by dialysis—is mainly a mixture of two globulins, differing from each other in composition and in coagulation points.

3. The mixed globulins can be approximately separated from each other by fractional heat-coagulation or by deposition from warm dilute salt-solution. In the former process there is formed a small amount of proteose-like bodies.

4. The two globulins separable by the above methods, are a myosin-like body and a vitellin-like body.

The myosin-like globulin agrees closely in composition with animal myosin as shown by the following analyses. It has, however, a coagulation point (in 10 per cent. sodium chloride solution) of about 70° C.

	Maize Myosin. Average of two analyses.	Animal Myosin. Average of analyses of 13 preparations from various sources.
Carbon	52.66	52.82
Hydrogen	7.02	7.11
Nitrogen	16.76	16.77
Sulphur	1.30	1.27
Oxygen	22.26	22.03
	100.00	100.00

The vitellin-like globulin is almost entirely non-coagulable by heat, when dissolved in dilute salt-solutions. It is more soluble in warm than in cold salt-solutions and when separated from the former, either by cooling the fluid or on dialysis, almost invariably appears in the form of small spheroids.

It has the following composition :

Maize Vitellin.	Average of six analyses.
Carbon	51.71
Hydrogen	6.85
Nitrogen	18.12
Sulphur	0.86
Oxygen	22.46
	100.00

5. These two globulins exist as such in the maize kernel, as is evident from the coagulation points of their salt-solution, from the fact that their separation can be accomplished without the aid of heat; and lastly since it is possible to extract the individual globulins directly from the kernel by the use of appropriate solvents.

6. Direct extraction of the finely powdered maize meal with water yields a dilute salt-solution which dissolves the myosin, leaving the bulk of the vitellin undissolved. Probably the character of the salts present in the kernel plays an important part in this separation. From this solution the myosin can be separated in a fair degree of purity by the usual methods.

7. Extraction of maize meal with 10 per cent. sodium chloride solution, after previous extraction with water, dissolves the vitellin, which can be separated from this solution by the customary methods. So prepared it agrees exactly in composition with the vitellin separated by heat-coagulation from the mixed globulins.

8. The third globulin present in the maize kernel is characterized by extreme solubility in very dilute salt-solutions, especially of phosphates and sulphates. It separates from such solutions only by prolonged dialysis, i. e., not until nearly every trace of the salts has been removed. It coagulates in a 10 per cent. sodium chloride solution in the neighborhood of 62° C. and has the following composition :—

Maize Globulin.	Highly soluble.
Carbon	52.38
Hydrogen	6.82
Nitrogen	15.25
Sulphur	1.26
Oxygen	24.29
	100.00

* This paper is a brief summary of the results of an extended investigation of the Proteids of Indian Corn carried on during 1890 and 1891, in the Sheffield Biological Laboratory of Yale University. The full details of the research are printed in the *American Chemical Journal*, vol. xiii, pp. 453–468 and pp. 529–552, and vol. xiv, pp. 20–44. The Indian Corn used was the White Dent variety raised on the farm of Mr. J. H. Webb, near New Haven, and was freshly ground at this Station as required.

9. Through the long continued action of water and also of strong solutions of salts, as ammonium sulphate, the myosin and the globulin noticed in the preceding paragraph are changed into insoluble modifications, soluble however in 0.5 per cent. sodium carbonate solution, from which solution they are precipitated, on neutralization, apparently as albuminates. So prepared these insoluble modifications are characterized by a relatively high content of carbon.

10. An aqueous extract of maize meal as well as a sodium chloride extract apparently contains in addition to the globulins, two albumin-like bodies, more or less coagulable by heat, but, as prepared, unlike in chemical composition. Owing to the difficulties encountered in separating these albumins their composition could not be determined with certainty.

11. A small amount of proteose can be detected in the extracts of maize meal, after the globulins have been entirely removed, but apparently this is mainly if not wholly, an artificial product, resulting from alteration of some one or more of the preceding bodies.

12. The chief proteid in the maize kernel is the peculiar body, known as maize-fibrin or better as *Zein*, which is soluble in warm dilute alcohol, but insoluble both in water and in absolute alcohol. Zein is characterized by a high content of carbon, by its resistance to the action of dilute alkalies (i. e., non-convertibility into alkali-albuminate) and by the ease with which it is converted into an insoluble modification on being warmed with water or with very weak alcohol.

Soluble zein and its insoluble modification have the same chemical composition, as indicated by the following analyses:

	Soluble Zein. Average of six analyses.	Insoluble Zein. Average of three analyses.
Carbon	55.28	55.15
Hydrogen	7.27	7.24
Nitrogen	16.09	16.22
Sulphur	0.59	0.62
Oxygen	20.77	20.77
	100.00	100.00

OBSERVATIONS ON THE GROWTH OF MAIZE CONTINUOUSLY ON THE SAME LAND.

In 1888* this Station studied the effect of distance of planting on the quality and quantity of the maize crop.

In 1889† the experiment was repeated on the same land.

In 1890‡ the Station studied the comparative effects of planting in hills and drills on the quality and quantity of the maize crop, using for the test the plots which had been used in the two previous years.

In 1891 the same land was planted to maize for the fourth season in order to observe the yield from year to year when grown continuously on the same land; contrasting the crops grown with heavy applications of manure or of fertilizer chemicals with those grown where no fertilizer of any kind was applied.

Following is a record of the results for the first year. These do not require discussion till further data accumulate. It is hoped the experiment may be carried on for a considerable number of years.

Arrangement of the Field.

The accompanying diagram will make clear the arrangement of the field in 1891 and its division into strips.

The whole piece was divided into strips identical with those figured in the Report of 1890, page 184. They are four in number running from north to south, and each one containing three-tenths of an acre. They will be referred to as Plots A B C and D.

South.		North.
	Plot A.—Cow Manure at the rate of 10 cords per acre.	
	Plot B.—Hog Manure at the rate of 13½ cords per acre.	
	Plot C.—Fertilizer Chemicals at the rate of 1700 pounds per acre.	
	Plot D.—No manure or fertilizer of any kind.	

* Report Connecticut Experiment Station, 1889, p. 9.

† Report Connecticut Experiment Station, 1889, p. 219.

‡ Report Connecticut Experiment Station, 1890, p. 184.

Fertilizers and Manure used.

In the years 1888 and 1889 the same commercial fertilizer was applied on all the Plots and the quantity of crop removed was practically alike on all.

In 1890, Plot A received 20,925 pounds or 3.2 cords of cow manure, which is at the rate of 10.7 cords per acre.

Plot B received 21,141 pounds or 4 cords of hog manure which is at the rate of 13.3 cords per acre.

Plot C 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.

Plot D received no fertilizers.

Analyses of the samples of manure are given on page 71, of the Report for 1890.

The following table shows 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.

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 each plot in fertilizer per acre in 1888	45.1	107.2	77.8
Took off in crop per acre	94.8	39.4	50.2
Gained (+), or lost (−) by the soil in 1888	−49.7	+67.8	+27.6
Put on each plot in fertilizer per acre in 1889	45.1	107.2	77.8
Took off in crop	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 Plot A in cow manure per acre in 1890	293	142	209
Took off in crop per acre	114	47	60
Gained or lost on Plot A per acre in 1890	+179	+95	+149
Put on Plot B in hog manure per acre in 1890	409	569	72
Took off in crop per acre	120	50	64
Gained or lost on Plot B per acre in 1890	+289	+519	+8
Put on Plot C in mixed chemicals per acre in 1890	172	162	69
Took off in crop per acre	103	43	55
Gained or lost on Plot C per acre in 1890	+69	+119	+14
Took off in crop from Plot D which received no fertilizer in 1890	66	27	37
Lost by the soil on Plot D per acre in 1890	−66	−27	−37

If from the quantities of these ingredients added to the plots during the three years in the manure, is deducted the quantities of each ingredient taken from the land in the same time by the crops, the remainder shows how much has been added to (+) or taken from (−) the original capital of the soil by the three years' cropping, leaving out of any account at present losses by drainage or liberation of nitrogen from the soil.

Table I expresses the result in pounds per acre.

TABLE I.—ENRICHMENT (+) OR IMPOVERISHMENT (−) OF SOIL BY THREE YEARS' CROPPING.

	Nitrogen.	Phosphoric acid.	Potash.
Plot A	+113.5	+241.3	+205.9
Plot B	+223.5	+665.3	+ 64.9
Plot C	+ 3.5	+265.3	+ 70.9
Plot D	−131.5	+119.3	+ 19.9

In 1891 practically the same quantities of fertilizers were applied to each plot as in 1890.

Plot A received 20,453 pounds or 3.1 cords of cow manure, equal to 10.3 cords per acre.

Plot B received 21,721 pounds or 4.1 cords of hog manure, equal to 13.6 cords per acre.

Plot C received precisely the same chemicals as in 1890, and Plot D received nothing.

The manure was hauled and spread on April 1st and 3d. The land was plowed about the first of May, and on the 16th of May the fertilizer was sown on Plot C, and all four plots were harrowed and planted.

Planting.

With an Aspinwall planter, White Edge Dent—a variety of maize which has been raised in this farm for many years,— was put in on all four plots alike, in rows four feet apart. The stalks stood on the average 12 inches apart in the row.

Cultivation.

The crop came up well and made good growth through the season. It was cultivated with the horse cultivator three times and the weeds in the rows hoed out. Plots A and B did not differ in appearance through the season. Plot C was at first behind those above named in development, but by the end of the season the difference was not very noticeable. The crop on D was spindling and poor.

The season was very favorable for ripening corn and there was no soft corn in the field at harvest. All of it was sound though on Plot D there were many very small ears or "nubbins."

Cutting and Harvest.

On October 4th the corn was fully ripe and there had been no frost.

There were nine rows in each strip. The central row of each was cut for the laboratory sample and stacked by itself. The whole crop was cut and separately stacked on the same day.

On October 26th, the crop on each plot was weighed and husked and samples were taken to the laboratory and immediately prepared for analysis.

GROSS YIELD OF THE PLOTS.

Table II presents the gross yield of field-cured kernels, cobs and stover on the several plots.

Inasmuch as the kernels were air-dried on the cob the weight of the latter in the field-cured condition could not be ascertained. The weight therefore of the kernels in the table is slightly higher and that of the cobs correspondingly lower than it should be. But the error is insignificant.

The gross yield of kernels and of total crop on plots A and B which received a heavy dressing of manure, is practically the same; the difference being less than three per cent. The Stover on these plots differs by about six per cent. being largest on plot A where cow manure was used.

Plot C, which had received fertilizer chemicals, gave less gross yield than Plot A by somewhat more than eight per cent.

Plot D, which for two years has had no fertilizer of any kind, produced a crop weighing about sixty-two per cent. of the weight of the crop harvested from the plots which had been heavily manured for the last two years.

TABLE II.—GROSS YIELD OF THE PLOTS IN POUNDS PER ACRE.

	Plot A Cow manure.	Plot B Hog manure.	Plot C Chemicals.	Plot D No fertilizer.
Kernels	6003.8	6132.8	5688.0†	3154.6
Cobs*	697.5	717.5	665.7	431.3
Stover	6720.0	6300.0	5969.9	4710.0
	13422.3	13150.3	12323.6	8295.9

DRY SUBSTANCE OF THE CROPS IN POUNDS PER ACRE.

Since the field-cured crops contained large and varying quantities of water a strict comparison of yields can only be made on the dry substance of the crops. This comparison is as follows:

TABLE III.—DRY MATTER OF THE CROPS, POUNDS PER ACRE.

	In kernels.	In cobs.	In stover.	Total.
Plot A, cow manure	4296.3	623.8	3255.8	8175.9
Plot B, hog manure	3723.3	640.7	3235.0	7599.0
Plot C, fertilizer chemicals	2897.0†	594.5	3216.6	6708.1
Plot D, no fertilizer	2515.8	385.2	2490.2	5391.2

The total dry matter is largest on Plot A, which had been heavily dressed with cow manure for two years. The dry matter on plot B, which had a heavy dressing of hog manure for two years was a little more than nine-tenths as large, the yield of plot C,† which had received commercial fertilizers was a little more than eight-tenths as large, while that of plot D that had received no fertilizer for two years was only two-thirds as large as that of the largest yield, that is of plot A.

The yield of dry stover was practically the same on plots A, B and C. The weight of stover on plot D was a little more than three-quarters that of the others.

The greatest differences between the plots is in the yield of dry kernels. Plots B, C and D yielded respectively 86.6, 67.4, and 58.5 per cent. of the yield from plot A.

YIELD OF EACH FOOD INGREDIENT, IN POUNDS PER ACRE.

From the analyses which are given later on and from the gross weights of crops, has been calculated Table IV, which shows how many pounds of each food ingredient was harvested in the kernels, the cobs, and the stover separately and how much in all together. The cobs were not analyzed, but as their total weight was comparatively small and as their composition is not likely to vary widely, the average composition of cobs, as determined in other analyses, was applied for the calculation.

* Air dry. † See foot note on page 145.

TABLE IV.—YIELD OF EACH FOOD INGREDIENT IN POUNDS PER ACRE.

	Plot A. Kernels.	Plot A. Cob.	Plot A. Stover.	Plot A. Total.	Plot B. Kernels.	Plot B. Cob.	Plot B. Stover.	Plot B. Total.	Plot C. Kernels.	Plot C. Cob.	Plot C. Stover.	Plot C. Total.	Plot D. Kernels.	Plot D. Cob.	Plot D. Stover.	Plot D. Total.
Water	1707.5	74.7	3464.2	5246.4	2409.6	76.8	3065.0	5551.4	2791.0	71.2	2753.3	*5615.5	638.8	46.1	2219.8	2904.7
Ash	60.0	9.8	194.8	264.6	52.8	10.0	184.3	247.1	37.0	9.4	164.2	210.6	32.8	6.0	126.2	165.0
Albuminoids	431.1	16.7	162.6	610.4	375.3	17.2	186.3	578.8	257.7	16.0	157.6	431.3	199.7	10.3	115.9	325.9
Fiber	49.3	210.3	1007.4	1267.0	37.4	215.9	981.0	1234.3	33.0	200.4	1005.3	1238.7	30.9	129.8	776.7	937.4
Nitrogen-free extract	3507.4	383.5	1847.3	5738.2	3043.7	393.9	1831.7	5269.3	2403.3	365.4	1848.9	4617.6	2108.9	236.8	1437.5	3783.2
Fat	248.5	3.5	43.7	295.7	214.1	3.7	51.7	269.5	166.0	3.3	40.6	209.9	143.5	2.3	33.9	179.7
	6003.8	698.5	6720.0	13422.3	6132.9	717.5	6300.0	13150.4	5688.0	665.7	5969.9	12323.6	3154.6	431.3	4710.0	8295.9

* See foot note on page 145.

The production of each food ingredient was greatest on Plot A, least on Plot D.

There was more water in the harvested crop on Plot C than in that of any other plot.*

While the albuminoids make up 7.47 and 7.61 per cent. respectively of the whole dry matter of the crops on Plots A and B they make only 6.05 per cent. of the crop on Plot D.

The crops on A and B are therefore richer in albuminoids, as well as larger than on the other two plots.

Differences in Chemical Composition of Crop caused by Differences in Fertilization.

Table V gives the analyses of the kernels and stover from the four plots both in the field-cured and water-free condition. The latter best serves for comparison.

Fat and Fiber.—There are no striking differences in the per cent. of these ingredients in the crops from the different plots.

Ash.—The per cent. of ash in the kernels from the several plots is practically the same; in the stover it is noticeably lower on Plots C and D.

Nitrogen-free Extract.—(Starch, Sugar Gum),—is one per cent. higher in the kernels from Plot C and two per cent. higher in those from Plot D, than in kernels from Plots A and B.

TABLE V.—ANALYSES OF FIELD-CURED MAIZE KERNELS AND STOVER FROM PLOTS A, B, C, D.

Plot.	Analyses of Field-cured Maize. Water.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract (starch, gum, etc.)	Fat.	Analyses. Calculated Water-free. Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract (starch, gum, etc.)	Fat.
Kernels.											
A	28.44	1.00	7.18	.82	58.42	4.14	1.42	10.05	1.15	81.60	5.78
B	39.29	.86	6.12	.61	49.63	3.49	1.42	9.98	1.02	81.81	5.77
C	49.07*	.65	4.53	.58	42.25	2.92	1.26	8.89	1.15	82.97	5.73
D	20.25	1.04	6.33	.98	66.85	4.55	1.30	7.95	1.23	83.83	5.69
Stover.											
A	51.55	2.85	2.42	15.04	27.49	.65	5.88	5.02	30.97	56.76	1.37
B	48.65	2.93	2.96	15.57	29.07	.82	5.70	5.76	30.32	56.63	1.59
C	46.12	2.75	2.64	16.84	30.97	.68	5.10	4.90	31.26	57.47	1.27
D	47.13	2.68	2.46	16.49	30.52	.72	5.07	4.66	31.13	57.77	1.37

* The per cent. of water in the kernels from Plot C is so much higher than that in the kernels of either of the other plots or than has ever been found in field-cured maize from this locality that an error in weighing or recording the weight of the subsample of kernels is strongly suspected. This cannot now be detected or remedied. Therefore there is reason to doubt in case of the kernels from Plot C, the correctness of the figures for gross yield, for dry matter, water, and all the other ingredients and the analysis in the field-cured condition. This affects only the kernels on Plot C. The water-free analysis is not affected.

Most interesting are the differences in the per cent. of protein in the kernels, that portion of the plant which is regarded as most constant in composition.

The dry matter of the kernels from Plots A and B, the heavily manured plots, contained in round numbers one per cent. more protein than the kernels from Plot C* which received commercial fertilizers and two per cent. more than those of Plot D which had no fertilizer.

On plots which received an excess or an abundance of available plant food, the kernels in the crop were decidedly richer in albuminoids and less starchy than on plots which were relatively deficient in plant food.

Quantities of Nitrogen, Phosphoric Acid and Potash applied in the Manure or Fertilizer and Removed by the Crop.

The manure used, which was made from the same kind of feed and of animals as in 1890, was not analyzed again in 1891 but was assumed to have the same composition as in the previous year.

In Table VI are given, first, the total quantities of nitrogen, phosphoric acid and potash which have been applied to the land in the years 1888, 1889 and 1890 in excess of the quantities removed by the crops of those years, second, the quantities applied in 1891, third, the quantities removed by the maize crop of 1891 and fourth, the quantities of these ingredients added in four years in excess of what was removed by the four crops, marked [+], or the quantities of each removed by the crops in excess of what was supplied in fertilizers, marked [−].

The larger quantity of phosphoric acid and smaller quantity of potash in excess on Plot B as compared with A is explained by differences in the feed of the cattle which made the manure used. The cows ate large quantities of hay and stover, relatively rich in potash while the hogs had phosphates in the bones which came in garbage, but potash in the food was relatively small in quantity and it may be that the slightly smaller yield in 1891 of Plot B was caused by a relative deficiency of potash.

So heavy an application as 4.1 cords per acre of this hog manure while supplying nitrogen and phosphoric acid in very great excess of the quantity which the crop removes supplies only a small excess of potash, less than eight pounds.

* See foot note, page 145.

Table VI.—Enrichment or Impoverishment of Soil by Four Years Manuring and Cropping.

	Cow Manure. Plot A.			Hog Manure. Plot B.			Fertilizer Chemicals. Plot C.			No Fertilizer. Plot D.		
	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.
After three years' cropping	+113.5	+241.3	+205.9	+223.5	+665.0	+64.9	3.5	+265.3	+70.9	−131.5	+119.3	+19.9
Applied in 1891	286.3	136.4	204.5	419.9	586.5	72.4	172.0	162.0	69.0	00.0	00.0	00.0
Taken off in Crop of 1891	97.7	37.5	79.9	92.7	31.6	65.0	69.3	23.5	47.7	52.1	22.2	30.7
Leaving in excess (+) or deficiency (−) after four years' cropping	+302.1	+340.2	+330.5	+550.7	+1219.9	+72.3	+106.2	+403.8	+92.2	−183.6	+97.1	−10.8

The relative proportions of phosphoric acid, potash and nitrogen in the average maize crop and in the cow manure and hog manure made on this farm are as follows:

	Phosphoric acid.	Potash.	Nitrogen.
Average maize crop	1	1.6	2.4
Cow manure	1	1.9	2.7
Hog manure	1	.12	.72

That is, for every pound of phosphoric acid removed by the crops, 1.6 pounds of potash and 2.4 pounds of nitrogen are also taken. With every pound of phosphoric acid applied in cow manure, 1.9 pounds of potash and 2.7 pounds of nitrogen are applied; the ratio being quite nearly the same as in the crop.

But if enough hog manure is applied to cover the nitrogen which is to be removed in the crop, there will also be applied about three times as much phosphoric acid but only one-third as much potash as the following crop will remove.

Of course in crop rotation as usually practiced, the crop residues and unused manure remaining in the soil as well as the natural capacity of the soil itself, are taken account of in manuring for the next crop.

Yields of "Shelled Corn," and Percentage Composition of Dry Matter for Four Years.

Table VII 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 and from Plots A, B, C, D in 1891 calculated to an acre. The rows were four feet apart in all four years.

The plots marked A were on cow manure, B were on hog manure, C on commercial fertilizers, and D had no fertilizer in the years 1890 and 1891.

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 VII.—YIELD OF DRY MATTER AND "SHELLED CORN" PER ACRE FOR FOUR YEARS AND PERCENTAGE OF DRY MATTER.

	Year.	Distance of Planting.	Yield of Dry Matter per Acre.	Bushels of Sound Shelled Corn.	Percentage Composition of Dry Matter: Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
Fertilized alike	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						
On Cow Manure	1890A	" 10 "	9014	91	4.0	7.9	19.8	65.7	2.6
On Hog Manure	1890B	" 10 "	9436	97	4.2	8.0	19.6	65.5	2.7
On Fertilizer Chemicals	1890C	" 10 "	8070	87	3.9	8.0	21.2	64.4	2.5
No Manure or Fertilizer	1890D	" 10 "	6626	51	3.8	6.2	20.7	66.7	2.6
On Cow Manure	1891A	" 12 "	8176	103	3.2	7.5	15.5	70.2	3.6
On Hog Manure	1891B	" 12 "	7599	89	3.3	7.6	16.2	69.3	3.6
On Fertilizer Chemicals	1891C	" 12 "	6708	70	3.2	6.4	18.5	68.8	3.1
No Manure or Fertilizer	1891D	" 12 "	5391	60	3.1	6.0	17.4	70.2	3.3

FURTHER RESULTS FROM THE APPLICATION OF FUNGICIDES TO PREVENT THE "SPOT" OF QUINCE (*Entomosporium maculatum.*)

By Dr. Roland Thaxter.

In the last report of the Station (1890) photo-reproductions were given showing the beneficial results of treatment with Bordeaux mixture for the leaf-spot of quince in the orchard of Mr. Geo. F. Platt at Milford, as compared with portions of the same orchard which received no treatment, the rows in the one case having retained their foliage intact till the last of October, while the untreated rows beside them lost their leaves by the end of summer. Owing to the injury done by the fungus in previous years no fruit set in 1890, even on the treated rows, a natural result of successive defoliation, and it was suggested in the report just referred to that a second season's treatment would have an additional interest in connection with the comparative set of fruit on the rows treated and untreated during the previous year. That the effect was strikingly in favor of the treatment, may be seen by reference to the photo-reproduction of single treated and untreated rows reproduced from photographs taken about September 20th, as well as by the figures which will be given presently.

At the time of blossoming, in May of the present year, the treated rows were conspicuous from a distance by the much greater body of bloom upon them, and it may be mentioned that the two rows which had received Bordeaux mixture showed a decided superiority in this respect over those treated with carbonate of copper.

The first treatment of the season was given just as the first blossom buds were opening, and in all the applications the two Bordeaux-mixture rows were sprayed with the same strength of the mixture which was employed during the season of 1890 (6 lbs. sulphate of copper, 4 lbs. of lime, to 25 gallons of water). On the two remaining rows that were treated, a precipitated carbonate of copper was used in place of the ammoniacal solution employed in 1890, about three pounds of sulphate of copper being precipitated

from concentrated solution with carbonate of soda, and then diluted to twenty-five gallons with water.

The first application was made May 11, the second May 28, and the third *and last* June 22. Owing to the unusually dry summer a fourth application was unnecessary, the Bordeaux mixture adhering so firmly that it was conspicuous on the leaves late in September.

The rows treated with Bordeaux mixture set an abundant yield of fruit, in most cases as much as the tree could properly mature, while the other two treated rows set a much smaller amount. The "set" of the untreated rows was very small, and at the time of harvesting the relative yield of *marketable* fruit was as follows:

	Marketable fruit.
Two rows sprayed with Bordeaux mixture in 1890–91	71½ baskets.
" " " " ammoniacal carbonate of copper in 1890, and with precipitated carbonate of copper in 1891	7 "
Five rows untreated in 1890–91	1 "

The superiority of the fruit from the rows sprayed with Bordeaux mixture as compared with that from the other treated rows in regard to the *quality*, was quite remarkable. While the yield from the carbonate of copper rows was very fair as regards quantity, the fruit was so badly injured by the spot and more especially by being "wormy," that only the very small quantity of fruit above stated was found to be marketable. The apparent effectiveness of the Bordeaux mixture in keeping off the quince "maggot" suggests the advisability of using an insecticide with the fungicide in the first two treatments as is often done in spraying for the codlin moth and apple scab. If Paris green is used it should be mixed to a smooth paste with a little water, and then stirred into the Bordeaux mixture in the proportion of one pound of Paris green to 100 gallons of mixture.

The application of the fungicide in the present case was made much more effective than in the previous year, and a perfectly even distribution of the material ensured by means of a plunger, which was worked in the barrel by the person who pumped. This consisted of a broom-stick with a short piece of board screwed on the end and was worked through a small hole bored in the top of the barrel. Such a contrivance, the details of which need not be dwelt upon, gives the most satisfactory results for rapid and complete stirring, and is indispensable for good work.

It was found that a second or third stream turned into the barrel was either utterly ineffectual in practice, or interfered too seriously with the working of the nozzles if it was made large enough to do its work with any thoroughness.

The cash account with the two rows treated with Bordeaux mixture is about as follows :

Dr.	
To 3 men and team 3 hours	$1.80
To 36 lbs. sulphate of copper at 6c.	2.16
To 24 lbs. lime at 1 c.	.24
	$4.20
Cr.	
To 71½ baskets of first-class fruit at .75	$53.62
Balance above expenses	$49.42

Comparing the yield from the untreated rows and estimating it at ⅓ basket per row, which is more than was actually obtained, the net income from a single treated row was one hundred times as great as from an untreated row.

Quince Orchard showing result of Spraying with Bordeaux Mixture, 1891.

POTATO SCAB.

By Dr. Roland Thaxter.

Since the publication of the report of the Station for 1890, in which the cause of the above disease was described in some detail and referred to the action of a peculiar fungus as yet unnamed, experiments on the subject have been continued at the Station and elsewhere, which fully corroborate the conclusions reached in regard to the causation of the disease. Cultures and infections under test conditions, similar to those described in the report referred to, were repeated in the green-house with similar results and demonstrated beyond question that the fungus and the disease are directly connected as cause and effect. Observations in the field in Connecticut as well as in other New England States, have also satisfied the writer of the correctness of this view, the fungus being easily demonstrated in every case examined, and visible to the naked eye in all freshly dug tubers affected by the disease in question.

It should be remarked that no condition of the disease, whether deep-seated or superficial, was found without this accompanying growth, and the season's observations in this respect have led the writer to believe that the supposed types of the disease previously referred to as "deep" and "surface" scab are really variations, merely, in the action of the same agent, which might be readily attributable to various physiological or other causes. This view is also supported by further observations which will be referred to presently; but it is still possible that the writer has never encountered the surface form in nature and that the apparently invariable occurrence of the fungus may be thus explained.

Through the kindness of Prof. Arthur the writer received a small lot of tubers from La Fayette, Ind., affected by the same form of the disease recently studied by Prof. Bolley and pronounced by him to be of bacterial origin. Unfortunately plate cultures were not made from these specimens; but all were planted in clean ground in which undiseased tubers planted at the same time yielded a practically clean crop. The La Fayette tubers, however, yielded from the eleven hills planted, 50 per cent. of scabbed tubers, on every diseased spot of which the fungus was apparent to the naked eye.

Prof. Arthur also writes me that he has isolated the scab fungus at La Fayette from tubers grown in that vicinity, and Prof. Bolley himself has found no other cause associated with the disease as it occurs in North Dakota, his present station. In a recent bulletin upon the subject (Bulletin No. 4, N. Dakota Experiment Station, Dec., 1891), Prof. Bolley remarks that "The first cause of deep scab as studied here is found to be a plant organism of very minute character which attacks the surface of young growing tubers, eroding, irritating and blackening the adjacent tissues, and is identical with that associated with the disease in the East (Thaxter l. c.)," also that "Pure masses of the scab plant grown upon nutrient gelatine as seen in Fig. 1, free from all other germs, when transferred to the surface of healthy growing potato tubers, will invariably produce the disease at the point of application."

The writer's results are thus strikingly confirmed by observations made in a widely different locality as well as by the additional experiments, already referred to, which have been made at this Station, and there seems little doubt as to the true origin of the disease, as it occurs in this vicinity.

Prof. Humphrey informs me that the supposed bacterium of scab was isolated by Prof. Bolley from material received from Amherst, Mass., and pronounced by the former observer to be identical with the La Fayette form. If two distinct diseases really exist, therefore, they should be more or less widely distributed in New England as well as in the Western States. As already mentioned, however, the writer is inclined to believe that there is no essential difference between the two as to cause at least. But since Prof. Bolley is in a better position to judge concerning this matter from his more extended acquaintance with the La Fayette form, I take the liberty of quoting from his bulletin already referred to, merely remarking that I am inclined to agree with his suggestion that the so-called bacterium of scab is merely an accompaniment and not a cause of the disease, and probably only partially (if it is at all) parasitic in a state of nature.

"As to the question whether two distinct diseases exist, I may say that I am even yet much in doubt. This would at first glance seem to imply that I doubt the accuracy of my last year's infection tests. This is, however, in no wise necessarily so, as various other circumstances are involved which render such an assumption on my part as yet comparatively groundless. Certainly, in common with those conversant with the details of such work, I recognize that there are many possibilities of error; but that work was too carefully done to admit of any change in the assertion made in the report of the same (Agricultural Science, loc. cit.) other than in so far as they assume only one form of the disease, a point which with me must remain in doubt until I shall have been able to do work under conditions similar to those under which the work was then carried out. The organism with which I then worked, a true bacterium, was undoubtedly very different from that pointed out by Dr. Thaxter, as the originator of "*deep scab*," the one which upon coming to Dakota I was immediately and readily able to recognize as the active agent in the disease here. Furthermore, in so far as cultural and infection tests have been conducted this year, affirmative results have been attained only with the latter form, the bacterium not being found. I have, however, to that end, to date, used only the disease as found here, a form very much more pronounced than that studied last year, possessing some characteristics of action not then noticed. How many of these were present but not then noticed, and how much they are due to soil differences, I cannot say. Certain it is that it is hard to draw the line between a *surface* and a *deep* form of the disease from a consideration only of gross characters, unless it be in the point of a pink coloration of the surrounding living tissues not then noticed.

That, in the Indiana work, I many times under apparent exclusive infection conditions, induced potato scabs, recognized as such by all who saw them, there is no question. Considering then for the time that the disease as generally understood has but one origin, there are two possible ways for accounting for those results: *First*—Error in formation of the infection material so that other germs than the bacterium were present (possible but not probable). *Second*—That the bacterium used (which was undoubtedly parasitic in the potato plant) might under the conditions of the inoculations produce the scabbing which in nature would not occur. This I deem very probable from the then determined capabilities of the bacterium to penetrate living tissues of the potato plant even to parts of young growing stems. The question is yet an open one. I can only regret that my authentic material was unavoidably lost and await opportunity to give it further test. I may say, however, that the parasite studied this year acts much more rapidly in artificial infection than did the bacterium, and there is little question that it is the originator of the chief amount of damage done by potato scab." (Bolley, l. c.)

The experiments made at this Station during the present year consisted in a repetition of the artificial infection of growing tubers in the green-house, with pure scab fungus grown on potato agar and transferred to definite areas in the form of letters, etc., as described in my former report. But since they merely confirm the conclusions already stated in the report just mentioned, it is superfluous to describe them in detail. It may, however, be mentioned that in connection with these inoculations an attempt was made to produce an effect upon growing tubers by means of the fungus spoken of in my previous report (p. 17 note) and doubtfully referred to *Oospora perpusilla* by Prof. Saccardo. Pure cultures of this fungus were obtained from horse dung on which it always appears as a whitish coating, but when transferred to the potato tubers no effect whatever was produced.

Two small field experiments were also tried upon the Station grounds. The first of these was intended to test the effect, if any, of sulphur and of muriate of potash used as a fertilizer in the hills, upon the amount of scab produced in tubers grown on land known to be infected. The experiment was without result, no difference being found between the hills thus treated and the alternate hills untreated, the tubers being very generally scabbed in all cases.

A second experiment was tried on a piece of new land, also on the Station grounds, the sod of which had not been turned for a period of years. On this land 178 hills were planted as follows:

Set a.—28 hills; planted with scabbed seed known to be attacked by the scab fungus, every second hill unfertilized, the rest fertilized with mixed fertilizer.

Set b.—28 hills, planted with clean Beauty of Hebron seed. Every second hill unfertilized, the rest fertilized with manure from horse fed on hay and oats.

Set c.—28 hills, planted as in *set b*, but every second hill fertilized with manure from horse fed on oats in which pure cultures of the scab fungus had been mixed.

Set d.—14 hills, planted as in *b* with addition of a trowel full of oxide of iron in the alternate hills, every second hill fertilized with mixed fertilizer.

Set e.—14 hills, planted as in *b*, the alternate hills containing broken plaster and cement, the rest mixed fertilizer.

Set f.—22 hills, every other row planted with scabbed seed from La Fayette (unfertilized), the rest as in *Set b*, unfertilized.

Set g.—28 hills, planted as in *b*, the alternate rows fertilized with wood ashes, the rest with commercial fertilizer.

The potatoes were dug July 28, with the following results:

Set a.—66½ per cent. scabbed badly in all hills.
Set b.—5 " " in hills containing manure.
9 " " " commercial fertilizer.
Set c.—50 " " " manure.
3½ " " " commercial fertilizer.
Set d.—8 " " " treated with oxide of iron.
2 " " in alternate hills.
Set e.—60 " " in hills containing plaster, etc.
6 " " in alternate hills.
Set f.—50 " " in hills containing La Fayette seed.
4 " " in alternate hills.
Set g.—7½ " " in hills containing wood ashes.
12½ " " in alternate hills.

As far as so small an experiment is of value the results seem to show that in clean land in which about six per cent. only of the crop of potatoes would be normally scabbed, (1) scabbed seed very greatly increases the number of diseased tubers produced, (2) that barn-yard manure which has not been contaminated by the scab fungus, either by food ingested or otherwise, *may* not materially increase the amount of scab, (3) that oxide of iron in amount sufficient to color new tubers red exerts no appreciable influence on the amount or virulence of scab, (4) that plaster and cement, for some reason not apparent, exercises a very decided influence, especially upon the virulence of the disease, which was worse in these hills than in any others, (5) that wood ash has no apparent connection, as has been suggested, with the presence of the disease.

Although the hills fertilized with barn-yard manure from a horse fed with pure culture of the scab fungus, show a decided increase in the amount of scab, the experiment can hardly be considered a fair one, as the cultures in question consisted almost wholly of the vegetative mycelium of the fungus, so that comparatively few spores were ingested, and the purely vegetative hyphæ may have been killed in the digestive tract, such spores as were present alone surviving, and perhaps multiplying only to a limited extent in the fæces after evacuation. The reverse would be true where scabbed potatoes, on which the spore formation is always very abundant, were fed to stock, and the writer is convinced that the practice of feeding diseased tubers in this way is one of the most important means by which the disease is spread on farms. In view of the well-known fact that great numbers of fungus spores can and do pass through the digestive tract without injury, and that the scab fungus is known to grow luxuriantly in decoctions of horse or cow dung, it is not unreasonable to assume that its spores, passing through the digestive tracts of stock fed with diseased potatoes, continue their development in the manure after evacuation, and thus afford the means of wide-spread infection on land fertilized with such material.

The condition of the hills treated with plaster and cement was very striking; the scabs upon the tubers being unusually deep and widespread and the grey appearance produced by the fungus very conspicuous. The reason for the apparent stimulus which these substances seem to exert on the growth and spread of the fungus is not easily explained, and further experiments should be made to ascertain whether or not the results obtained were accidental.

The theory entertained by many persons in the State, that scab originated with the use of wood ashes as a fertilizer, is certainly in no way supported by the results obtained, and it is moreover quite improbable that so thoroughly sterilized a substance should be a medium of infection.

In regard to the question of prevention by treatment little can be said. Prof. Bolley in the Bulletin referred to, gives the results which he obtained by treating the seed potatoes in various ways in order to kill the fungus upon seed tubers before planting: but the use of clean seed would seem to be a simpler and more effectual means of avoiding infection of this nature. The application of any substance to the vines is manifestly absurd in view of the nature and action of the disease, and it seems extremely doubtful whether any advantage would be gained by treating the seed and adjacent earth with Bordeaux mixture (as claimed in a recent bulletin of the Rhode Island Experiment Station) or with any other substance.

Certain preventative measures may, however, be taken with great advantage.

(1.) The seed must be free from any scabs.

(2.) Land which has produced scabbed crops in previous years either of potatoes or of beets or has been fertilized with manure from scab-fed stock must not be planted to potatoes.

(3.) Scab potatoes should never be fed to stock under any circumstances, unless they have been thoroughly cooked, even if the land on which the manure is to be used is not to be cropped with potatoes at once.

(4.) In general any fertilizer is to be preferred to barn-yard manure for potatoes, whether the stock has been fed with diseased potatoes or not.

(5.) If it is suspected that a crop is scabbed *it is of great importance to dig the potatoes as soon as possible* after they are mature, since the scab spots increase in size and deepen as long as they are left in the ground and what is at first a comparatively slight surface injury may be sufficiently extended to render tubers worthless which would otherwise have been marketable.

In regard to the botanical relations of the fungus producing scab, it has already been stated that the form appears to be undescribed, and since a definite designation seems desirable for the agent of so important a disease the following diagnosis may be given.

Oospora scabies, nov. sp.

Vegetative hyphæ brownish .06–1 μ in diameter, curving irregularly, septate or pseudoseptate, branching. Aërial hyphæ at first white, then grey, evanescent, breaking up into bacteria-like segments after having produced single terminal spiral spores (?) by the coiling of their free extremities. Forming a firm lichenoid pellicle on nutrient jelly and usually producing a blackish-brown discoloration of the substratum on which it grows, causing the disease known as "scab" on potato tubers, and a similar disease of beet roots (sec. Bolley).

The fungus is referred to Oospora merely for the reason that it appears more nearly allied to certain forms included in this genus by Saccardo, than any others known to the writer. There seems to be, however, at least one, perhaps several saprophytic forms, having the same morphological characters, which may prove constant enough to warrant a new generic designation. The white "efflorescence" which appears on horse dung soon after it is placed in a moist chamber, is almost identical with the scab fungus, and similar forms are constantly met with especially in transfers to plate-cultures from all sorts of substances. It is needless to remark that the genus Oospora, as given by Saccardo, has no scientific value, and the reference of a form to this genus is merely, as in the present case, a confession of ignorance concerning its true position.

It is to be hoped that observers in Europe may be induced to examine the disease as it occurs there, in the light of the writer's observations, and substantiate or disprove the conclusions reached as far as concerns the European form of the disease. The fungus is unusually easy to isolate by plate-cultures of potato agar or gelatine, on account of its blackening effect upon the substratum, so that its presence or absence even in old scabs is readily ascertained. One precaution only is necessary, namely, that the material for culture be taken from near the surface of the tuber, or at least not from the deeper tissues which may be invaded only by bacteria that have followed the attack of the fungus, and extended its injury.

THE CONNECTICUT SPECIES OF GYMNOSPORANGIUM (CEDAR APPLES).

By Dr. Roland Thaxter.

So much has been written in popular and scientific literature concerning the so-called Cedar Apples and their connection with the production of certain rusts on fruit trees and elsewhere, that it is unnecessary here to give more than a general statement of the facts which should by this time be familiar to agriculturalists generally or at least to fruit growers who are directly interested in the matter. The general facts referred to are as follows. Towards the end of spring, usually in early May, and during rainy weather, the fungus which produces the well-known distortions (cedar apples) just mentioned, protrudes from them in the form of orange-colored gelatinous masses, the orange color being chiefly due to vast numbers of fungus spores formed on the surface of these masses, and known as *teleutospores*. These teleutospores germinate rapidly, without becoming detached from the swollen masses, and give rise each to a number, sometimes as many as a dozen, small secondary spores which are discharged into the air from the sides of short threads protruding from them at various points. These secondary spores (*sporidia*) falling into the air are blown to apple or quince trees or some other plant of the same family, and adhering to the surface of the tender leaves or shoots germinate in their turn, and entering the plant tissues produce in and upon them the second or rust condition of the fungus, known as the *Roestelia* stage. The rust first shows itself as an orange or yellow spot on the upper side of a leaf for instance, in which cavities are formed producing certain bodies (*spermatia*) of unknown function, while subsequently after a period of time varying in different species from ten days to three or even four months the Roestelia appears in the form of tooth-like projections from the under side of the same spot. These projections contain great quantities of spores which are discharged into the air, and blowing back to the cedars and germinating upon them enter their tissues and give rise to new cedar apples which again reproduce the rust and so on.

The object of the present paper is to call attention to experiments which have been carried on at this Station in regard to the relations of the different species of cedar apples to the various forms of rust or Roestelia which they produce, and more especially to the development of the so-called "bird's nest" Gymnosporangium, the characteristic distortions of which are so familiar as to need no further description. Although so common a species, the experiments and observations of the writer have demonstrated that it has been hitherto undescribed, owing to various confusions which need not here be dwelt upon, and the appropriate name *nidus-avis* (bird's nest) is here proposed to distinguish this characteristic and strictly American form. The interest in the subjoined account is therefore rather scientific than economic, except in so far as it enforces the already well-known fact that to avoid certain rusts which are often serious on apple, quince or pear trees as well as on hawthorn used for ornamental or other purposes, and several related plants, it is necessary to cut down adjacent cedars as far as is practicable; for although it has been shown that infection from cedars may take place at a distance of eight miles, the virulence of the disease is of course proportionate to the proximity of the cedars.

We have in Connecticut, so far as is now known, seven distinct species of Gymnosporangium; two upon the white or swamp cedar (*Cupressus thyoides*), neither of which are economically important, one peculiar to the common juniper (*Juniperus communis*), three upon the red cedar (*J. Virginiana*), and one occurring on both the last named plants; the last five species all possessing more or less economic interest, from the rusts which they are likely to produce. The writer has continued experiments on all these species for the past five years, and has succeeded by artificial cultures under test conditions in connecting all but one of them (*Gymnosporangium Ellisii*) with its proper rust, making at the same time a critical study and comparison of the different forms and stages. In a paper on the subject published in the Botanical Gazette (Vol. xiv, No. 7) attention was called (p. 169 and 172, note) to the fact that the so-called bird's nest Gymnosporangium of the red cedar, which had hitherto been confused with another American (*G. clavipes*) as well as with a European species (*G. conicum*), was shown by cultures made at this Station and at Cambridge as well as by observations made in the vicinity of New Haven, to be a distinct and peculiarly American form as above stated.

In regard to the remaining species of Gymnosporangium it may be mentioned in passing that the experiments performed by the writer before he became connected with this Station have been repeated here in the case of *G. macropus*, *G. globosum*, *G. biseptatum*, and *G. clavariaeforme*, the failure of cultures with *G. Ellisii* on the two occasions when they were attempted, having been directly traceable to the use of teleutospores which were not in good condition for cultures, the species not being readily obtainable in a fresh state. In the case of *G. macropus*, *G. clavariaeforme* and *G. biseptatum* results were obtained identical with those previously published by the writer, while in the case of *G. globosum* certain additional facts were ascertained; namely that perhaps the most common orange rust of apples in this state is undoubtedly caused by this species. This rust, which has been referred to in previous papers as "*lacerata z*," was induced by inoculation with sporidia from *G. globosum* on three seedling russets, the inoculation being made in the greenhouse by forcing the cedar apple as well as its host so early in the spring that all possibility of accidental mixture was avoided. Spermogonia appeared the first week in April, the infection having been made late in March, and perfect and typical aecidia were developed early in July. In addition to the cultures of *G. globosum* which were made on these apples, two plants of the mountain ash (*Pyrus Americana*) were inoculated with the same Gymnosporangium in April, and having produced luxuriant spermogonia gave abundant and well developed aecidia late in July. It may be mentioned in passing that these aecidia were *not* the *Roestelia cornuta* which occurs on the same host further north, but had all the characters of the Roestelia which follows inoculation by *G. globosum* on other hosts. In addition to the above facts it was ascertained that a rust of quinces and of Keiffer pears both hitherto unrecorded hosts for this species, was referable to the same source. Cultures of *G. globosum* on Hawthorn (*Crataegus crus-galli*) were also repeated and produced abundant and well developed aecidia under equally strict conditions, confirming the writer's previous statements in all respects.

Returning to the "bird's nest" Gymnosporangium, infections with this species have been made by the writer every year since the spring of 1886, in order to determine definitely the true character of the rust which it produced, and the results in all the cultures were identical, as to the mode and rapidity of development and gross as well as microscopic characters. Until 1889, however, this rust had never been recognized in nature; but as soon as search was made for it in the light of the results artificially obtained, it was found in abundance near the Station and elsewhere in the State growing on Quince, but most luxuriantly on the Service berry (*Amelanchier Canadensis.*) Owing to its rapid development, the Roestelia matures by the first of June, simultaneously with the Roestelia of the juniper Gymnosporangium (*G. clavariæforme*), and since the two rusts inhabit both the above-mentioned host plants, they often occur together side by side on the same leaf, shoot or berry. For this reason although the two are quite distinct in gross appearance when closely examined, as well as in microscopic characters, they have never hitherto been distinguished and will doubtless be frequently met with in herbaria under *Roestelia* "*lacerata*," or the equally erroneous name *R. penicillata.* The general habit of the two is much the same, the *Roestelia nidus-avis* being, however, slightly less lacerate than *R. lacerata* and much darker owing to the rich rust brown color of its spores which contrasts strongly with the much paler dead brown of the spores of *R. lacerata* when seen *en masse.* Microscopically the two are separated at a glance, the spores of *R. nidus-avis* being smooth while those of *R. lacerata* are verruculose.

The *Gymnosporangium nidus-avis* it may be mentioned by no means confines itself to bird's nest distortions, but may occur in isolated areas on the smaller branches on which it produces a slight swelling like *G. clavipes*, or may attack the larger branches and even, not uncommonly, the main trunk of the tree in which its perennial mycelium has survived for years as a result of infection when the tree was very small, causing a conspicuous swelling of a part or the whole of the trunk, the bark of which in the diseased area is usually very rough. That these forms are not due to any species other than the *nidus-avis* has been shown by cultures.

The new species may be characterized as follows:

Gymnosporangium nidus-avis, nov. sp.

Sporiferous masses when young, cushion like, irregularly globose or oval, small and distinct or elongate and confluent according to the habitat; rich red brown; when mature indefinitely expanded by moisture, orange-colored. Teleutospores two-celled, irregular in

shape, broadly ovate to sub-elliptical or fusiform, bluntly rounded or slightly tapering towards the apex, symmetrical or often slightly bent. Average dimensions .055 × .025^{mm}. Promycelia several, not uncommonly proceeding from either extremity. Pedicels when young often more or less inflated below the spore. Mycelium perennial in leaves, branches or trunks of *Juniperus Virginiana* very commonly inducing a "bird's nest" distortion.

Roestelia stage. Spermogonia yellowish orange, preceding the aecidia by about ten days. Aecidia hypophyllous or more commonly on petioles, young shoots and especially on young fruit, densely clustered, brown, at first subulate, then fimbriate; the peridia splitting to the base with its divisions slightly divergent. Peridial cells rather slender; the ridges somewhat prominent, sub-labyrinthiform, horizontal or becoming inwardly oblique towards the extremites. Average measurements (towards the apex of the peridia) .07 × .018^{mm}. Aecidiospores smooth, spherical or irregularly oval to oblong, average diameter 25^{mm}.

Mycelium annual in the leaves of *Cydonia* (quince) and in leaves, stems and fruit of *Amelanchier Canadensis* (Service berry) in June.

FUNGUS IN VIOLET ROOTS.

By Dr. Roland Thaxter.

Specimens of diseased violet plants have been received at the Station several times and the present note is designed to call attention to the presence in the roots of such diseased plants of a peculiar fungus, not previously observed in this country, as far as the writer is aware. It is a well known fact that in the Middle and New England states violet growers are often subjected to great loss from the effects of a somewhat obscure affection which stunts or hinders the growth of the violet plants, causing them to turn yellowish and giving them a generally sickly look. This sickly condition may be present in plants grown under glass as well as in open ground, and appears to attack those grown out of doors most severely during continued damp weather. It may or may not be accompanied by the leaf spot fungus (*Phyllosticta violæ*) which in itself is often a very destructive disease, or by certain minute insects resembling the "red spider" of greenhouses, but much smaller and hardly visible to the naked eye, which might be responsible for much of the damage. Nevertheless many plants having the characteristic sickly yellow look of the violet disease have been received and examined, on which no sign of either the fungus or the insect could be found. No apparent cause for the observed condition being discoverable in the portion of the plant above ground, the writer was led to examine the roots and stems with some care and after washing the earth from the former, great numbers of dark spots were observed commonly involving the whole substance of the root for a distance of a few millimeters. Sections of such spots show the tissue more or less blackened and destroyed and lying in the cells, in greater or less numbers, certain peculiar looking squarish brown bodies, sometimes filling the cells completely and looking not unlike some form of smut. These squarish bodies are the result of the breaking up of large cylindrical 2–5 (or more) septate brown spores formed from a rather scanty septate mycelium which apparently causes the death of the root cells at the affected points.

The fungus is undoubtedly the form described by Zopf (Sitz. d. Bot. Ver. d. Prov. Brandenb. June 1876, p. 105) under the name *Thielavia basicola*, figured in Winter's Pilze (Vol. II, p. 44) and also described and figured by Sorokin as *Helminthosporium fragile* (Clasterosporium frag. Sacc.) in Hedwigia (1876, p. 113) where the characteristic breaking up of the spores into squarish segments is well represented. According to Zopf the fungus is the same with the form described by Berkeley & Broome (Ann. and Mag. of Nat. History, Ser. II, Vol. V, No. 465, Pl. 11, fig. 4) as *Torula basicola*, yet for reasons not mentioned all these are kept distinct by Saccardo.

Zopf describes an ascosporic condition on which the genus Thielavia is founded, which has not been observed by the writer except as a parasite on other fungi (species of Isaria), and states that a very serious disease of the roots of Senecio is due to its action.

As concerns the disease of violets, however, it seems doubtful whether the observed injury done by the Thielavia would alone account for the condition of the plants, yet the mere presence of a form supposed to cause serious disease in the roots of other plants, seems of sufficient interest to warrant the present note.

Another disease of violet roots due to nematode worms and common in Connecticut as in other localities, produces great numbers of hard rounded swellings upon the roots, but according to the statements of several violet growers does not appear to do much injury to the plants.

PRELIMINARY REPORT ON THE SO-CALLED "POLE-BURN" OF TOBACCO.

By William C. Sturgis, Ph.D.

Ever since the year 1833 when the tobacco industry of Connecticut was permanently affected by the introduction from Virginia by B. P. Barber of East Windsor of what is now known as the "Barber broad-leaf variety," and the growing of fine, silky tobacco suitable for wrappers, superseded the strong, narrow "Shoestring" tobacco, this important crop has been seriously injured by several diseases, mycological as well as physiological in nature.

The present report has to do with the cause and effects of one of these diseases, familiarly known in this State and in other sections of the country as "pole-burn," "pole-sweat," and "house-burn," names indicative of the burned appearance of the affected leaves.

Origin of "Pole-burn."

Practical experience has shown us the conditions under which this disease makes its appearance. Thus all tobacco-growers know that if the tobacco is cut and hung during warm, damp, and foggy weather it is very susceptible to "pole-burn;" that if a period of such weather ensues a week or ten days after the hanging of the tobacco, even though the conditions under which the tobacco was cut and hung were favorable, the crop is sure to suffer more or less; in brief, that the severity of the disease is intimately connected with atmospheric conditions.

The appearance of tobacco affected with "pole-burn" is too familiar to require any extended description.

As the disease was first brought to the notice of the writer it was seen to be characterized by the appearance on the surface of the leaf, of small blackened areas, giving the leaf the aspect of having been sprinkled with sulphuric acid, or some other corrosive liquid. At first the disease is limited to the neighborhood of the veins and midrib of the leaf where moisture is superabundant, but its spread is very rapid, the small blackened areas increase in size,

become confluent, and sometimes within thirty-six, or at most forty-eight hours, not only is the whole leaf affected, but the entire contents of the curing barn may be rendered quite worthless as tobacco. Examination shows that the leaves have changed from greenish-yellow to a dark brown or almost black color, that the fine texture has disappeared, and that instead of being tough and elastic, the whole leaf is wet, and soggy, and tears almost with a touch, falling of its own weight from the stalk.

The severity of the disease varies, as has been said, with the atmospheric conditions of warmth and moisture, and certain years, e. g. 1872 and 1878, are memorable in Connecticut, as having been peculiarly conducive to the disease. The 10th Census of the United States is authority for the fact that the weather throughout the curing season of those years was damp and foggy. It is, however, safe to say that a tobacco crop is very seldom, if ever, cured in Connecticut without showing some trace of disease. Even during the most favorable seasons the disease does make its appearance in the center of the curing barn where the temperature is higher and the moisture more retained in and about the leaves, whereas in unfavorable seasons the loss has often amounted practically to the entire crop.

Finally, the disease is not peculiar to Connecticut. The Station has been in correspondence with the principal tobacco-growers of Virginia and Kentucky with reference to the subject and the replies have been invariably that the disease is well known in both States, and that it is induced or aggravated in air-cured tobacco—that is, tobacco cured without the aid of artificial heat—by hanging the tobacco too closely crowded in the barn to admit of the free circulation of the air; by hanging it when moist or wet from dew or rain, and by fogs penetrating the barn; or by the prevalence of damp sultry weather.

The past curing season in this State was exceptionally favorable to the tobacco grower, so much so that it was found impossible to secure specimens of diseased leaves for examination at the Station until the latter part of October. It was then learned that the disease had made its appearance at Melrose, and had destroyed in thirty-six hours, 2000 lbs. of Connecticut seed leaf. A quantity of the diseased material was sent to the Station, and was there subjected to thorough microscopic examination. On the less damaged leaves the appearance was as described above, but a small hand-lens revealed in the center of each blackened spot, a minute, elevated pustule. Sections through the center of one of these pustules showed that the tissue of the leaf was largely disintegrated, and the cells themselves were completely filled with bacteria, which as they issued from the cells in vast numbers, gave a milky appearance to the water in which the section was lying. This being presumably the incipient stage of the disease it was only necessary in order to trace its development, to select a series of leaves showing more and more advanced stages of decay and to examine the pustules successively. This method showed that the bacteria develope rapidly in the tissue of the leaf, raising the epidermis, and finally breaking through at one or more points in the blackened area. Oozing through the ruptured tissue, they spread out in a thin slimy film over the surface in the immediate neighborhood of the pustule, finally forming a brown, translucent crust of a cheesy consistency, and composed entirely of the bacteria themselves. It was now an easy matter to take a minute portion of this crust, place it in a drop of distilled water through which it at once became disseminated, and examine it under the microscope, or transfer a portion of it to some nutrient material, liquid or solid. Examination with the microscope showed that there were invariably two forms of bacteria present, and only two—one in the shape of minute rods very rarely connected in chains, and belonging therefore to the genus Bacterium, the other consisting of spherical cells often united in chains and belonging to the genus Micrococcus.* It must be noted that two forms of bacteria very similar to those described—a Bacterium and a Micrococcus—always accompany, and are taken to be the active agents in, putrefaction whether of vegetable or animal substances, and the question naturally arises whether we have here merely a process of fermentation and putrefaction (whatever we may mean by these terms) common to all putrescible substances, and induced by the previous growth of some fungus on the diseased spot, or whether we have to do with specific agents of disease peculiar to tobacco.† A fungus related to one of the common leaf-diseases of the tomato, of the genus Cladosporium, does occur in spots on tobacco leaves. Leaves partially cured, that is, leaves taken at the period when the "pole-burn" usually makes its appearance, but free from any developed fungus and bacterial disease, were kept in a damp atmosphere for some days. Under these conditions there developed on the leaves in the course of a few days, small brown spots of a velvety appearance under the microscope, the Cladosporium mentioned above. This fungus caused no wide-spread damage to the leaf, being limited to the very small spots in which it first appeared. In the course of six weeks, however, examination showed that the fungus was decaying rapidly and that in its place vast numbers of bacteria were developing, identical with those found in the pole-burned leaves. The gross appearance of the decaying areas was similar to that characteristic of "pole-burn," though owing to the fact that the leaves were by this time almost thoroughly cured, the spread of the decay was not so rapid. Finally, mingled with the bacteria in the pustules of leaves undoubtedly afflicted with "pole-burn," there were often found the remains of a fungus identical with the Cladosporium above mentioned.

We may therefore infer, although conclusive results can only follow further examination, that "pole-burn" is due primarily to the growth of a fungus upon the leaf, which by disintegrating and partially destroying the tissue of the leaf, gives access to a bacterial process of decay.

Were it not for this process of decay, however, we should have little to fear from the Cladosporium. The latter, as we have seen, is very limited in its area of growth, but the reproductive activity of the bacteria is very great, and the decay which they cause spreads with corresponding rapidity. For this reason the investigations undertaken in the laboratory have been upon

*The dimensions of these two forms are: Bacterium, $1.9\mu - 3.7\mu \times 0.8\mu$; Micrococcus, spherical, $0.9\mu - 1.4\mu$ in diameter.

†In this connection it is well to note that a German investigator, Emil Suchsland, has recently discovered living organisms belonging to the groups Bacteriaceæ and Coccaceæ, associated with the process of fermentation of all kinds of tobacco. "Generally," he writes, "only two or three species are found on each kind of tobacco. Bacteriaceæ predominate, but Coccaceæ also occur. That these bacteria are the active agents of the ferment of tobacco is shown by the fact that if pure cultures are made from one kind of tobacco and another kind is inoculated with this pure material, there is reproduced in the latter tobacco the flavor and aroma characteristic of the original tobacco." By making use of the proper forms of bacteria Suchsland succeeded in so improving the quality of German domestic tobacco that experienced judges were unable to recognize it. E. Suchsland, Ueber Tabaksfermentation. Ber. d. deutsch. bot. Ges. Band ix, Heft. 3 April, 1891, pp. 79–81.

It may be therefore that the damage to curing tobacco known as "pole-burn" is merely an abnormal development of the same bacteria which are the active agents in the subsequent process of fermenting or "sweating" of the tobacco.

the bacteria themselves and the means by which their activity may be prevented. It is a matter requiring only delicate manipulation, to isolate the bacteria from the "pole-burned" leaves, and to obtain pure cultures. These were made in test-tubes on both solid and liquid media. The bacteria developed readily on potato-agar with a slight percentage of tobacco-ash or a trace of peptone, on slices of sterilized potato, and in potato broth with a trace of peptone. The sterilized potato gave the best results, and the cultures have been continued on that substance. Under these conditions the bacteria form on the surface of the potato round, or elongated and irregular colonies, of a slimy consistency, varying in color from livid gray to deep orange, and producing in the potato a dark stain beneath and around the colonies. In liquid media they develope, not on the surface, but as a flocculent deposit in the liquid. Certain facts may now be noted and compared with facts ascertained in the curing of tobacco.

(1) As the cultures become dry, the bacteria cease to develope so rapidly, and finally their development ceases. They require therefore moisture for growth, and decreasing the amount of moisture decreases their vitality. This bears out the general view that the origin and spread of "pole-burn" is in some way connected with an excess of moisture in the curing-barn.

(2) Nine tubes containing each a slice of sterilized potato were inoculated with the bacteria. Of these, three were kept at a temperature of 100° F., three at a temperature of 70° F., and the remaining three at a temperature of about 40° F. At the end of three days the tubes kept at 70° showed the usual growth, the colonies averaging 1½ inches in length by ½ inch in breadth; neither of the other sets of tubes showed any marked growth, but upon being placed at the medium temperature for forty-eight hours the development of the bacteria proceeded with marked activity. These experiments were repeated at various degrees of temperature. Temperature therefore has a marked influence upon these germs; warmth, up to 70°, and even 90°, is favorable to their development, whereas temperatures above 100° or 110° and below 35°–40° act as a temporary or permanent check upon their vitality. To this fact again we find a corresponding theory, that warmth as well as moisture is conducive to "pole-burn." Inasmuch as in this regard bacteria, as a rule, follow the laws governing the active growth of the higher fungi, it is immaterial at present to decide whether the former or the latter are the primary

cause of "pole-burn," since the means which may be recommended to prevent the decay, apply equally well to arresting or preventing the growth of the Cladosporium.

(3) One more fact should be stated, viz: that all attempts to inoculate thoroughly cured tobacco with the bacteria, failed. This result is partial confirmation at least of the generally expressed view that when tobacco has cured to a certain degree, the period varying from ten days to three weeks after hanging, there is very little danger to be apprehended from "pole-burn."

Remedial Measures.

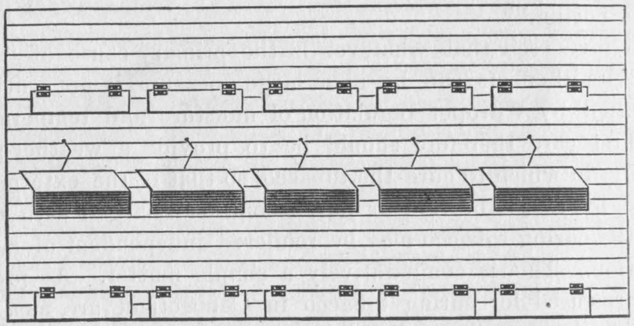
"Insufficient or badly managed ventilation is the chief cause of bad curing."*

We have seen that whatever is the primary cause of "pole-burn," its ill effects can be in a large measure, if not entirely, prevented by a proper regulation of moisture and temperature. Our first care therefore should be to provide a weather-proof building in which to cure the tobacco, so that if the external air should by reason of rain or fog become surcharged with moisture, the curing tobacco may be rendered independent of such a condition. This is comparatively a simple matter. At present the barns used for curing tobacco in Connecticut are, as a rule, anything but weather-proof; they are generally roughly built, and the air within them is, even when the doors are closed, practically in the same condition as the outside air, whether the latter be dry or moist. Under such conditions it is only to be wondered at that a crop is ever cured satisfactorily. The first step then, should be to render the existing barns as far as possible weather-proof, by covering them with water-proof paper and sheathing, or by any other means which commends itself to the common-sense of the grower. Having secured this condition, the next step should be to secure free ventilation. Not only does an excess of moisture in curing tobacco come from the external atmosphere if the barn is not weather-proof, but the tobacco itself in the process of curing gives off a large amount of moisture, and if fermentation takes place, a considerable degree of warmth is generated; so that even if the barn should be weather-proof, there exist within it all the conditions favorable to the development of "pole-burn."

*Tenth Census of the United States, 1880, vol. iii, Report of J. B. Killebrew, p. 107.

Ventilation.

This excess of warmth and moisture can be remedied only by a complete system of ventilation. Fortunately such a system can be readily and cheaply adapted to the existing tobacco-barns. It should be such that when the weather is sufficiently dry to expedite the curing of the tobacco, air can be admitted freely and can circulate *from below upwards*, in order that the warmth and moisture generated by the tobacco shall be carried up, and out through ventilators in the roof, being displaced by the dry air coming in from outside. The best method to secure free and uniform ventilation is to have a row of *horizontal* ventilators near the



ground, a similar row for each tier of tobacco, and one or more large ventilators along the ridge-pole. The ventilators in the walls should open *horizontally* at intervals of about four feet as shown in the cut. They should be from five to ten feet long, one foot high, hung from the upper edge by strap hinges so as to be raised and hooked up, and occupying the full length of the building. When these are all open, the air will enter freely, not only near the ground, but also just below each tier of tobacco. Free ventilation in the roof to allow of the escape of moist, warm air, is absolutely essential. This can be secured by large cupola ventilators placed at intervals of twenty or thirty feet along the ridge-pole and reinforced by openings under the eaves, or better still the ridge-pole may be occupied by a continuous slat ventilator running the full length of the barn and reinforced if necessary by a similar ventilator midway down the slope of the roof on both sides.

We have thus secured, at a very slight expense, a free circulation of air through the barn and an outlet for the accumulating

moisture from the leaves, when the weather is dry; and at the same time, in case of a period of prolonged damp weather, the barn can be rendered weather-proof and the curing can proceed in a measure independently of atmospheric conditions.

It must, however, be remembered that we are not aiming merely at rapid *drying* of the tobacco. The terms "drying," and "curing," are by no means synonymous. The change of color in curing tobacco is largely due to a process of fermentation which takes place in the hanging tobacco, and for which a certain amount of moisture in the leaf is a prerequisite. If the leaf is dried too rapidly this fermentation is either prevented or checked, and the result is a disagreeable, sickly green color in the product, instead of the rich brown desired. With a weather-proof barn, well provided with ventilators, the curing of the tobacco may be made to proceed as rapidly or as slowly as the circumstances, and the desired quality of the product, demand, in other words the process of curing, and therefore the result, under these conditions, depends only on the good judgment of the one in charge of the operation. If the tobacco is not curing rapidly enough owing to damp weather, the barn can be tightly closed; if, on the other hand, the process is proceeding too rapidly, the barn may be closed by day and opened by night; or if more moisture still is required, it may be closed and the floor sprinkled with water. If again, the weather is hot and dry, so much so that the rays of the sun will bleach the leaves, the barn can be closed so as practically to exclude both light and air.

With regard to the floor of the barn, the older barns of this State have dirt floors, and inasmuch as the "dampness arising from the ground is supposed to exercise a beneficial influence on the curing process,"* there seems to be no present necessity for a change in this respect, which would involve considerable expense.

Changes induced in the process of Curing.

We have thus far seen the advantages to be secured in the curing of tobacco by conducting the process in a weather-proof barn where ventilation and hence the influence of atmospheric conditions is to a great degree under control. But even under these conditions a successful cure will depend largely upon good management. Tobacco which is very rapidly dried out by means

* Tenth Census of the United States, 1880. Report of J. B. Killebrew, p. 248.

of a constant current of dry air, especially at a high temperature, undergoes very little, if any, chemical change, and retains to a greater or less degree its green color. Moreover, since the process of fermentation in bulk, accompanied by heat, depends upon and must be preceded by the changes in the leaf produced by gradual curing, it follows that tobacco which has been too rapidly dried loses to a great extent its ability to pass through the process of subsequent heating and sweating in bulk, and the greenish color remains permanent.

If the tobacco is dried in a current of air, care being taken not to drive the moisture out too rapidly, a change takes place in the interior of the leaf characterized by a change of color from green to brown, and the formation of *nitric acid* as a product of partial fermentation.

Finally, if tobacco is hung so closely as to prevent the free access of air, the color changes to brown, but *ammonia* is formed as a product of fermentation, the leaf loses its tenacity, becomes subject to "pole-burn," and decay follows to a greater or less extent.

These facts have been stated at length by two German investigators,* and are borne out by experience in this country.

It follows therefore that to secure immunity from "pole-burn" we must not only have the ventilation of the barn itself under our control, but the utmost importance must be attached to the method of hanging the tobacco so as to secure free circulation of air about each leaf.

Methods of Curing.

This brings us to a consideration of the two methods now in vogue of hanging tobacco, the older method of cutting and hanging the whole stalk with the leaves attached, and the method of detaching the leaves from the stalk before hanging, a method which is comparatively new in this country, but is almost universally employed in Germany and France. It is not our intention at present to discuss the merits of either method, inasmuch as the data at hand are not such as to warrant such a discussion. It will be well, however, to state briefly the arguments which are generally adduced for and against each method, and thus enable

* Nessler, Der Tabak, seine Bestandtheile und seine Behandlung, pp. 109, 110. L. von Wagner, Tabakkultur, Tabak- und Zigarrenfabrikation, pp. 34–38.

each grower to act as seems to him best, reserving any expression of opinion until further observation warrants such expression.

In the Tenth Census of the United States, (p. 44 of J. B. Killebrew's Report) various reasons are given showing the advantage of curing the leaves separately, over the method of stalk-curing. The advantage first stated is that all the leaves may be harvested when just ripe, and that therefore the crop shows a greater weight per acre. This is an undoubted advantage if absolutely true. That depends, however, on whether tobacco leaves attached to the stalk, do or do not mature after the stalk is cut, that is, whether the leaf feeds from the stalk during the process of curing, or the stalk from the leaf, or whether there is no appreciable transfer of material one way or the other. Upon this point opinions differ. One undoubted authority on the subject says: "Cut twigs or herbs yield to their leaves, etc., the water and the dissolved nutriment which the stems contain. The course is always from stem to leaf so far as the expenditure is concerned. Hence leaves and fruit grow heavier under such circumstances, as is well shown in the ripening of grains on cut wheat. But the same nutriment which is called for by the leaf, etc., is also likely to be used by new buds, and hence (when this happens) the leaves suffer. Practically when tobacco is cut and new buds (suckers) do not start or are arrested before they get very far, the leaves gain in dry weight, and that is a distinct advantage."

This view is also borne out by Wagner* who says: "If the leaf is picked before it is ripe, it needs a process of subsequent ripening to give it a good quality. This is impossible if the leaf is separated from the stalk, but it takes place to perfection under the American method" (the leaves cured while still attached to the stalk). With this view another German writer, W. Tscherbatscheff,† also agrees. On the other hand an experiment conducted by Nessler‡ shows that the dried constituents of tobacco leaves cured on the stalk, and separate from it, show no appre-

* Wagner, l. c. p. 38.

† Tscherbatscheff, W. Der Tabak und seine Kultur in den nordamerikanischen Staaten, Landwirthschaftliche Jahrbücher, 1875, p. 102.

"The weight of tobacco leaves cured on the stalk is 15 per cent. greater than that of leaves cured separate from the stalk."

‡ Nessler, l. c. p. 111.

ciable difference in weight;* and finally, going to the other extreme, a recent experiment conducted at the North Carolina Experiment Station with a view to settling the matter, indicates that a comparison between the weight of one half of a crop of tobacco cured on the stalk, and the other half cured separate from the stalk, shows a difference of weight of 128 lbs. per half acre in favor of the latter. These opinions are irreconcilable at present; but there is certainly a possibility that the leaves may mature and increase in weight while attached to the cut stalk, and that the curing of the two together may therefore yield as large a weight as when the leaves alone are cured.

There is, however, another point in this connection. We are aiming to secure free circulation of air about each leaf, so that, other things being equal, it is merely a question which method will best accomplish this. It has been argued very rightly that by stripping the leaves they can be hung much more loosely, that is, farther apart, and that the crop can be cured more quickly.

But as has been seen, the latter is not always an advantage, and if circulation of air sufficient for gradual and continuous curing is obtained when the entire stalk is hung with the leaves attached, our object is fully attained and a looser method of hanging is not absolutely necessary. Whether that object is attained by this method is, however, very doubtful, experience seeming to show that those leaves which are more or less covered by the overhanging leaves of the stalk are most subject to the attacks of pole-burn.†

* The following figures representing the results of this experiment are copied from Nessler's work.

Calculated from dry material, 100 parts of tobacco contain:

Dried.	Ash.	Total Potash.	Soda.	Carbonate of Potash.	Nitrogen.	Fat.
No. 1. On the stalk	22.02	4.62	0.67	3.62	2.34	
Leaves alone	23.24	4.65	0.59	3.46	2.00	
No. 2. On the stalk	24.57	3.24	0.36	0.27	4.66	5.20
Leaves alone	23.22	3.26	0.46	0.35	4.22	5.00
No. 3. On the stalk	22.12	3.79	0.19	2.43	3.25	4.93
Leaves alone	22.86	3.84	0.24	2.88	3.96	4.56

† Upon this point Nessler (l. c. p. 110) writes: "In many localities the stalk is cut with the leaves and both cured together. It cannot be denied that with due care this method presents many advantages. The leaves never hang so close together as to prevent the circulation of air, consequently more nitric acid and less ammonia is formed, and the leaves are less liable to rot. By this method the tobacco cures better, especially as regards the burning quality."

The questions of the final weight of the product and the free circulation of the air are not the only ones to be considered in this connection. It is urged in favor of picking the leaves that the different qualities may thus be kept separate from the start, and that therefore less time is required for preparing the product for market; that the saving of barn room is considerable, six tiers containing leaves only, being accommodated in a space large enough for only four tiers containing both stems and leaves; that the physical strength required to strip and hang the leaves alone, is much less than when the stalks are cut and hung, and can therefore be done by girls and boys at slight proportional expense; and finally that the second crop of suckers and leaves arising from the stalks left standing, if ploughed in, forms a most valuable fertilizer, superior to the dried stalks.* It might be further urged that it is difficult to dissipate the excess of moisture given off by the large, juicy stalks in the curing process, that the process is thereby unnecessarily delayed, and the leaf decidedly endangered. This objection to stalk curing is certainly a most striking one in any section where tobacco is cured by air only, without artificial heat, and merits the serious consideration of the Connecticut growers.

To sum up on the other side, the added expense of the method of picking and hanging the leaves alone, including as it must the initial expense of special devices for hanging the leaves,† must be an objection in the mind of every grower of tobacco, unless he is convinced that the superior quality of the product, and the consequent increase in its value; the saving of time; and therefore of money, in the process of curing; and the increased immunity from "pole-burn" attendant upon a less crowded method of hanging the tobacco, outweigh the increased expense of harvesting. Enough has been said upon these points to enable a grower to decide the matter for himself as conclusively as it is possible at present for

* It sometimes happens that the earlier hatched "tobacco worms" or "horn-caterpillars" complete their transformation on the first crop of tobacco. The moth then lays eggs upon the second growth in the fall, and it is in order to destroy this second brood that the ploughing in of the second growth is often recommended.

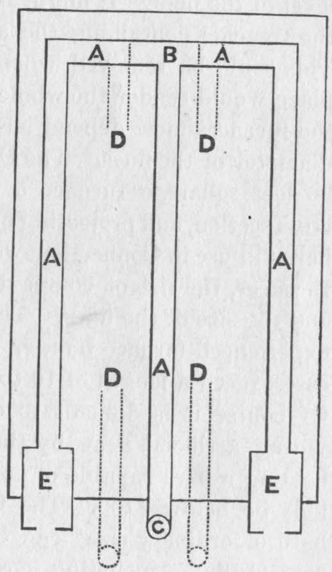
† The wired sticks used in what is known as Snow's Modern Barn System are quoted at $5.00 per 100 cash, or $6.00 per 100 on time. Similar curing sticks provided with wires are manufactured by the Tobacco Hanger Manufacturing Co., of Houston, Va., and are quoted at $3.00 per 100 cash or $3.50 per 100 on time.

anyone to decide it. Opinions differ regarding this added expense. One grower in Virginia writes: "The cost of leaf curing is from actual experience much greater than in curing the entire plant and I have failed to find any compensating advantages to be derived from it." Another grower in Kentucky says: "I do not believe that the advantages received from stripping the uncured leaves, if there are any at all, compensate for the additional labor." On the other hand, Maj. Ragland, perhaps the largest grower of tobacco in Virginia, writes that he has for years employed both methods with success, and there is no doubt that in parts of Virginia and North Carolina the method of stripping the leaves has recently come into decided favor.

The Employment of Artificial Heat.

We must, however, pass to another measure which, when properly employed has, as far as we can learn, never failed to prevent "pole-burn," viz: the use of artificial heat, when necessary, during the process of curing. It has been more than once suggested that any machinery that could be devised to ensure active circulation of air through the barn, would, even in damp weather, prevent the occurrence of "pole-burn." It seems difficult to believe, however, that a disease, the harmfulness of which is largely due to warmth and moisture, would be materially checked by a free supply of warm, damp air, even though that air were in motion. It would seem more reasonable to dry the air in the barn by means of the application of artificial heat conducted by flues. In many sections of the country, especially in the South, where the tobacco industry has been long established, this method of curing has largely superseded air-curing. It is quite possible that in our climate we may secure immunity from "pole-burn" by merely altering our barns as already suggested, so as to ensure the interior from unfavorable atmospheric conditions, and at the same time provide for free ventilation; but when we have taken this step, it may prove merely preparatory to the final step of providing the existing barns with artificial heat. At any rate, inasmuch as this would undoubtedly prove a remedy against "pole-burn," a few words on the subject cannot be superfluous. In a letter addressed to the Station under date of Dec. 10th, Maj. Ragland says: "I have never known tobacco cured by artificial heat to be damaged by "pole-sweat" or "house-burn," so called," and this is the testimony of practically all the growers

in the South and West with whom we have corresponded. This being the case, it remains to see how artificial heat conducted through flues can be adapted to the barns at present existing in Connecticut, for it goes without saying that it would be impracticable to build new barns for the sake of providing them with a simple system of flues, and that open fires in the barn would produce a markedly unfavorable effect upon "wrapper" tobacco. This is a matter involving by no means so great an expense as has been often imagined; the flues and simple furnaces are comparatively cheap, much of the work can be done by unskilled labor, and it is not even necessary to substitute board floors, for the earth floors which many prefer. The simplest method seems to be that figured and described on p. 192 of the Report on Tobacco already referred to in the Tenth Census of the United States, and figured in the accompanying cut. Trenches are dug in the floor of the barn 15 to 18 inches wide and of the same depth, the side trenches being 12 or 13 inches from the walls of the barn, AAA. These side trenches encircle the floor space on three sides of the barn, meeting at the center in the rear, B. Here they connect with a trench BC, running lengthwise through the center of the barn. If it is desired to keep this portion of the floor free for the admission of wagons, the plan suggested in the Census Report may be adopted, each side trench being continued down the center independently, as indicated at DD, leaving a free space running the full length of the barn in the immediate center. These trenches covered with sheet iron or fire-proof stone, preferably lined with brick, may themselves serve as flues; or sheet-iron flues 12 to 15 inches in diameter, such as are used for stove piping may be laid in them. In any case the side flues should rise gradually from front to rear, and the central flue or flues from rear to front, about 1 inch in 2 feet, so that the point where the latter issue from the front wall of the barn will be elevated considerably



above the point where the side flues issue from the furnaces. The side flues each connect with a furnace E E at the front of the barn. The furnaces must be sunk below the level of the ground sufficiently to permit of the flues entering the upper part; they may be built of fire-proof brick or of iron, or some simple form of ready-made furnace may be found to be ultimately cheaper. The plan described in the Census Report provides that the flues shall be *built up* 18 to 20 inches *above* the level of the floor instead of being sunk a like distance *below* that level. Such a flue would give off more heat, since the heat would be given off from the sides as well as from the top, and also would allow of the furnaces being but very little, if at all, below the level of the ground; but it would occupy a good deal of floor space, which would be saved if the flue were sunk below the level of the floor. It might be possible in the latter case to cover the trenches containing the sheet-iron flues with heavy planking. This could be removed when the fires were lighted, but when in place would render the whole floor space available. The size of the furnaces must depend largely on the size of the barn and the diameter of the flues. The Census Report recommends for a barn 20 feet square, a furnace 5 feet long, 18 to 20 inches square in cross section, and projecting outside the wall 18 inches. The larger barns in use in Connecticut would have to be provided with larger furnaces, the size of course depending upon the size of the barn and the size of the flues. This could be readily estimated by any experienced furnace builder or dealer, but would probably in no case exceed a length of 10 to 12 feet, and a width of 6 to 8 feet. Of course it is difficult to estimate the expense incident to providing artificial heat by the method suggested. The cost for heating a barn capable of holding 5 acres of tobacco would probably be below $100. The Census Report, p. 68, states that "a barn of ordinary size* can be fitted with brick-walled and iron-capped flues, including cost of arches for the furnaces, and chimneys for carrying off the smoke, at a cost of from $40 to $75, varying with cost of materials and labor.

Use of Artificial Heat.

There seems to be in the minds of many, an idea that the use of artificial heat is entirely to *dry* the tobacco, the quicker the

*With a capacity probably of 1 to 2 acres. If iron furnaces were used the expense would probably be larger.

better; and that the fires must therefore be kept up continuously at a considerable expenditure of fuel and labor. This is a mistake. It has been already shown that the process of curing is to a great extent a process of fermentation. To aid this process when other conditions are unfavorable, and to establish within the barn at critical periods conditions which shall prevent the occurrence of "pole-burn," are the only uses of artificial heat in this connection.

We cannot do better than quote at length from a letter on this subject recently received from Maj. R. L. Ragland, of Virginia, whose wide experience in the growing and curing of tobacco, gives weight to his opinion. He says: "I have never known tobacco cured by artificial heat to be damaged by 'pole-sweat' or 'house-burn' so-called. The heat evidently dispels or prevents any attack of bacterial disease and deterioration of the leaf during the curing process, except from scald or undesirable change of color due to excessive heat. Cigar tobacco requires very little artificial heat to cure properly—the heat should be used supplementally, and the temperature kept at a point that will keep the leaf drying *gradually*, but drying *all the time* until the moisture is entirely dispelled from the leaves. I have long advocated that all classes and types of tobacco are best and safest cured by the application of artificial heat to assist in drying, and this opinion is not based merely upon theory, but is found after trial in the curing of every class and type grown in this country. I have cured all of them with and without artificial heat, and give it as my opinion based on experience that tobacco cured over flues or stoves emitting no smoke is better than sun or air-dried tobacco. Tobacco of any class is more *speedily* and *thoroughly* cured by artificial heat than when air-dried, and it is a well known fact that tobacco thoroughly cured over flues will keep sounder than when air-dried."

We have heard the opinion expressed that tobacco cured over flues will not pass through a subsequent "sweating" or fermenting process. Others of experience have doubted that statement, and the doubt proves to be a reasonable one when the matter is tested. In the same letter from which we have just quoted, Maj. Ragland says, "Air-cured tobacco is not only the better for being "sweated" for months, but *requires* more time to complete this process than flue-cured tobacco. It is my experience that tobacco when bulked down 'in case,' viz: when it has absorbed enough moisture to render it supple and flexible, will always pass though a "sweat" if it remains in bulk long enough. And this is the case with tobacco cured by artificial heat as well as when cured without that aid. I believe that flue-cured tobacco bulked down will *in a shorter time* be ready for the manufacturer than sun or air-dried tobacco, but all tobacco so cured passes through a slightly fermenting process accompanied by the generation of heat."

This is all that can be said at present with any certainty on the subject of the causes, mycological and atmospheric, of "pole-burn" of tobacco, and the means which have been successfully employed in combating it. This report is, however, only preliminary; the subject is still under investigation, and it is hoped that further experience will tend to clear up certain points which are still doubtful, and warrant the publication of a special Bulletin on the subject.

STEM-ROT.

There is at least one more disease of tobacco affecting the crop in the latter stage of curing which merits some consideration. The stalk of the tobacco plant is, as we should expect in so rapid a grower, exceedingly succulent and juicy. For this reason, the proper drying of it as necessitated when the whole plant is cured, is a long and tedious process, often accompanied with most undesirable results. This stalk after it has been cut for some days, and has become partially wilted, forms a most admirable field for the growth of fungi, especially for those which usually grow upon dying vegetation. One such fungus at least, has proved most troublesome in the curing barns, and from its pernicious action is commonly known as "stem-rot." If stems affected with this disease are examined, they will be found to be covered with pure white patches having the appearance of a long-pile velvet. These patches spread rapidly, encroaching upon the veins of the leaf, and destroying the tissue, and in the end induce a more or less wide-spread decay, especially in the neighborhood of the mid-rib and veins of the leaf, where the moisture is longer retained than in the delicate tissue of the leaf. The velvety appearance is due to the growth of the vegetative part, or "mycelium," of a fungus long known to botanists, and belonging to a group of fungi familiar to the vegetable pathologist. We may place it for the present in the genus Botrytis.

The vegetative threads of the fungus grow at first over the surface of the stalk, and penetrate it to a greater or less extent. In the course of time erect branches arise from these threads in great numbers, often attaining a height of a quarter of an inch, and producing the white velvety or furred appearance on the stalk. From these erect branches there soon arise shorter branches at right angles to the main branches, and finally at the tips of these shorter branches the fruit is borne in the shape of vast numbers of spores.

The fungus seldom reaches maturity on the curing stalks, for it requires some days and considerable moisture for its complete development, hence by the time the vegetative threads are ready to produce the fruiting branches, the stalks are too far dried to afford the requisite nutriment. After the curing process is completed, however, the tobacco is taken down, and the stalks and leaves most seriously affected with "stem-rot" are thrown down on the floor with the refuse which always remains after the curing of a crop of tobacco. Here on the damp earth floors and in company with decaying stalks and leaves, the "stem-rot" fungus finds all the conditions favorable to its farther development. The fungus spreads among the refuse, and produces its spores in enormous quantities. It is not unusual upon entering a barn even during the process of curing, to find the floor partially covered with the refuse of the previous year's crop, the latter often looking as though a fall of snow had whitened it, so densely is it covered with the mycelium and spores of this fungus, named on account of its long fruiting branches or arms, *Botrytis longibrachiata*.* The slightest current of air serves to separate the spores from their attachment, and carry them through the barn, some finding lodgment upon and at once infecting the curing stems and leaves, others being deposited on the beams or walls of the barn and there remaining to propagate the disease another year.

Remedial Measures.

Against such a pest absolute cleanliness is the best and simplest precaution. After the crop is cured, all the diseased stems and leaves should be carefully collected and at once burned before the fungus has reached maturity. All the refuse remaining on

* This fungus is not peculiar to tobacco but occurs on various dying or dead herbaceous plants.

the floor of the barn should then be thoroughly gathered together and burned, and the floor should be liberally sprinkled with a mixture consisting of equal parts of dry air-slacked lime and sulphur. If the floor is of earth, covering it to the depth of an inch with clean dry earth would prevent the dissemination of the spores through the air. A more effectual method of reaching the spores in all parts of the barn would be fumigation by means of sulphur, kept boiling for two or three hours in any iron vessel over a small kerosene stove. In the larger barns it would be advisable to have three or four such stoves, and keep the sulphur boiling simultaneously in different parts of the barn; of course during the process of fumigation the building must be kept tightly closed so that the fumes may thoroughly penetrate every part. If this were done once after the removal of the cured tobacco, and again the following season a fortnight before the tobacco is harvested, the danger from "stem-rot" would be largely decreased if not entirely obviated.

In closing this report upon tobacco we wish to express our sincere thanks to Maj. R. L. Ragland, and Messrs. E. R. Cocke and W. T. Sutherlin of Virginia; to Messrs. Leslie Combs, A. P. Gooding, W. Z. Thomson, and Lewis L. Johnstone of Kentucky; and to Messrs. Austin and Pinney of Suffield, Conn.; all of whom have furnished most valuable information in connection with the subject.

NOTES ON THE CURING OF HAVANA SEED LEAF TOBACCO BY ARTIFICIAL HEAT.

The system of curing tobacco on the stalk in barns which are not weather-proof, or being weather-proof cannot be properly ventilated in very unfavorable weather, nor heated at any time, is almost universal in this State. The faults of the system are also universally recognized. In a very favorable season the curing is all that could be desired. In a clear dry season, like that of 1891, the cured tobacco is apt to show considerable "white vein;" *i. e.* the veins cure white and shining and make the affected leaves worthless for wrappers, a fault ascribed by growers to too rapid drying of the veins.

On the other hand, if warm, moist, ("muggy,") weather prevails for ten days after cutting the crop, it is sure to be associated with prevalence of "pole-burn" which may ruin from a tenth to a half of the entire crop, or in extreme cases actually the whole of it. "Stem rot" is another disease believed to be peculiar to pole-cured tobacco. These diseases of tobacco are discussed in the report of the mycologist, Dr. Sturgis.

Leading tobacco growers admit that the present system of pole-curing is very crude and unsatisfactory, chiefly for the reason that the owner cannot control the heat and moisture in his barns enough to prevent "pole-burn." It is admitted that artificial heat alone or with a supply of moisture at the same time might prevent this disease without damaging the color or texture of the leaves. It is also true that in past years no method to do this has been devised successful enough in Connecticut to warrant general adoption.

THE SNOW MODERN BARN SYSTEM.

A new process of harvesting and curing tobacco, the so-called "Snow Modern Barn System," was introduced into this State last season as an experiment, and the Station was asked by tobacco growers in Suffield to make observations on this mode of curing; particularly to test the conditions of heat and moisture in the barn while the curing was going on.

It is not necessary here to fully describe the barn and apparatus. Suffice it to say that the Snow Modern Barn System as a system of *curing* tobacco (certain important advantages are claimed in harvesting) consists in this. The fresh leaves, stripped from the stalks in the field are brought to the barn in baskets and strung through the butt back to back, about the width of a finger apart, on pointed wires which project at right angles from a wooden "stick."

As the "sticks" are filled they are placed in moveable racks in a barn and as fast as a rack is filled it is raised by a simple device to the top of the building. Other racks follow leaving only as much space between racks as is required for the hanging leaves.

The barn by a very complete system of ventilators can be closed tight or thoroughly ventilated. The floor is of slats and in the cellar are two small furnaces or stoves and a system of flues which exposes a large radiating surface and makes it possible to warm all portions of the floor space above evenly.

When the barn is filled and the leaves wilted, the heat is raised considerably above that of the air outside and held there. The moisture, however, is not allowed to escape freely from the building but the air of the barn is nearly saturated with it. Soon a "sweat" begins in the tobacco which produces more water and following shortly after, the leaf begins to change color, but without drying. The curer watches the color, regulating heat and moisture as experience has taught is necessary and when the color wanted is obtained he raises the heat and diminishes the moisture to "fix" the color. Finally the leaves become dry and the cure is done. It is only necessary then to moisten the leaves, which is quickly done by sprinkling water on the basement floor and leaving the building closed for sometime. The tobacco is then removed from the wires and bulked down to sell. The above is a brief outline only of the "System." The Modern Tobacco Barn Co. claim patents to cover "all tobacco sticks with projecting prongs on each side, at right angles to the stick, by any and all permanent means of attachment, no matter how attached or fastened."

The following advantages of this method are claimed by the representative of the company:

1. All loss from "burn," "stem rot" or "white vein" is avoided.

2. A more uniform color is secured than by pole curing.
3. Better control of the color is possible, *i. e.* it can be made dark, medium or light as the market demands.
4. Great saving of time is effected in curing the crop.
5. The tobacco so cured will not "sweat" as pole-cured tobacco sweats in the case, but only requires a short "mull" in bulk, to fit it for immediate manufacture.

The Experiments at Suffield.

In the spring of 1891 the Modern Tobacco Barn Co., through their agent, Mr. J. B. Roney, constructed a barn on Mr. H. H. Austin's farm in Suffield, at their own expense, and in the late summer and fall made several experimental curings of Havana seed tobacco grown in that town. Mr. E. F. Paschal who conducted the curings has had a wide experience with southern smoking tobacco, but as far as known the system had not been applied before to the curing of wrapper tobacco which is the only kind raised here. Mr. Paschal said at the outset that because of this difference in the character of the tobacco it was not to be expected that the first few trials would be perfectly successful. Experience would be needed to secure perfection of color in the curing.

The experimental barn was quite small—twenty feet long, sixteen feet wide and twenty feet high, with four sets of stanchions. About thirty thousand leaves can be conveniently cured in this barn at a time. The barn and fixtures were made on the same plan as those which are used in the South. The furnaces are made to burn wood. Should the method be introduced here probably coal or steam would be found cheaper and more convenient requiring less attention from the curer. In this experiment about a cord of hard wood was used in each curing.

Owing to the close attention required to the details of the curing process the representative of the Station was unable to gather data regarding the cost of picking the leaves and filling the barn, and indeed the only point which the Station was asked to investigate was the conditions of heat and moisture in the barn during the curing process. It was understood that the quality and quantity of the Modern Barn-cured tobacco as compared with the pole-cured would be determined by the growers themselves.

Mr. Winton of this Station witnessed the second and third curings and with an assistant made observations of the tempera-

Observations of Temperature and Relative Humidity in the Snow Modern Barn During the Curing Process.

Date.		Weather.	Temperature. Outside.	Temperature. In the Curing Barn. First Floor. Front.	First Floor. Rear.	Second Floor.	Third Floor.	Relative Humidity. Outside.	Relative Humidity. In Curing Barn. First Floor.	Second Floor.	
August.											
22,	5 p. m.		85	85	92	89	92	56	85	--	
	9 "		72	89	93	94	94	82	100	--	
23,	2 a. m.		64	87	91	92	93	93	100	--	
	6 "		62	87	91	92	93	98	100	--	
	10 "		77	93	96	97	100	75	96	--	Leaves wilting perceptibly.
	2 p. m.		85	96	101	100	102	61	86	--	
	6 "		79	96	103	100	103	70	86	80	
	10 "	Heavy shower about 11 o'clock.	74	98	105	105	110	91	87	78	A few pails of water sprinkled in basement [at 7.30.
24,	2 a. m.		70	96	98	100	103	100	90	80	Leaves beginning to turn yellow.
	6 "	Damp and rainy following clear sunrise.	69	93	97	98	102	98	89	81	One fire out for short time.
	10 "	Mist and rain.	76	96	100	100	105	94	88	77	
	2 p. m.	Sunshine at 12 m.	83	97	104	101	106	77	85	77	
	6 "		80	96	108	102	106	78	78	69	
	10 "		76	95	101	100	106	93	81	77	Leaves fully wilted and decidedly yellow on tips and in spots.
25,	2 a. m.		74	93	98	98	106	91	82	76	
	6 "	Clear day.	74	95	100	101	107	91	81	71	Leaves brown on tips and in spots.
	10 "		81	96	100	101	105	71	79	71	Six pailfulls of water added at 9.30 a. m.
	2 p. m.		83	96	101	100	105	53	78	67	
	6 "		77	96	101	100	106	63	76	65	
	10 "		69	93	98	99	102	72	78	66	
26,	2 a. m.		66	90	96	96	100	80	77	67	
	6 "	Cloudy.	65	91	98	98	105	80	74	64	
	10 "	Few drops of rain at noon.	71	97	102	103	107	71	73	64	Strong tobacco odor in barn for first time.
	2 p. m.		73	98	102	103	108	78	73	67	
	6 "	Light rain till 6 a. m. of 27th.	72	97	102	103	106	88	75	67	
	10 "		70	95	104	105	111	93	74	65	
27,	2 a. m.		69	93	98	100	105	97	75	65	The leaves were about *one-quarter brown.*
	6 "	Dense mist.	67	96	101	102	108	100	80	63	
	10 "		70	101	107	107	113	91	70	60	Tobacco odor in barn *almost unendurable.*

Observations of Temperature and Relative Humidity in the Snow Modern Barn During the Curing Process.

Continued.

Date.		Weather.	Temperature. Outside.	Temperature. In the Curing Barn. First Floor. Front.	First Floor. Rear.	Second Floor.	Third Floor.	Relative Humidity. Outside.	Relative Humidity. In Curing Barn. First Floor.	Second Floor.	
August.											
27,	2 p. m.	Shower at 3.00 p. m. Then "open and shut" weather.	77	102	106	107	112	84	69	60	
	6 "		77	101	106	106	111	89	71	64	
	10 "		73	100	106	106	111	95	67	59	
28,	2 a. m.		73	98	104	104	110	95	65	59	
	6 "		72	102	109	109	115	97	62	54	Browning of leaves continues.
	10 "	Shower.	78	103	109	109	119	84	63	55	Opened two top ventilators.
	2 p. m.	Rain.	73	102	107	107	109	93	62	55	Most of the leaves are brown except on the ribs The midribs are still juicy or "fat."
	6 "	High wind began at 8 p. m.	74	106	112	111	119	86	58	54	
	10 "		66	106	112	112	115	66	50	40	Leaves near the door still greenish.
29,	2 a. m.		60	97	100	103	107	65	43	37	Till now the midribs have not cured much.
	6 "		56	97	97	98	105	65	37	31	Ventilators shut. Midribs drying.
	10 "		60	115	122	123	137	63	42	35	Tobacco odor still very strong
	2 p. m.		71	114	118	118	128	52	39	38	
	6 "		65	116	124	122	136	61	39	34	
	10 "		60	132	140	140	162	73	--	31	
30,	2 a. m.		58	124	129	133	147	89	31	28	
	6 "	Rain toward morning.	58	127	133	135	147	94	24	23	
	10 "		58	128	135	136	148	94	23	20	Midribs almost dry except by door.
	2 p. m.		60	142	151	151	169	95	22	20	
	6 "		60	149	156	156	171	84	16	12	
	9 "		59	150	156	158	169	94	12	10	Fire left to go out.
31,	8 a. m.	Cloudy day.	60	84	86	86	88	68	34	35	Opened top and bottom ventilators and added about 50 gallons of water.
	12 m.		66	70	75	74	79	61	73	58	
	5 p. m.		67	74	77	78	80	81	88	63	At 3 p. m. leaves getting pliable. Much water [added.
	7 "	Few drops of rain.	63	70	73	74	75	89	82	82	Opened all doors and side vents.
	9 "		62	66	73	74	75	89	82	82	
September.											
1,	8 a. m.		61	61	--	--	--	89	--	--	Leaves fairly moist though midribs still rather brittle.

ture at five different places and of the relative humidity of the air at one place in the building every two hours day and night from 3 P. M. on Aug. 22 to 8 P. M. on Sept. 1.

The accompanying table pages 190 to 191 gives in detail the observations made by Mr. Winton. The term "relative humidity" signifies what portion (per cent.) of the moisture which air of the given temperature could possibly hold, was actually present at the time of observation.

The particulars regarding the weather, the temperature and humidity of the interior of the barn as well as of the outer air and of the progress of the curing are given in the table.

A study of the figures and of Mr. Winton's notes will make evident the following facts.

Some of the leaves near the door did not come to color properly and the thermometer hung near the door shows greater fluctuations than the others because very many people visited the barn during the curing and the front door was often opened. The manager was willing to allow this although knowing that it was a damage to the tobacco nearest the door.

The third story was throughout warmer and dryer than the lower part of the barn but the cure was as successful there as elsewhere.

The thermometer on the second floor showed the same temperature as the one on the first floor farthest from the door and the following statements refer to the mean of the readings of these two instruments and to the readings of the sling psychrometer on the first floor.

The time required for filling the barn and curing the leaves was just eleven days and may be conveniently divided into the following periods which are of course quite arbitrary and might differ considerably in different curings.

A	Filling the barn	12 hours.
B	Wilting the leaves	18 "
C	From time of starting the fire till the yellowing began	43 "
D	From yellowing till the brown color began to appear	24 "
E	From D till the rank odor developed	24 "
F	From E till leaves were mostly brown except on midrib	54 "
G	From F till color was satisfactory	18 "
H	Time of drying the midrib and fixing color	38 "
I	Cooling and dampening	34 "
		264 "

It should be said that this is twice as long a time as was required for curing the lower leaves which were picked and cured previously and probably considerably longer than was necessary. But as this kind of tobacco had never been cured before by this process, the expert, Mr. Paschal, wished to go surely if slowly.

Our observations began when the barn was closed and the fires built, at 1 P. M. Aug. 22, the beginning of period C.

1. From the time the fires were fairly going and the flues warmed till the yellow color appeared on the tips and in spots over the leaf, 39 hours, the temperature of the barn fluctuated between 91° and 105° and on the average was 97°.

The relative humidity in the barn was from 86 to 100 and on the average was 92, while that of the outer air averaged 82.

This is a nearly saturated atmosphere and while a good deal of water in the aggregate might evaporate from leaves four-fifths of whose weight was water when they were put in, there is nothing like a rapid drying.

2. From the time when yellow patches first appeared to the first signs of browning, period D, 24 hours, the temperature of the barn varied between 98° and 105° and on the average was 102°.

The relative humidity varied between 78 and 90 or on the average 83, while that of the outer air varied from 77 to 94 and averaged 86.

In this period the temperature has risen five degrees and the humidity has fallen slightly. The leaves are "sweating;" water stands on them in drops. Here again there is no doubt a slow drying but nothing like what would take place in even moderately dry air. The atmosphere of the barn is at this time almost insupportable because of the moisture.

3. In the following 24 hours, period E, the same state of things continues. Temperature between 96 and 101, averaging 99°; relative humidity 74 to 81, averaging 77.

At the end of this period note was first made of a "tobacco odor" difficult to describe but due to an exhalation that was intensely irritating to the eyes and considerably so to the throat. Analyses of the leaves before and after curing do not indicate any considerable loss of nicotine.

4. Next follows a longer period, F, of 54 hours, during which the tobacco odor is very strong, at times almost unbearable even for the time needed to make observations. In this period the

leaves are drying somewhat more rapidly, though entirely limp and damp to the touch, and the curer is waiting for the brown color to spread over the whole leaf and to become dark enough.

Temperature from 99° to 109°, averaging 105°.

Humidity from 62 to 80, averaging 70.

5. Next is a short period, G, of 18 hours, during which the air grows rapidly drier. This period might probably have been omitted and the heat raised at 2 P. M. on the 28th, but for greater security the curer waited.

6. In the last period of the cure the heat was run up to 157° simply to cure and dry out the midribs perfectly. When this was done it was only necessary to cool and dampen the leaves so they could be handled.

Curing of Upper Leaves and Miscellaneous Tobacco.

On Sept. 5 the top leaves from the stalks whose lower and middle leaves were cured in the first and second experiments were picked and put in the barn and as they did not occupy over a quarter of the space, the remaining space was filled with a miscellaneous lot of leaves from different fields.

Time of Observation.	Notes on Process.	Temperature (F).				Relative Humidity.			
		Outside.	In the Building.			Outside.	In the Building.		
			1st Story.	2d Story.	3d Story.		1st Story.	2d Story.	3d Story.
Sept. 5 and 7 -----	Barn filled.								
" 8th, 8 A. M.-	Fire started.								
" " 1 P. M.-		63	77	79	81	60	95	87	83
" " 4 P. M.-		63	81	86	86	60	88	73	77
" " 7 P. M.-		58	83	86	87	72	92	77	77
" " 10 P. M.-		52	83	85	85	84	92	80	77
" 9th, 2 A. M.-		47	81	83	83	93	88	80	80
" " 6 A. M.-	Yellowing well started-----	45	77	79	79	96	87	75	79
" " 10 A. M.-		65	83	85	87	56	92	80	77
" " 2 P. M.-		68	86	90	91	50	84	68	71
" " 6 P. M.-		59	89	92	96	62	88	75	67
" " 10 P. M.-		55	87	90	92	70	88	75	69
" 10th, 2 A. M.-		48	84	86	87	93	84	73	74
" " 6 A. M.-		46	82	85	87	96	80	73	67
" " 10 A. M.-		68	89	92	95	60	88	78	72
" " 2 P. M.-		75	97	101	104	47	86	74	69

As the leaves were of different degrees of ripeness and of different texture the curing did not proceed with the same rapidity in all cases. The leaves from near the tops of the stalks cured much more rapidly than the others.

During this curing no water was added to the cellar except at the end of the process after the fires were out.

The record of temperature and moisture were taken for the first three days during the most critical part of the process and are given above.

It will be noticed that the temperature in this curing was kept for the first three days from 15° to 20° lower than in the previous curing but the relative humidity in the barn was fully as high if not higher than before. But the curing was equally successful.

Mr. Paschal stated that the heat in the building must be regulated somewhat by the temperature outside which was considerably lower in this curing than in the last. The curing was easily done in six days.

Curing of Stem Suckers.

The first curing, not witnessed by us, was of lower leaves picked by hand on a certain part of a tobacco field. The second curing, described in detail above, was of the middle leaves from which the prime long wrappers are made; the third curing just alluded to was of the shorter upper leaves.

When the lower and middle leaves were picked, from most of the stalks there grew a stem sucker. The season being an exceptionally long and favorable one, these suckers grew leaves of good size which appeared quite fairly ripe and all other tobacco being harvested the barn was filled with the stripped sucker leaves to see if they could be cured. Somewhat to the surprise of every one they cured almost as rapidly as the others. Their texture and color when cured were certainly all that could be desired. They added very considerably to the value of the crop.

It would have added greatly to the value of the observations if there had been opportunity to make notes of the weight of tobacco obtained and the cost of harvesting; and if samples could have been submitted to an expert, who was ignorant of their origin, for a judgment of their texture, color and burning quality comparing each with other portions of the same crop, pole-cured.

The representatives of the Modern Barn System were ready to coöperate in any plans but when the Station was called on by tobacco raisers there was too little time to arrange for any thing more than was done.

The circular referred to in report of Board of Control, p. 11, is here reproduced.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

NEW HAVEN, CONN., November, 1891.

DEAR SIR:

It is said that a larger number of old, well established varieties of Indian corn are grown in Connecticut than in any other State in the Union.

Some of these have been raised in one place for more than a century, and during that time have been strikingly improved by selection.

It is very desirable that specimens of these varieties should be collected, with all available information regarding their names, origin, history, improvement under selection, and actual yield per acre. This is especially so in view of the Columbian Exposition at Chicago in 1893, where there should be a fair exhibit of the leading agricultural products of this State. It is also important that a full set of samples be kept in the State for the instruction of our citizens.

The collection should be begun at once, as it cannot well be made complete in one season. This Station, therefore, asks the coöperation of farmers in an attempt to prepare an exhibit of Indian corn which shall do credit to the State. To this end the Director invites Granges, Farmers' Clubs and Farmers to furnish this Station samples of corn selected from this year's crop, of those varieties which have been raised in Connecticut for a term of years, and of new kinds which are considered valuable.

Ten ears of field-cured corn (with the husk attached if possible) should be selected which fairly represent the *average quality* of the variety. Besides, four ears of extra size of each variety are desirable.

Each ear should be separately wrapped in plenty of dry paper, and the whole, tied firmly together, should be packed with straw

in a box; or, if that cannot be done, should be so carefully done up in cotton and stout paper that the ears cannot be in any way injured in transportation. The samples may then be sent by express to the Connecticut Agricultural Experiment Station, New Haven. In all cases the shipper's name should be enclosed in or marked on the package. If several varieties are sent together, each variety should be separately labeled with its name. The Station will pay the express charges.

At the time of forwarding the samples, fill out and return the following blank for each variety.

1. Name most commonly used and all other names which are sometimes applied.
2. How long raised by you or in your town.
3. Where the seed was first got by you.
4. Whether it has changed its habit of growth, and how.
5. Number of rows to ear, ; of ears to stalk.
6. Time of ripening.
7. Average and maximum height of stalks.
8. Average yield of shelled corn and of stalks or stover, under ordinary conditions.
9. Yield under very favorable conditions. State year and specify the conditions.
10. Planted in hill or drill. Number of stalks in hill. Distance between hills and rows, or between plants and rows in drill.
11. How manured and cultivated.
12. Any other data regarding the sample which the sender thinks important.

The Station will receive and store the samples, will keep with each the sender's name and address, and all data regarding the sample, will make such chemical examinations as may seem desirable, and will endeavor to have all the samples properly exhibited at the Columbian Exposition as well as *permanently preserved in the Station Museum.*

In order that the sending of many duplicate samples may be avoided, it is asked that those having corn suitable for the exhibit will *notify the Station at once, naming the varieties* which they are prepared to furnish. The Station will then write in reply, advising whether to send or stating that the kind is already sufficiently represented among the samples received or promised.

S. W. JOHNSON, *Director.*

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