STATE OF CONNECTICUT.

10th

ANNUAL REPORT

OF

The Connecticut Agricultural

EXPERIMENT STATION

For 1886.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN, CONN.:
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1887.

The Connecticut Agricultural Experiment Station.

OFFICERS FOR 1886.

STATE BOARD OF CONTROL.

Ex-officio.
HIS EXC. HENRY B. HARRISON, *President.*

	Term expires
Appointed by Connecticut State Agricultural Society:	
HON. E. H. HYDE, Stafford, *Vice-President.*	July 1, 1888.
Appointed by Board of Trustees of Wesleyan University:	
PROF. W. O. ATWATER, Middletown.	1888.
Appointed by Governor and Senate:	
EDWIN HOYT, New Canaan.	1886.
H. L. DUDLEY, New London.	1887.
Executive Committee. — *Appointed by Board of Agriculture:*	
T. S. GOLD, West Cornwall.	1886.
Appointed by Governing Board of Sheffield Scientific School:	
W. H. BREWER, New Haven, *Secretary and Treasurer.*	1887.
Ex-officio.	
S. W. JOHNSON, New Haven, *Director.*	

Chemists.
E. H. JENKINS, PH.D., *Vice-Director.*
E. H. FARRINGTON, B.S.
A. L. WINTON, JR., PH B.
T. B. OSBORNE, PH.D.

In charge of Buildings and Grounds.
CHARLES J. RICE.

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, soils, milks, and other agricultural materials and products, to identify grasses, weeds, and useful or injurious insects, 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 by *consumers* from stock now in the market, and in accordance with the Station instructions for sampling.
3. That the samples are fully described on the Station "Forms for Description."

All other work proper to the Experiment Station that can be used for the public benefit will be made without charge. Work done 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. See p. 21.

Results of analysis or investigation that are of general interest will be published in Bulletins, of which copies are sent to each Post Office in this State, and will be summed up in the Annual Reports made to the Legislature.

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 the farmers is essential for the full and timely protection of their interests. 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.

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 individual officers*, but simply to the

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

☞ Station Grounds, Laboratory and Office are on Suburban st., between Whitney avenue and Prospect st., $1\frac{5}{8}$ miles North of City Hall. Suburban st. may be reached by Whitney Lake Horse Cars, which leave corner of Chapel and Church sts. each hour and half hour.

☞ The Station has Telephone connection and may be spoken from the Central Telephone Office, 346 State st., or from Peck & Bishop's Office in Union R. R. Depot.

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REPORT OF THE BOARD OF CONTROL.

To the General Assembly:

The Board of Control of The Connecticut Agricultural Experiment Station begs leave to present herewith its Tenth Annual Report. The Experiment Station has been engaged during 1885 as in previous years, chiefly with the analysis of Commercial Fertilizers and Feeding Stuffs. The State "Law concerning Fertilizers" in its 9th Section requires the Director of the Station to make and publish annually at least one analysis of each Commercial Fertilizer sold in Connecticut. The number of brands of Commercial Fertilizers legally sold in the State during the year has been 134, and of some of these it has been necessary to make two or more analyses. This work has been on hand during the entire year and has mostly employed the time of the Station chemists from April to November.

An Act passed at the last session of the General Assembly entitled "An Act to Prevent and Punish Fraud," in its fifth section provides that "The Dairy Commissioner may have samples, suspected to be imitation butter, analyzed at the Connecticut Experiment Station, or by any State Chemist, and a sworn or affirmed certificate of the analyst shall be *prima facie* evidence of the ingredients and constituents of the sample analyzed." Since this law went into effect the Station, at the request of the Dairy Commissioner, has examined fifty suspected samples, thirty-five of which proved to be imitation butter. In nearly all the prosecutions brought by the Commissioner for violation of the law it was deemed needful that either the Director or Vice-Director of the Station should attend court to give evidence. In connection with this work necessarily a good deal has been done in testing methods of butter analysis and in gathering statistics on the composition of genuine butter.

During the last winter a feeding experiment was carried on with sheep on the digestibility of gluten meal. Considerable labor has also been bestowed on methods of soil-analysis and on vegetation experiments with reference to the relative fertilizing value of horn shavings and ground horn and hoof. The Station records show that the Station has analyzed 263 fertilizers, 24 feeding stuffs and 73 samples of milk. It has published and distributed four printed Bulletins, each averaging ten pages, in editions of 5,000 copies, and has issued eight "weekly statements," printed by the hektograph process and supplied to the Agricultural Press and to the Secretaries of Farmers' Clubs and Agricultural Societies. The requirement that Reports to the General Assembly are to be prepared and printed on or before November 1st, cannot well be carried out in respect to the details of this work, which properly constitute the Report of the Director of this Station. That Report is valuable to farmers and gardeners especially, because it puts into their possession an accurate and complete account of the composition and relative values of all the commercial fertilizers and of most of the concentrated cattle foods found in our markets. These analyses furnish indispensable data to practical farmers in arranging their operations for the coming agricultural year which begins in the early spring and it is of the highest importance to them that the information be as complete as possible and be brought down to the latest date. The Director cannot finish his Annual Report in a manner satisfactory to the agriculturists of the State until the work of nearly the entire calender year is completed. To close the Station work in September as would be necessary in order to make and print a Report before November 1st, would in our opinion seriously impair the practical usefulness of the Station. Furthermore the printing of the Director's Report is necessarily slow, great care and repeated proof-reading being required to insure correctness of the numerous tables of analyses which it contains.

The Director's Report for 1886 is in preparation, but it cannot be ready for the printer until well into December and the printing and proof-reading will require a month or more for their completion. It is expected to be mostly or entirely in type at the time designated in the Act establishing the Station for the regular annual meeting of this Board, viz: "on the third Tuesday in January." To that Report we beg leave to refer for full details of the doings of the Station.

In order to be able to respond with promptitude to the requisitions of the Dairy Commissioner it was needful to increase the working staff of the Station, and since May, Dr. T. B. Osborne has been engaged. The Station has enjoyed during July and August the valuable volunteer assistance of Professor J. H. Washburn of the Storrs Agricultural School, and of Dr. E. A. Schneider, late of Johns Hopkins University.

The Director finds that the Station laboratory is already insufficient for the increasing amount of work that is required to be done. The laboratory was conformed as respects its space and outfit to the appropriation made by the General Assembly in 1882, "for the purpose of buying a suitable lot and erecting thereon buildings and equipping the same for the permanent use of the Station." It was then foreseen that the Station would soon outgrow the laboratory thus built and furnished at a cost of about $8,000, and the building was accordingly so planned as to admit of extension without disturbing its arrangements. An addition to the laboratory building, and to the apparatus and appliances for its work and an increased annual appropriation must shortly be provided if the Station is to meet the growing demands made upon it in a satisfactory manner.

HENRY B. HARRISON,
President.

WILLIAM H. BREWER,
Secretary.

November 1st, 1886.

REPORT OF THE TREASURER.

Wm. H. Brewer, *in account with the Connecticut Agricultural Experiment Station.*

July 1st, 1885 to June 30th, 1886.

Receipts.

Balance from old account	$13.33	
Annual Appropriation	8,000.00	
Analysis Fees	3,781.19	
Sale of Bulletins and Reports	38.75	
Repayment of Customs Duties	28.00	
		$11,861.27

Expenses.

Salaries	$7,231.00	
Laboratory expenses	1,290.03	
Grounds and Establishment, repairs and improvements	966.91	
Printing	249.67	
Stationery	182.55	
Postage	201.01	
Library	97.75	
Collecting Fertilizers	126.80	
Traveling expenses of Board of Control	35.05	
Telephone	100.00	
Water	154.00	
Gas	250.99	
Fuel	524.25	
Insurance	203.25	
Miscellaneous sundries	55.13	
Balance on hand	192.88	
		$11,861.27

WM. H. BREWER, *Treasurer.*

Memorandum.

There is due the Station three hundred and thirty-one ($331) dollars, unpaid Analysis Fees.

WM. H. BREWER, *Treasurer.*

REPORT OF THE DIRECTOR.

During the year 1885 the work of the Station has gone on without interruption. The analysis of commercial fertilizers as in past years has occupied the larger part of the time and attention of the Station's working force.

The number of brands of fertilizers legally sold in the State the past season was 135. The Station is required by law to make and publish at least one analysis of each of these, and other analyses made of commercial and home-mixed fertilizers, manures and waste products used for composts has brought the total number of analyses up to 280. Since in all cases the Station makes at least two analyses on each sample and sometimes more to insure accuracy, the actual number of analyses of fertilizers is about 560.

Twenty-four proximate analyses, mostly of feeding stuffs, have been made and the results of all accessible American analyses of this kind which have been published during the year have been incorporated in tables to be found in this report. About eighty milk analyses have been made and some work has been done in testing methods of analysis, etc., part of which is not yet ready for publication.

At the request of Hon. J. B. Tatem, the Dairy Commissioner, the Station has examined 61 samples of suspected butter obtained by the Commissioner in different parts of the State. Forty-seven of these were proved to be imitation butter. In thirty-nine cases suit was brought by the Commissioner against dealers in this article and in every case conviction was secured.

In connection with this work methods of butter analysis have been tested and statistics gathered in regard to the composition of pure butter made in the State. In the latter work valuable and gratuitous assistance has been rendered by Prof. J. H. Washburn of the Storrs Agricultural School.

A series of vegetation experiments has been carried out on the relative fertilizing value of horn and hoof, horn shavings and dried blood, the results of which are to be found in this Report. During last winter a feeding experiment was carried on with sheep, on the digestibility of gluten meal from which valuable results were anticipated, but the trial was a failure as regards the main question to be investigated because of the extremely poor quality of the hay purchased for use as a maintenance ration. Two samples of milk suspected of being poisoned were examined with negative results.

The Station has published and distributed in editions of 5000 copies, four printed bulletins, each averaging ten pages. The object of these Bulletins is to place in the hands of those concerned the results of the Station work as promptly as possible.

As required by law, a package of each Bulletin is mailed to every post-office in the State. The package is directed to the postmaster, with a request to distribute to farmers. The number sent will be increased in any case on application. The distribution of these Bulletins is of course optional with the postmaster.

The Bulletins are also regularly sent to every newspaper in the State, and to the Secretary of each agricultural society, farmers' club and grange whose address is known to the Station.

The Bulletins are regularly sent, also, on application, to any private address in Connecticut. Such application, as a rule, must be renewed annually.

To citizens of other States remitting fifty cents, the publications of the current year, including Bulletins and Annual Report, are mailed as they appear. Applications should be made early in the year.

The Station has also issued eight Weekly Statements printed by the hektograph process and supplied as far as possible to the agricultural press, and to Secretaries of farmers' clubs and agricultural societies.

The necessary Station correspondence increases from year to year. During the last twelve months, this has involved the sending of something over 1300 manuscript letters and reports of analyses.

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. Since a full understanding of the provisions and penalties of this law is important to all who buy or sell commercial fertilizers the law is here reprinted and attention is specially directed to the following points:

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.

2. The law also requires, in case of any fertilizer selling at ten dollars or more per ton, that a *certified statement* of composition, net weight in package, etc., shall be filed with the Director of the Experiment Station, and that a *sealed sample* shall be deposited with him by the MANUFACTURER OR IMPORTER. Section 2.

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.

Here follows the full text of the law, with explanatory footnotes.

AN ACT CONCERNING COMMERCIAL FERTILIZERS.

GENERAL ASSEMBLY,
January Session, A. D. 1882.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. Every person or company who shall sell, offer, or expose for sale, in this State, any commercial fertilizer or manure, the retail price of which is ten dollars, or more than ten dollars per ton, shall affix conspicuously to every package thereof a plainly printed statement, clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand, or trade-mark under which the fertilizer is sold, the name and address of the manufacturer, the place of manufacture and the chemical composition of the fertilizer, expressed in the terms and manner approved and currently employed by the Connecticut Agricultural Experiment Station.*

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

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

SEC. 2. Before any commercial fertilizer, the retail price of which is ten dollars, or more than ten dollars per ton, is sold, offered, or exposed for sale, the manufacturer, importer, or party who causes it to be sold, or offered for sale, within the State of Connecticut, shall file with the Director of the Connecticut Agricultural Experiment Station two certified copies of the statement named in section one of this act, and shall deposit with said director a sealed glass jar or bottle containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.*

Before sale certified copies of statement, and Sealed Sample to be deposited with Director.

* 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.

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.

SEC. 3. The manufacturer, importer, agent, or seller of any commercial fertilizer, the retail price of which is ten dollars or more than ten dollars per ton, shall pay on or before the first of May, annually, to the Director of the Connecticut Agricultural Experiment Station, an analysis fee of ten dollars for each of the fertilizing ingredients† contained or claimed to exist in said fertilizer: *provided*, that whenever the manufacturer or importer shall have paid the fee herein required for any persons acting as agents or sellers for such manufacturer or importer, such agents or sellers shall not be required to pay the fee named in this section.

Analysis Fee to be paid annually on or before May 1st.

SEC. 4. Every person in this State who sells, or acts as local agent for the sale of any commercial fertilizer of whatever kind or price, shall annually, or at the time of becoming such seller or agent, report to the Director of the Connecticut Agricultural Experiment Station his name, residence, and post-office address, and the name and brand of said fertilizer, with the name and address of the manufacturer, importer, or party from whom such fertilizer was obtained, and shall, on demand of the Director of the Connecticut Agricultural Experiment Station, deliver to said director a sample suitable for analysis of any such fertilizer or manure then and there sold or offered for sale by said seller or agent.‡

Yearly Report to Station of Dealers or Agents.

SEC. 5. No person or party shall sell, offer, or expose for sale, in the State of Connecticut, any pulverized leather, raw, steamed, roasted, or in any form, as a fertilizer or as an ingredient of any fertilizer or manure, without explicit printed certificate of the fact, such certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany and go with every parcel or lot of the same.

Leather.

* The analysis of samples sent in accordance with section two is discretionary with the Station. Such samples are intended for preservation as manufacturers' standards.

† 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.

On receipt of statements, samples and analysis-fees, the Station will issue Certificates of Compliance with the law.

‡ Blanks for Dealers' Reports will be mailed to applicants.

Fish-guano, &c.

SEC. 6. Every manufacturer of fish guano, or fertilizers of which the principal ingredient is fish or fish-mass from which the oil has been extracted, shall, before manufacturing or heating the same, and within thirty-six hours from the time such fish or mass has been delivered to him, treat the same with sulphuric acid or other chemical, approved by the director of said experiment station, in such quantity as to arrest decomposition: *provided, however*, that in lieu of such treatment such manufacturers may provide a means for consuming all smoke and vapors arising from such fertilizers during the process of manufacture.

Fines.

SEC. 7. Any person violating any provision of the foregoing sections of this act shall be fined one hundred dollars for the first offense, and two hundred dollars for each subsequent violation.

Fertilizers for private use.

SEC. 8. This act shall not affect parties manufacturing, importing, or purchasing fertilizers for their own private use, and not to sell in this State.

Director's duties and authority.

SEC. 9. The director of the Connecticut Agricultural Experiment Station shall pay the analysis-fees received by him into the treasury of the station, and shall cause one or more analysis of each fertilizer to be made and published annually. Said director is hereby authorized, in person or by deputy, to take samples for analysis from any lot or package of manure or fertilizer which may be in the possession of any dealer.

Bulletins.

SEC. 10. The director of the Connecticut Agricultural Station shall, from time to time, as bulletins of said station may be issued, mail or cause to be mailed two copies, at least, of such bulletins to each post-office in the State.

Repeal of former acts.

SEC. 11. Title sixteen, chapter fifteen, sections fifteen and sixteen, and title twenty, chapter twelve, section five of the general statutes, and chapter one hundred and twenty of the public acts of 1881, being an act concerning commercial fertilizers, are hereby repealed.

SEC. 12. This act shall take effect on the first day of September, 1882.

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.

1. MANUFACTURERS who have paid Analysis Fees as required by the Fertilizer Law, and Fertilizers for which the Fees have been thus paid for the year ending May, 1887.

Firm.	*Brand of Fertilizer.*
Adams & Thomas, Springfield, Mass.	Adams' Market Bone Fertilizer.
Apothecaries Hall Co., Waterbury, Conn.	Victor Phosphate.
Baker, H. J. & Co., 215 Pearl St., New York.	A. A. Ammoniated Superphosphate.
	Pelican Bone Fertilizer.
	Potato Fertilizer.
	Corn Fertilizer.
	Tobacco Fertilizer.
	Castor Pomace.
	Ground Bone.
Bennett, P. W., Middlefield, Conn.	Superphosphate of Lime.
Bosworth Bros., Putnam, Conn.	Ground Bone.
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Stockbridge Grain Manure.
	" Forage Crop Manure.
	" Vegetable Manure.
	Bowker's Hill and Drill Phosphate.
	" Dissolved Bone.
	" Fish and Potash.
	" Dry Fish.
Bradley Fertilizer Co., 27 Kilby Street, Boston, Mass.	Bradley's Superphosphate.
	B. D. Sea Fowl Guano.
	Original Coe's Superphosphate.
	Complete Manure for Corn and Grain.
	" " Potatoes and Root Crops.
	Complete Manure for Top Dressing Grass and Grain.
	Circle Brand Bone and Potash.
	Fish and Potash, Anchor Brand.
	" " Triangle A Brand.
Buffalo Fertilizer and Chemical Works, Buffalo, N. Y.	Crocker's Buffalo Ammoniated Superphosphate.
	Crocker's Buffalo Potato, Hop and Tobacco Phosphate.
	Crocker's Pure Fine Ground Bone.
Clark's Cove Guano Co., New Bedford, Mass.	Great Planet A Brand.
	" B Brand.
	Bay State Fertilizer.
Coe, E. Frank, 16 Burling Slip, New York City.	Unicorn Ammoniated Superphosphate.
	Excelsior Guano.
	High Grade Ammoniated Bone Superphosphate.
	Alkaline Bone.
	Ground Bone.
Coe, Russell, Tremley, N. J.	Ammoniated Superphosphate.
Collier White Lead & Oil Co., St. Louis, Mo., by F. Ellsworth, Hartford, Conn.	Collier Castor Pomace.
Common Sense Fertilizer Co., Boston, Mass.	Common Sense Fertilizer No. 2.
	" " No. 3.
Cooper's, Peter, Glue Factory, 17 Burling Slip, N. Y.	Peter Cooper's Bone Dust.

Firm.	Brand of Fertilizer.
Curtis, J. G., Elliot, Conn.	Ground Bone.
Darling, L. B., Fertilizer Co., Pawtucket, R. I.	Darling's Fine Bone. " Animal Fertilizer. Eagle Brand Bone.
Dickenson, D. B., Middle Haddam, Conn.	Ammoniated Bone Superphosphate.
Harris & Son, Eagleville, Conn.	Bone. Superphosphate.
Hurtado & Co., 16 & 18 Exchange Place, New York.	Peruvian Guano, Standard.
Kelsey, E. R., Branford, Conn.	Fish and Potash.
Lamb, J. A., 238 State Street, Hartford, Conn.	Church's Fish and Potash, Brand D.
Lister Agricultural Chemical Works, Newark, N. J.	Ground Bone. Standard Phosphate. Ammoniated Dissolved Bone. Potato Manure. U. S. Superphosphate.
Mapes' Formula and Peruvian Guano Co, 158 Front St., New York.	Mapes' Potato Manure. " Corn Manure. " Complete Manure [Light Soils.] " " " [General Use.] " Tobacco " [Conn. Brand.] " " " [for use with stems.] Mapes' Complete Manure [A Brand.] " Nitrogenized Superphosphate. " High Grade Superphosphate. " Fine Dissolved Bone. " Muriate of Potash. " Nitrate of Soda. " Sulphate of Ammonia. " Ground Bone. " Grass and Grain Spring Top Dressing.
Meyer, C., Jr., Maspeth, L. I.	Acme Fertilizer No. 1. " No. 2.
Miles, G. W., Agent, Milford, Conn.	I. X. L. Ammoniated Superphosphate. Fish and Potash, "Fish Brand."
Miller, G. W. Middlefield, Conn.	Flour of Bone Phosphate. Pure Ground Bone.
Mitchell, A., Linden, N. J.	Mitchell's Phosphate.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's Fish and Potash. " Ammoniated Bone Superphosphate. " Complete Fertilizer. " Fine Animal Bone.
New Haven Fertilizer Co., New Haven, Conn.	Standard Superphosphate.
Newton & Ludlam, 182 Front St., New York.	Cereal Fertilizer. Cecrops or Dragon's Tooth Fertilizer. Animal Bone.
Olds and Whipple, Hartford.	Cotton Hull Ashes.
Peck Brothers, Northfield, Conn.	Pure Ground Bone.
Plumb & Winton, Bridgeport, Conn.	Bone Fertilizer. Ground Bone.
Preston Fertilizer Co., Green Point, L. I.	Preston's Ammoniated Bone Superphosphate. " Ground Bone.

Firm.	Brand of Fertilizer.
Quinnipiac Fertilizer Co., New London, Conn.	Quinnipiac Phosphate. " Extra Superphosphate. Quinnipiac Potato Manure. " Bone Meal. " Fish and Potash Crossed Fishes Brand. Quinnipiac Fish and Potash Plain Brand. Dry Ground Fish. Muriate of Potash. Nitrate of Soda.
Read & Co., 88 Wall St., New York.	Cook's Blood Guano. " Dissolved Ground Bone.
Rogers & Hubbard Co., Middletown, Conn.	Ground Bone—Meal. " Bone, Grade A. " Bone, Grade AX. Muriate of Potash. Nitrate of Soda.
M. L. Shoemaker & Co., Philadelphia, by F. Ellsworth, Hartford, Conn.	Swift-Sure Bone Meal. " Superphosphate.
Smith, Edmund, South Canterbury, Conn.	Ground Bone.
Soluble Pacific Guano Co., Glidden & Curtis, Agents, Boston, Mass.	Soluble Pacific Guano. Golden Leaf Fertilizer.
I. L. Spencer, Suffield, Conn.	Fish and Potash. Cotton Hull Ashes.
Stearns & Co., 181 Front St. New York.	Ammoniated Bone Superphosphate. Eagle Brand Fish and Potash. Ground Fish Guano.
Thompson, Gilbert, 249 Front St., N. Y.	Bone Fertilizer.
Thomson, Paul, Hartford, Conn.	Charter Oak Fertilizer.
Wilkinson & Co., 239 Center St., N. Y.	Wilkinson's Ammoniated Superphosphate.
Williams, Clark & Co., Hanover Square, New York.	Americus Superphosphate. Bone Meal. Dissolved Bone Black. Dry Ground Fish. Dried Blood. Fish and Potash. Kainite. Muriate of Potash. Potato Phosphate. Tobacco Phosphate. Royal Bone Phosphate.

2. Dealers who have complied with the law by furnishing the Director of the Station with the information required in the 4th section:

Alford, G. H., Winsted.
Anderson, W. H., Putnam.
Blakeslee, Jacob, Watertown.
Barstow, J. P. & Co., Norwich.
Benton, C. E., Sharon.
Brownell, E. C., Moodus.
Boswell, J. W., Sterling.
Case, S. E., New Hartford.
Ellsworth, F., Hartford.
Griffiths, S., Sterling.
Gifford, H. M., East Woodstock
Hopson, Geo., Kent.
Kingsley, Andrew, Coventry.
Kingsley, J. P. & Son, Plainfield.
Lord, C. C., Cheshire.
Munson, S. A., Riverton.
Pratt, Chas. M., Westbrook.
Smith, J. E., East Granby.
Tayler & Hubbell, Newtown.
Tucker, R. H., Saybrook.
Wilson & Burr, Middletown.
Warner, D. B., East Haddam.

Section 7 of the law imposes on those who violate the previous provisions a penalty of one hundred dollars for the first offence and two hundred for each subsequent offence.

The failures of most of the dealers to comply with section 4 of the law has made it difficult for the Station to find and promptly collect all the brands of fertilizers which are in our market. It will be necessary the coming season to secure general compliance with the law on the part of dealers.

Analyses of Fertilizers.*

In respect to its terms, the Station makes *two classes* of analyses of fertilizers and fertilizing materials: the first for the benefit of farmers, gardeners, and the public generally; the second for the private use of manufacturers and dealers. Analyses of the *first class* are made gratuitously, and the results are published as speedily and widely as possible for the guidance of purchasers and consumers. Those of the *second class* are charged for at moderate rates, and their results are not published in a way to interfere with their legitimate private use. The Station, however, distinctly reserves the liberty to use at discretion, for the public benefit, all results obtained in this laboratory, and in no case will enter into any privacy that will work against the public good.

During 1886, two hundred and eighty (280) samples of fertilizers have been analyzed. Of these, 30 were examined for private parties, and the remainder for the general use of the citizens of the State.

Sixty-eight samples of commercial fertilizers analyzed for the public benefit have been sent in by purchasers and consumers. The rest have been supplied by agents of the Station who during the spring and early summer endeavored to visit all sections of the State, to take samples from every brand of fertilizer offered for sale in the State, and to take them from the stock of dealers in remote places as well as from centers of trade.

The Station agents are instructed when drawing samples to open at least three packages of each brand of goods in every case, and if the number of packages is large, to take a portion

* The matter of this and several subsequent pages, explanatory of the sampling and valuation of fertilizers, is copied, with a few appropriate alterations, from the Report for 1885. This repetition appears to be necessary for the use of readers who have not seem former Reports.

from every tenth one, by means of a sampling tube, which withdraws a section or core through the entire length of the package.

The greatest care is necessary in sampling fertilizers that the small sample taken shall accurately represent the whole stock from which it is drawn. Otherwise serious injustice may be done.

Ten out of sixty-eight samples of commercial fertilizers sent to the Station by private individuals were found, after the analyses were finished to be unfairly taken or wrongly labeled, and therefore the work spent on them was wasted.

The Station none the less 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 such samples are understood to be taken in accordance with the printed instructions which the Station supplies to all applicants. Here follows a copy of these instructions.

Gratuitous Analysis of Commercial Fertilizers.

To insure justice to manufacturers, dealers and consumers alike, the Station henceforth will make gratuitous analyses of Commercial Fertilizers only on samples taken by the Agents of the Station or on such others as are properly authenticated by the certificate of the person drawing the sample *and in addition* the witness, either

1. Of a Selectman;
2. Of an Officer of a farmer's club, grange or local agricultural society; or
3. Of the Dealer from whose stock the sample is taken.
4. In case a Dealer takes samples of his own stock, the witness of one of the Officers aforesaid will be required.

In special cases of importance the Station may send its Agent to draw samples.

Instructions for Sampling Commercial Fertilizers.

1. Provide a teacup, some large papers and for each sample a glass fruit can or tin box holding about one quart that can be tightly closed, all to be clean and dry.

2. Open at least three full and unbroken packages, or if there are more than thirty, every tenth package, and mix well together the contents of each for a foot in depth, take out two cupfuls from different parts of the mixed portions of each package, pour them

[six in all] one over another upon a paper, intermix thoroughly but quickly to avoid gain or loss of moisture, fill the can or box from this mixture, close tightly, fix securely on the outside of the can a label with some distinguishing letter or mark (which is to be copied in the "Descripti onof Sample" as *sampler's mark*), and send prepaid to the Agricultural Experiment Station, New Haven, Conn.

3. If convenient weigh separately at least three packages and enter these *actual weights* in the "Description of Sample."

4. When a sample has been taken it should *always* be bottled, labeled and the form for its description filled out completely *before* beginning to sample another fertilizer.

Further Remarks on Sampling.

In case of a fine, uniform and moist or coherent article, a butter-tryer or a tin tube, like a dipper handle, put well down into the packages in several places, will give a fair sample with great ease.

With dry, coarse articles, such as ground bone, there is liable to be a separation of coarse and fine parts on handling. Moist articles put up in bags or common barrels may become dry on the outside. It is in these cases absolutely necessary to mix thoroughly the coarse and fine, the dry and the moist portions before sampling.

The quantity sent should not be too small. When the material is fine and uniform, a pint is enough, but otherwise and especially in the case of ground bone, which must be mechanically analyzed, the sample should not be *less than one quart.*

It is important that samples for analysis should be taken at the time when the fertilizer is purchased, and *immediately dispatched* to the Station. Moist fish, blood or cotton seed meal will soon decompose and lose ammonia, if bottled and kept in a warm place. Superphosphates containing much organic nitrogen will suffer reversion of their soluble phosphoric acid under similar circumstances. Most of the moist fertilizers will lose water unless tightly bottled, but some of the grades of potash salts will gather moisture from the air and become a slumpy mass if not thoroughly protected.

Samples as to whose authenticity or fairly representative character there is any reasonable doubt, the Station will not analyze.

The Station reserves the right to reject samples taken from less than half a ton of stock or those drawn from goods that have been wintered over from last year.

Send with each sample any printed circular, pamphlet, analysis or statement that accompanies the fertilizer or is used in its sale.

Description of Sample.

Station No.------ Rec'd at Station,------------------, 188

Each sample of Commercial Fertilizer sent for gratuitous analysis *must* be accompanied by a Description made by filling out legibly and as fully as possible, the blanks that follow :

Sampler's Mark, --

Brand of Fertilizer,------------------------------------

Name and address of Manufacturer,-----------------------

Name and address of Dealer from whom this sample was taken,

Date of taking this sample,-----------------------------

Is it stated to be fresh stock ?------------------------

Dealer's cash price per ton or hundred, bag or barrel, ---------

Selling weight claimed for each package weighed,-----------

Actual weight of the several packages opened,--------------

Number of packages from which the sample was taken,--------

Here write the per cents of valuable ingredients which the fertilizer is guaranteed to contain.

Soluble Phosphoric Acid,----------------- Nitrogen,---------

Reverted Phosphoric Acid, ------------- (Ammonia, --------)

(Available Phosphoric Acid,--------------) Potash, ---------

Insoluble Phosphoric Acid,------------------------------

Certificate of Person taking the Sample.

I, the undersigned, certify that the accompanying sample marked------was taken by me from full packages, and in accordance with the Station's Instructions for Sampling and to the best of my knowledge and belief fairly represents the stock from which it was drawn, and that said stock when sampled was properly housed and in good condition. I also certify that the foregoing description is correct.

Signature --

Post Office address--------------------------------------

WITNESS OF OFFICER OR DEALER.

The above described sample was drawn in my presence.

Signature ....

Title ....

Township ....

Post Office Address ....

On receipt of any sample of fertilizer from the open market, the filled out "Form for Description" which accompanies it is filed in the Station's Record of Analyses, and remains there as a voucher for the authenticity of the sample and for the fact that it has been taken fairly, or, at least, under suitable instructions. It is thus sought to insure that manufacturers and dealers shall not suffer from the publication of analyses made on material that does not correctly represent what they have put upon the market.

The "Form for Description," when properly filled out, also, contains all the data of cost, weight, etc., of a fertilizer which are necessary for making, with help of the analysis, a valuation of its fertilizing elements, and estimating the fairness of its selling price. Neglect to give full particulars occasions the Station much trouble, and it is evident that want of accuracy in writing up the description may work injustice to the manufacturers or dealers, as well as mislead consumers. It is especially important that the *brand* of a fertilizer and its *selling price* shall be correctly given. The price should be that actually charged by the dealer of whom it is bought, and if the article be purchased in New York or other distant market, that fact should be stated, and the cost at the nearest point to the consumer, on rail or boat, should be reported also.

In all cases, when possible, *ton prices* should be given, and if the sale of an article is only by smaller quantities, that fact should be distinctly mentioned.

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.

With the analysis there is sent to the party furnishing the sample a printed page of "Explanations," intended to embody the principles and data upon which the valuation of fertilizers is based.

These Explanations are essential to a correct understanding of the analyses that are given on subsequent pages, and are, therefore, reproduced here, as follows:

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

REVISED.

Nitrogen is commercially the most valuable fertilizing element. *Organic nitrogen* is the nitrogen of animal and vegetable matters. Some forms of organic nitrogen, as those of blood and meat, 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* and *nitric acid* are results of the decay of *organic nitrogen* in the soil and manure heap, and are the most active forms of Nitrogen. 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.

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 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 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 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 raw bones is nearly insoluble, because of the animal matter of the bones, which envelopes it; but when the latter decays in the soil, the phosphate remains in essentially the "reverted" form.

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

The Valuation of a Fertilizer, as practised at this Station, signifies finding *the worth in money or trade-value, of its fertilizing ingredients.* This value, it should be remembered, is *not necessarily proportional to its fertilizing effects* in any special case.

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 $60 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 money-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

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

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

These Trade-values were agreed upon by the Experiment Stations of Connecticut, New Jersey and Massachusetts for use in their several States during 1886.

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals for 1886.

	Cents per lb.
Nitrogen in ammonia salts	18.5
" in nitrates	18.5
Organic nitrogen in dried and fine ground fish	17
" " in guanos, dried and fine ground blood and meat	17
" " in cotton seed, linseed meal and in castor pomace	17
" " in fine ground bone	17
" " in fine medium bone	15
" " in medium bone	13
" " in coarse medium bone	11
" " in coarse bone, horn shavings, hair and fish scrap	9
Phosphoric acid, soluble in water	8
" " soluble in ammonium citrate*	7½
" " insoluble in dry ground fish	7
" " in fine bone	7
" " in fine medium bone	6
" " in medium bone	5
" " in coarse medium bone	4
" " in coarse bone	3
" " in fine ground rock phosphate	2
Potash as high grade sulphate	5½
" kainit	4¼
" muriate	4¼

The above trade-values are the figures at which on March 1st, the respective ingredients could be bought at retail for cash, in our markets, in the *raw materials* which are the regular source of supply. They also correspond to the average wholesale prices 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

* 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.

agree fairly with the *reasonable retail price* in case of standard raw materials such as:—

Sulphate of Ammonia,	Azotin,
Nitrate of Soda,	Dry Ground Fish,
Muriate of Potash,	Cotton Seed,
Sulphate of Potash,	Castor Pomace,
Dried Blood,	Bone,
Plain Superphosphate.	Ground So. Car. Rock.

Trade Values in Superphosphates, Special Manures and Mixed Fertilizers of High Grades.

The Organic Nitrogen in these classes of goods is reckoned at the highest figure laid down in the Trade-Values of Fertilizing Ingredients in Raw Materials, namely 17 cents per pound, it being assumed that the organic nitrogen is derived from the best sources, viz: bone, blood, animal matter, Peruvian guano or other equally good forms and not from leather, shoddy, hair or any low-priced inferior forms of vegetable matter, unless the contrary is ascertained.

Insoluble Phosphoric acid is reckoned at 3 cents, it being assumed that it is from bone or similar source and not from rock phosphate, unless found otherwise. In this latter form the insoluble phosphoric acid is worth commercially only 2 cents per pound or but two-thirds as much as if from bone. Potash is rated at $4\frac{1}{4}$ 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 as sulphate.

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. These charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investment, bad debts, and finally, profits.

In 1886 the average selling price of Ammoniated Superphosphates and Guanos was $36.58, the average valuation was $29.42 and the difference $7.16, an advance of 24.3 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials

In case of Specials the average cost was $42.56, the average valuation $36.70, and the difference $5.86 or about 16.0 per cent. advance on the valuation.

To obtain the Valuation of a Fertilizer (i. e. the money-worth of its fertilizing ingredients), 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 fineness of the sample is graded by sifting, and we separately compute the nitrogen-value of each grade of bone which the sample contains, by multiplying the pounds of nitrogen per ton in the sample, 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 for phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

The uses of the "Valuation" are twofold:

1, To show whether a given lot or brand of fertilizer is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be quite sure that the price is reasonable. If the selling price is several dollars per ton more 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 valuations 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 always 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-values 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 possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

The Agricultural value of a fertilizer is measured by the 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, plaster, 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 the Fertilizers Analyzed.

The fertilizers and manurial waste products analyzed at the Station laboratory from November 1st, 1885, to November 1st, 1886, were as follows:

Phosphate Rock	7
Thomas Slag	1
South Carolina Floats	1
Superphosphates (plain)	12
Superphosphates (ammoniated) and Guanos	121
Home-mixed Superphosphates and other Fertilizers	4
Special Manures	32
Bone Manures	29
Bone and Potash	1
Dry Ground Fish	4
Fish-Peat	1
Dried Blood	1
Tankage	3
Cotton Seed Meal	3
Castor Pomace	5
Nitrate of Soda	5
Sulphate of Ammonia	5
Sulphate of Potash	3
Muriate of Potash	11
Kainit	1
Cotton-Hull Ashes	12
Wood Ashes	3
Canada Leached Ashes	3
Tobacco Stems	1
Star Fish	1
Hen Manure	1
Peat and Muck	3
Deposit underlying Peat	1
Salt	1
Lime	1
Salt Marsh Mud and Soil	3
	280

Thirty of these samples were analyzed for private persons and are not further noticed in the Report. The remaining analyses are given in detail so far as they have any general interest, with such discussion as may make them more serviceable.

Grand Cayman's Phosphate.

1861. Sample drawn from four bags sent to the Station by N. B. Powter, agent of the Grand Cayman's Phosphate Co., 181 Pearl street, N. Y. Cost not stated.

This material is a very finely pulverized phosphatic rock, represented by the agent to contain considerable iron and alumina as well as lime, which is obtained from Grand Cayman's Island in the West Indies.

It contains by our analysis:

	1861
Phosphoric acid soluble in ammonium citrate*	1.81
" " insoluble in "	27.68
Total phosphoric acid	29.49

The following analyses show the composition of this phosphate in detail.

* Dissolved from 2 grs. phosphate by 100 c.c. neutral ammonium citrate solution, sp. gr. 1.09, in half an hour, shaken frequently at 65° centigrade.

	Analyzed by Habirshaw. 1885.	Stillwell & Gladding. 1886.
Moisture at 212°	6.15	20.00
Sand and Silica	6.02	5.60
Alumina	11.01	6.34
Oxide of Iron	4.67	3.08
Magnesia	0.63	
Lime	31.27	31.07
Phosphoric Acid	26.73	23.99
Carbonic acid	} 13.52	2.69
Undetermined matter		7.23
	100.00	100.00
Equivalent of Bone Phosphate	58.35	52.37

The above analyses are taken from Mr. Powter's pamphlet. That by Stillwell & Gladding has been altered in form somewhat for convenience of comparison. The last named chemists report the phosphoric acid as phosphate of lime simply. The undetermined matter (besides carbonic acid) is probably for the most part combined water. Mr. Powter, we understand from reading his letters and pamphlets, claims that on sandy or calcareous soils, iron and alumina phosphates are more certain in their action and preferable to phosphates soluble in water. He furthermore gives us the impression that the Grand Cayman's Phosphate applied directly to the land may be expected to yield good returns, and for the reason that it is largely a phosphate of iron and alumina.

The analyses however are not conclusive as to the chemical constitution of the Rock, and while we should recommend trial of the ground material, we should hesitate to rely upon it any more than on South Carolina rock, without the positive evidence of experience. Iron and alumina phosphates, like the lime phosphates, differ greatly in their solubility in ammonium citrate and presumably also in their availability as plant food. It may be added that "phosphoral" (an easy soluble fertilizer made from iron and alumina phosphates by the action of sulphur and heat), and finely ground and *gently ignited* iron phosphate, may be very different in their properties from this ground phosphatic rock so that from the agricultural effect of one, that of the other cannot properly be inferred.

Thomas Slag.

This is a by-product of the Thomas process for removing phosphorus from iron preparatory to the manufacture of steel.

The phosphorus is oxydized to phosphoric acid and run off in a slag, combined chiefly with lime and perhaps iron. This slag is not homogeneous and the quantity of phosphoric acid in it varies widely according to the amount of phosphorus in the ore and the details of its treatment. As low as 11.4 and as high as 23.0 per cent. of phosphoric acid have been found in the slag of different steel works. According to Fleischer its average composition is:

Phosphoric acid	17.25
Lime	48.29
Magnesia	4.89
Protoxide of iron	9.44
Sesquioxide of iron	3.78
Protoxide of manganese	3.91
Alumina	2.04
Sulphur	.49
Sulphuric acid	.22
Silica	7.96
Water, etc.	1.73
	100.00

It cannot profitably be converted into superphosphate, but on keeping it slacks to a coarse powder, is easily brought to a high degree of pulverization and applied in that state has given favorable results, in Germany particularly, on land rich in humus. During the last year it has been introduced into this country. The following analysis was made on a sample from one bag sent to the Station by the agent, Paul Weidinger, No. 76 Pine street, N. Y.:

	1826
Phosphoric acid soluble in ammonium citrate	19.57
Phosphoric acid insoluble " "	.30

The slag was a fine meal which passed a $\frac{1}{50}$ inch sieve. It is sold bagged in New York, for $12.50 per ton. The phosphoric acid which it contains costs therefore about $3\frac{1}{5}$ cents per pound.

Plain Superphosphates.

1661. Dissolved Bone Black. From Williams, Clark & Co., New York. Sampled by station agent from stock of E. M. Jennings, Southport. Guaranteed 15–18 per cent. available phosphoric acid.

1641. Dissolved Bone Black. Made by C. Meyer, Jr., Maspeth, L. I. Sampled and sent by G. F. Platt, Milford. Guaranteed 17 per cent. phosphoric acid.

1684. Dissolved Bone Black. Made by C. Meyer, Jr., Maspeth, L. I. Sampled and sent by M. S. Baldwin, Naugatuck. Guaranteed 17 per cent. phosphoric acid.

	1661	1641	1684
Soluble phosphoric acid	15.46	12.15	16.26
Reverted phosphoric acid	2.88	4.46	.88
Insoluble phosphoric acid	.17	1.05	.15
Total phosphoric acid	18.51	17.66	17.29
Cost per ton	$35.00		32.30*

* In Naugatuck.

Nitrogenous Superphosphates and Guanos.

Samples Drawn by Station Agents.

In the following tables will be found all the analyses of ammoniated superphosphates, dry ground fish and guano which have been made at this Station during the present year on samples drawn by our own agents from goods of this season's manufacture which were in dealers' hands. The Station assumes full responsibility both for the accuracy of the sampling and the chemical analysis only on such samples. In a large number of cases and wherever possible, two or more samples have been drawn of the same brand of goods. For example, three samples were drawn of the sixth fertilizer given in the table, Chittenden's Fish and Potash; one from the stock of Mr. Eaton, of Plainville, one from Mr. Fowler of Milford, and the third from Warner & Son of East Haddam. The analysis No. 1799 was made on a mixture of equal parts of these three samples and may be believed to represent somewhat more fairly the average composition of the goods than an analysis made on a single sample.

The last column of the table of analysis is "Percentage Difference between Cost and Valuation." Its significance and the method of calculating it may seen by noticing as before the sixth analysis in the table, No. 1799. Here the cost is $35, the valuation is $32.08 and the difference between them is $2.92. By multiplying this difference, $2.92, by 100 and dividing it by the valuation, $32.08, we get the *percentage* advance of selling price over valuation, which advance should represent the costs and profits of the manufacturer in converting the raw materials into a mixed fertilizer, selling it and collecting on his sales.

Valuation is intended to represent the fair retail cash price of

the valuable ingredients of the fertilizer. When the valuation is subtracted from the cost, the remainder or difference represents in any case the costs and profits of manufacturing the article while the *percentage* difference furnishes a means of comparing different fertilizers whose composition is unlike, but the quality of whose ingredients is about the same. For instance, suppose there are two fertilizers, one A, selling for $50 per ton; the other B, for $30. From the analyses the valuation of A is reckoned to be $44 and that of B to be $25. The difference between the retail price and the valuation, i. e., the cost and profit of manufacture, in the case of A is $6, in the case of B $5. This of itself does not show that B is cheaper to purchase than A. In one case the advance charged by the manufacturer on $44 worth of materials was $6. In the other case he charged $5 advance on $25 worth of materials. Here there is no direct comparison. But we can compare by calculating what advance each manufacturer would make on $100 worth of materials. In the case of A it is $\frac{6}{44} \times 100$ or $13.64. In the case of B it is $\frac{5}{25} \times 100$ or $20. This is the "Percentage Difference" of the tables referred to and gives a fair comparison of different fertilizers by their valuation.

Certain brands of superphosphates on which an analysis fee has been paid do not appear in these tables, for Station agents have not found them on sale at the places which they have visited for the purpose of collecting samples and the agents who have had them on sale have failed to notify the Station as the law requires. In such cases the samples sent by the manufacturers themselves in compliance with the law, have been analyzed and the results are given on following pages.

1. *Cost price.*—The prices quoted are in all cases those which were given by the retailers at the time the samples were drawn. They were understood to be cash ton prices. They are not in all cases in accordance with the views of the manufacturers, some of whom claim to have a uniform retail price for each brand they make, and properly complain that parties acting as their agents have so advanced prices so as to make an undue increase of difference between valuation and selling price.

The Station therefore calls the attention of purchasers to the probability that they may in some cases get better terms by learning manufacturer's prices.

2. *Comparison of Cost and Valuation.*—Excluding the last three fertilizers in the table, "Common Sense" and "Charter

Oak," the average cost of 60 superphosphates has been $36.58 and the average valuation $29.42. The difference, $7.16, is 24.3 per cent. of the valuation. The valuation, as has been explained, is designed to cover *only retail cost of raw materials*, and does not take account of the expense of mixing, handling and selling. The 24.3 per cent. should represent the average cost of these last named items *plus* the average profit which the manufacturers have made.

In former reports attention has been called to the fact that those fertilizers which are sold at the lowest prices are not generally the most economical to buy. The tables of analyses afford another proof of this: The average cost of those tabulated on the first page of the tables is $36.93, and the percentage difference between cost and valuation is 11.2, while of those on the last page of the tables the average cost is only $32.71, but the percentage difference is 36.9. That is, while the margin for cost of mixing, freighting and selling and profits was 11.2 per cent. of the cost of the raw materials on goods that retailed at $36.93, the same margin was 36.9 per cent. on goods that retailed at $32.70.

3. *Guarantees.*—Sixteen out of the 63 superphosphates, were considerably below their guaranteed composition on one ingredient. In 8 cases this deficit was on potash and came about by an inaccurate (and in this State illegal) method of stating the guarantee. The law provides that the guarantee shall be "expressed in the terms and manner approved and currently employed by the Connecticut Agricultural Experiment Station." The terms and manner of statement have been clearly set forth in the reports of this Station from the time the law went into force. The amount of *actual potash* must be stated. If desired, the equivalent of sulphate of potash may also be given. The phrase "Potash [sulphate] 4.0 per cent." correctly understood, means 4.0 per cent. of actual potash in the form of sulphate and not 4.0 per cent. of sulphate of potash which contains but little more than half its weight of actual potash. Only two of the superphosphates are below their guarantees on more than one ingredient.

"Warranted No. 1 Peruvian Guano" No. **1798** is not, as the name implies, pure Peruvian Guano but is a mixture of some genuine guano with sulphate of ammonia and possibly other materials.

The prices of the last three fertilizers in the table, Common Sense Fertilizers, Nos. 2 and 3, and Charter Oak Fertilizer, are

nearly double their valuation and their chemical analyses do not sustain the confidence which their trade names are calculated to inspire.

Church's Fish and Potash. D.

On May 5th of this year, an agent of the Station drew a sample from bags branded "Church's Fish and Potash D," which were in the stock of J. A. Lamb, 238 State St., Hartford. Mr. Lamb was held liable for the payment of the analysis fee on this article, which, after some delay and protest he paid with this request: "Please send receipt, in which I wish you to say: Received of Joseph Church & Co., by the hand of their agent, J. A. Lamb, 238 Church St., Hartford," etc. Shortly after, the Station received a letter from Joseph Church & Co. saying that J. A. Lamb was not their agent and forbidding the Station to analyze anything on Church & Co's account by Mr. Lamb's order. Since the analysis-fee has been paid on this fertilizer the Station is obliged by law to make and publish an analysis and in fairness to the parties concerned makes the above explanation. The analysis and valuation of the article is as follows:

No.	**1771.**
Nitrogen as Ammonia	.55
Organic Nitrogen,	2.96
Soluble Phosphoric Acid,	2.70
Reverted Phosphoric Acid,	1.38
Insoluble Phosphoric Acid,	1.61
Potash,	3.41
Chlorine,	5.41
Cost per ton,	$35.00
Valuation per ton,	$22.35

Nitrogenous Superphosphates and Guanos Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost per ton.	Sampled by
1791	Fine Dissolved Bone.	Mapes' Formula and Peruvian Guano Co., 158 Front St., New York.	J. P. Barstow & Co., Norwich.	$35.00	Station Agent.
1819	Quinnipiac Dry Ground Fish.	Quinnipiac Fertilizer Co. N. London.	Olds & Whipple, Hartford.	40.00	"
1763	Stearns' Pure Ground Fish Guano.	Stearns & Co., 124 Front St., New York.	J. E. Leonard, Jewett City.	40.00	"
1769	Acme Fertilizer, No. 2.	C. Meyer, Jr., Maspeth, L. I.	A. R. Russell & Co., Meriden.	40.00	"
1745	Quinnipiac Phosphate.	Quinnipiac Fertilizer Co., N. London.	A. R. Russell & Co., Meriden.	45.00	"
1799	Chittenden's Fish and Potash.	National Fertilizer Co., Bridgeport.	Berry & Sherman, Bridgeport.	38.00	"
			Geo. W. Eaton, Plainville.	------	"
			Wm. M. Fowler, Milford.	35.00	"
1671	Quinnipiac Phosphate.	Quinnipiac Fertilizer Co., New London.	D. B. Warner & Son, E. Haddam.	35.00	"
			Olds & Whipple, Hartford.	38.00	"
1748	Swift Sure Superphosphate.	M. L. Shoemaker & Co., Philadelphia.	P. & G. M. Williams, New London.	38.00	"
			J. P. Barstow, Norwich.	40.00	"
1770	Acme Fertilizer, No. 1.	C. Meyer, Jr., Maspeth, L. I.	F. Ellsworth, Hartford.	40.00	"
			A. R. Russell & Co., Meriden.	45.00	"
1755	E. Frank Coe's Alkaline Bone.	E. Frank Coe, 16 Burling Slip, New York.	Strong & Backus, Colchester.	32.00	"
1728	Bosworth Bro's Superphosphate of Lime.	Bosworth Bros., Putnam, Ct.	Manufacturer.	36.00	"
1736	Kelsey's Fish and Potash.	E. R. Kelsey, Branford, Ct.	M. S. Baldwin, Meriden.	21.–21.50	"
1735	Mapes' Complete Manure "A" Brand.	Mapes' Formula and Peruvian Guano Co., 158 Front St., New York.	Mapes' Branch, Hartford.	38.00	"
			Birdsey & Foster, Meriden.	39.50	"
1674	Mapes' Complete for General Use.	Mapes' Formula and Peruvian Guano Co., 158 Front St., New York.	Dean & Horton, Stamford.	40.00	"
			Dean & Horton, Stamford.	43.00	"
			Mapes' Branch, Hartford.	41.00	"
			Strong & Backus, Colchester.	39.00	"

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost per ton.	Sampled by
1679	Americus Superphosphate.	Williams, Clark & Co., Hanover Square, New York.	J. P. Root, Tolland.	$38.00*	Station Agent.
			E. M. Jennings, Southport.	38.00*	"
			Strong & Backus, Colchester.	36.00	"
			Usher & Tinker, Plainville	38.00*	"
1797	Lister's Standard Phosphate.	Lister's Agricultural Chemical Works, Newark, N. J.	S. J. Hall, Meriden.	34.00	"
			Martin Bros., Wallingford.	33.00	"
1738	Golden Leaf Fertilizer.	Soluble Pacific Guano Co., Boston, Mass.	H. A. Stillman, Hartford.	42.–44.00	"
1789	Lister's U. S Superphosphate.	Lister's Agricultural Chemical Works, Newark, N. J.	Swan's Seed Store, Bridgeport.	26.00	"
1795	Complete Manure for Light or Sandy Soils.	Mapes' Formula and Peruvian Guano Co., New York.	Wilson & Burr, Middletown.	48.00	"
			W. W. Cooper, Suffield.	48.00	"
			Mapes' Branch, Hartford.	48.00	"
1764	Soluble Pacific Guano Co's Fish and Potash.	Soluble Pacific Guano Co., Boston, Mass.	H. A. Stillman, Hartford.	30.–32.00	"
			Jas. Greenfield, New London.	35.00	"
1713	Baker's A. A. Ammoniated Superphosphate.	H. J. Baker & Bro., 215 Pearl St., New York.	W. W. Cooper, Suffield.	37.50	"
			S. J. Hall, Meriden.	37.50	"
			Smith & Sons, West Cornwall.	35.00	"
1774	Bowker's Hill and Drill Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Jas. Greenfield, New London.	38.00	"
1729	Great Planet Fertilizer, B Brand.	Clark's Cove Guano Co., New Bedford, Mass.	J. H. Ives, Danbury, Ct.	48.00	"
1750	Pelican Bone Fertilizer.	H. J. Baker & Bro., 215 Pearl St., New York.	G. H. Alford, Winsted.	32.50	"
1762	Stearns' Ammoniated Bone Superphosphate.	Stearns & Co., 124 Front St., New York.	A. R. Russell & Co., Meriden.	35.00	"
			J. E. Leonard, Jewett City.	38.00	"
1732	Market Bone Fertilizer.	Adams & Thomas, Springfield, Mass.	Moran Bros., Windsor Locks.	38.00	"

* The manufacturer states that this brand should not retail above $36.00 per ton.

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost per ton.	Sampled by
1782	Darling's Animal Fertilizer.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	Olds & Whipple, Hartford.	$40.00	Station Agent.
			W. W. Cooper, Suffield.	38.00	"
			H. P. Hubbard Middletown.	38.00	"
1798	Warranted No. 1 Peruvian Guano.	Hurtado & Co., 16 Exchange Place, New York.	Southmayd & Gardiner, Middletown	-------	"
			Wheeler & Howes, Bridgeport.	62.00	"
1772	Bradley's Fish and Potash, Triangle A Brand.	Bradley Fertilizer Co., 27 Kilby St., Boston.	Wheeler & Howes, Bridgeport.	31.-32.00	"
1767	Stearns' Fish and Potash, No. 1, Eagle Brand.	Stearns & Co., 124 Front St., New York.	A. R. Russell & Co., Meriden.	35.00	"
1660	Cecrops or Dragon's Tooth Fertilizer.	Newton & Ludlam, 182 Front St., New York.	S. Banks, Southport.	40.00	"
1780	Excelsior Guano.	E. Frank Coe, 16 Burling Slip, New York.	Arnold Rudd, New London.	42.00	"
1731	Bay State Fertilizer.	Clark's Cove Guano Co., New Bedford, Mass.	A. B. Crandall, Tolland.	38.00	"
1822	Quinnipiac Extra Phosphate.	Quinnipiac Fertilizer Co., New London.	Coe & Marsh, Litchfield.	-------	"
			Olds & Whipple, Hartford.	35.00	"
1676	E. F. Coe's High Grade Ammoniated Superphosphate.	E. Frank Coe, 16 Burling Slip, New York.	S. Banks, Southport.	34.00	"
			Arnold Rudd, New London.	35.00	"
			Strong & Backus, Colchester.	36.00	"
			J. B. Carpenter, West Willington.	36.00	"
1716	Bowker's Dissolved Bone.	Bowker Fertilizer Co., 43 Chatham St., Boston.	Jas. Greenfield, New London.	36.00	"
			Strong & Backus, Colchester.	36.00	"
			Seymour & Bonhite, Ridgefield.	40.00	"
1711	Quinnipiac Phosphate.	Quinnipiac Fertilizer Co., New London.	Usher & Tinker, Plainville.	40.00	"
			D. B. Judd, Bristol	40.00	"
1760	Royal Bone Phosphate.	Williams, Clark & Co., Hanover Square, New York.	J. P. Root, Tolland.	30.00	"
			E. M. Jennings, Southport.	30.00	"

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost per ton.	Sampled by
1730	Great Planet Fertilizer, A Brand.	Clark's Cove Guano Co., New Bedford, Mass.	J. H. Ives, Danbury.	$47.00	Station Agent.
1818	Chittenden's Ammoniated Bone Superphosphate.	National Fertilizer Co., Bridgeport.	T. H. Eldredge, Norwich.	35.00	"
1849	Economical Bone Fertilizer.	Wilkinson & Co., 239 Center St., New York City.	Nelson Hanford, So. Wilton.	32.00	"
1714	Victor Phosphate, A 1.	Apothecaries' Hall, Waterbury.	Variety Store, Winsted.	35.00	"
			Apothecaries' Hall, Waterbury.	35.00	"
1777	Ammoniated Superphosphate.	Buffalo Fertilizer and Chemical Works, Buffalo, N. Y.	J. E. Leonard, Jewett City.	38.00	"
1677	Bradley's Superphosphate.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	A. C. Sternberg, Hartford.	38.00	"
			Chas. Jennings & Son, Southport.	40.00	"
			Usher & Tinker, Plainville.	40.00	"
			D. B. Judd & Co., Bristol.	40.00	"
			Strong & Backus, Colchester.	38.00	"
			Wm. D. Holman, West Willington.	38.00	"
1673	Quinnipiac Fish and Potash, Crossed Fishes Brand.	Quinnipiac Fertilizer Co., New London.	E. A. Godfrey, Westport.	38.00	"
			Olds & Whipple, Hartford.	38.00	"
			Usher & Tinker, Plainville.	38.00	"
1766	Fish and Potash.	Williams, Clark & Co., Hanover Square, New York.	E. M. Jennings, Southport.	34.00	"
			Wm. D. Holman, West Willington.	35.00	"
1765	Original Coe's Superphosphate.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Wheeler & Howes, Bridgeport.	-------	"
			S. Banks, Southport	$34.00	"
1662	Cereal Fertilizer.	Newton & Ludlam, New York.	Jas. Greenfield, New London	38.00	"
1675	Soluble Pacific Guano.	Soluble Pacific Guano Co., Boston, Mass.	J. B. Carpenter, West Willington.	36.00	"
			H. A. Stillman, Hartford.	36.-38.00	"

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

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost per ton.	Sampled by
1766	Fish and Potash.	Williams, Clark & Co., Hanover Square, New York.	E. M. Jennings, Southport	34.00	Station Agent.
1768	Circle Brand, Bone and Potash.	Wm. L. Bradley, Boston, Mass.	J. E. Leonard, Jewett City.	35.00	"
1773	B. D Sea Fowl Guano.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	W. W. Cooper, Suffield.	38.00	"
1838	Fish and Potash, "Fish Brand."	John Guyer, New Haven, G. W. Miles, Agent.	Raymond Brothers, South Norwalk.	36.00	"
			G. L. Gage, Ridgefield.	40.00	"
1663	Wilkinson & Co's Ammoniated Superphosphate.	Wilkinson & Co., 239 Center St., New York.	Ferris & Nolan, Stamford.	38.00	"
1749	Russel Coe's Ammoniated Bone Superphosphate.	Russel Coe Fertilizer Co., 88 Wall St., New York.	S. J. Hall, Meriden.	34.00	"
1821	Quinnipiac Fish and Potash, Plain Brand.	Quinnipiac Fertilizer Co., New London.	H. A. Stillman, Hartford.	32.–34.00	"
			D. B. Warner & Son, East Haddam.	32.50	"
			Usher & Tinker, Plainville.	33.00	"
1850	Bowker's Fish and Potash.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Olds & Whipple, Hartford.	34.00	"
			H. K. Brainard, Thompsonville	33.00*	"
1664	Cook's Blood Guano.	Read & Co., 88 Wall St., New York.	Swan's Seed Store, Bridgeport.	37.–38.00	"
1790	Mitchell's Standard Superphosphate	A. Mitchell, Tremley Pt., Staten Is.	J. A. Lewis, Williamantic.	36.00	"
1784	Bowker's Fish and Potash.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Burtis & Mead, New Canaan.	35.00*	"
1740	Common Sense Fertilizer, No. 2.	Common Sense Fertilizer Co., 42 Congress St., Boston, Mass.	Seymour & Barhite, Ridgefield.	38.00*	"
			D. Beers, Danbury.	35.00	"
1737	Charter Oak Fertilizer.	Paul Thomson, Hartford, Ct.	Jas. Greenfield, New London.	35.00	"
			J. R. Cogswell, Putnam.	30.00	"
1776	Common Sense Fertilizer, No. 3.	Common Sense Fertilizer Co., 42 Congress St., Boston, Mass.	B. B. Warner & Son, Plainville.	30.00	"
			Soule & Staub, New Milford.	40.00	"

* Manufacturer states that selling price should be about $32.–$33.00.

ANALYSES OF NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.

Station No.	Name or Brand.	Nitrogen: Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Phosphoric Acid: Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available: Found.	Available: Guaranteed.	Potash: Found.	Potash: Guaranteed.	Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
1791	Mapes' Fine Dissolved Bone.	----	----	2.38	2.38	2.1	5.17	11.99	2.02	19.18	----	17.16	12.0	----	----	----	$35.00	$35.56	----
1819	Quinnipiac Dry Ground Fish.	----	----	8.43	8.43	7.5	1.12	5.18	1.28	7.58	----	6.30	4.0	----	----	----	40.00	38.99	2.6
1763	Stearns' Pure Ground Fish Guano	----	----	8.53	8.53	7.8	1.08	4.24	1.81	7.13	----	5.32	----	----	----	----	40.00	38.63	3.2
1769	Acme Fertilizer, No. 2	----	4.66	1.39	6.05	5.0	6.99	1.65	.64	9.28	8.5	8.64	8.0	7.13	5.0	4.23	45.00	42.28	6.4
1745	Quinnipiac Phosphate	----	.82	3.44	4.26	2.7	7.21	3.48	.78	11.47	--	10.69	9.0	3.89	2.0	3.25	38.00	35.27	7.7
1799	Chittenden's Fish and Potash	----	.96	3.51	4.47	3.3	1.85	5.71	.94	8.50	6.0	7.56	----	5.32	5.0	4.57	35.00	32.08	9.1
1671	Quinnipiac Phosphate	----	1.73	1.25	2.98	2.5	7.56	4.81	.65	13.02	----	12.37	8.0	4.48	2.0	1.78	38.00	34.65	9.5
1748	Swift Sure Superphosphate	.47	----	2.34	2.81	2.5	10.24	2.40	.99	13.63	----	12.64	9.0	5.33	4.0*	trace	40.00	36.13	10.7
1770	Acme Fertilizer, No. 1	----	3.43	1.14	4.57	3.7	7.41	1.37	.58	9.36	8.5	8.78	----	10.01	9.0	----	45.00	40.05	12.3
1755	E. Frank Coe's Alkaline Bone	----	.22	1.84	2.06	.8	8.54	2.48	1.67	12.69	----	11.02	9.0	2.61	3.0*	.32	32.00	28.22	13.4
1728	Bosworth's Superphosphate of Lime	----	1.17	1.37	2.54	2.0	6.58	4.46	4.53	15.57	----	11.04	11.0	3.02	2.0	2.75	36.00	31.50	14.2
1736	Kelsey's Fish and Potash	----	.41	2.93	3.34	2.4	1.12	1.49	.22	2.83	3.0	2.61	----	3.29	3.0	----	21–21.50	18.44	15.3
1735	Mapes' Complete "A" Brand	.38	.51	2.17	3.06	2.4	6.98	5.20	1.98	14.16	----	12.18	10.0	3.31	2.5	4.72	38–40	33.64	15.9
1674	Mapes' Complete for General Use	.43	1.17	2.02	3.62	3.3	6.71	3.70	2.36	12.77	10.0	10.41	----	4.82	4.0	3.01	39–43	34.80	17.8
1679	Americus Superphosphate	----	.14	2.62	2.76	2.4	9.52	2.05	.81	12.38	11.0	11.57	----	2.94	2.0	.37	36–38	31.35	18.0
1797	Lister's Standard Phosphate	----	.60	1.75	2.35	2.3	8.93	2.46	.61	12.00	----	11.39	10.0	2.00	1.5	1.43	33–34	28.22	18.6
1737	Golden Leaf Fertilizer	----	2.92	.86	3.78	3.7	6.32	2.13	3.44	11.89	8.0	8.45	----	6.60	7.0	.81	42–44	36.08	19.2
1789	Lister's U. S. Superphosphate	----	.30	1.25	1.55	1.3	5.78	2.69	.69	9.16	----	8.47	6.0	3.09	2.0	6.51	26.00	21.69	19.9

* As Sulphate.

Analyses of Nitrogenous Superphosphates and Guanos 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 per Ton.	Percentage Difference between Cost and Valuation.
1795	Mapes' Complete for Light Soils	.71	2.55	2.45	5.71	4.9	4.50	3.91	1.21	9.62	7.0	8.41	----	6.96	6.0	5.29	$48.00	$40.10	20.2
1764	Pacific Guano Co's Fish and Potash	----	.30	2.59	2.89	2.4	5.42	1.98	2.38	9.78	6.0	7.40	----	4.45	4.0	5.66	30–35	26.77	21.4
1713	Bakers' A. A. Superphosphate	----	1.63	.87	2.50	2.4	10.91	.35	.03	11.39	----	11.26	10.0	3.02	2.0	3.85	35-37 50	29.56	22.6
1774	Bowker's Hilland Drill Phosphate	----	1.38	1.74	3.12	2.4	9.89	1.44	.70	12.03	11.0	11.33	----	1.57	2.0*	1.48	38.00	30.77	23.5
1729	Great Planet Fertilizer B.	2 63	2.04	1.18	5.85	5.0	5.24	.95	.27	6.46	----	6.19	5.0	7.47	7.0	2.44	48.00	38.67	24.1
1750	Pelican Bone Fertilizer	----	.69	2.21	2.90	1.8	7.69	.88	.04	8.61	----	8.57	8.0	2.91	2.2	5.88	32.50	26.17	24.2
1762	Stearns' Ammoniated Superphosphate	.53	----	2.36	2.89	2.3	7.14	2.67	1.13	10.94	----	9 81	8.0	3.81	2.0	4.53	35–38	29.33	24.5
1732	Market Bone Fertilizer	---	.50	3.03	3.53	3.0	4.29	4.86	.31	9.46	9.0	9.15	8.0	4.65	3.0	3.46	38.00	30.46	24.7
1782	Darling's Animal Fertilizer	.29	.41	3 12	3.82	3.3	1.93	4.87	5.11	11.91	10.0	6.80	----	5.21	4.0	6.62	38–40	31.10	25.4
1798	Warranted No. 1 Peruvian Guano	----	6.76	.84	7.60	7.4	1.91	8.25	4.09	14.25	12.0	10.16	----	3.42	2.0	1.65	62.00	48.96	26.6
1772	Bradley's Fish and Potash, Triangle A	----	.46	3.43	3.89	2.0	1.67	1.90	1.13	4.70	6.00	3.57	4.0	6.22	4.0	7.96	31–32	24.85	26.7
1767	Stearns' Fish and Potash, No. 1, Eagle Brand	----	----	3.07	3.07	2.4	3.04	3.77	4.00	10.81	8.0	6.81	3 0	5.01	1.7	7.29	35.00	27.62	26.7
1660	Cecrops or Dragon's Tooth Fertilizer	----	.95	2.41	3.36	3.3	6.51	1.01	.96	8.48	----	7.52	7.0	8.32	7.0	8.96	40.00	29	27

* As Sulphate.

Analyses of Nitrogenous Superphosphates and Guanos 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 per Ton.	Percentage Difference between Cost and Valuation.
1780	Excelsior Guano	----	.95	2.72	3.67	3.3	8.36	1.46	1.23	11.05	10 0	9.82	----	3.11	5.0*	.59	$42.00	$32.29	30.0
1731	Bay State Fertilizer	----	.49	2.16	2.65	2.1	9.21	1.25	1.03	11.49	9 0	10.46	----	2.78	2.0	.89	38.00	29.15	30.3
1822	Quinnipiac Extra Phosphate	----	.36	2.45	2.81	2.3	5.78	3.67	.92	10.37	----	9.45	8.0	2.20	1.0	2.68	35.00	26.83	30.4
1676	E. F. Coe's High Grade Superphosphate	----	.59	1.60	2.19	2.1	8.00	2.07	1.99	12.06	----	10.07	9.0	1.79	2.0*	.12	34–36	26.65	31.3
1716	Bowker's Dissolved Bone	----	.30	1.81	2.11	2.0	9.43	1.97	.82	12.22	10.0	11·40	8.0	1.88	4.0*	4.55	36.00	27.40	31.4
1711	Quinnipiac Phosphate	----	.47	2.63	3.10	2.7	7.11	2.75	.44	10.30	----	9.86	9.0	2.72	2.0	4.25	38.00	28.75	32.1
1760	Royal Bone Phosphate	----	----	1.18	1.18	.8	6.52	2.88	.36	9.76	8.0	9.40	----	2.84	2.0	.56	29.00	21.92	32.3
1730	Great Planet Fertilizer A	---	1.92	1.92	3.84	3.3	7.09	.91	.64	8.64	----	8.00	7.0	10.02	9.5	6.78	47.00	35.49	32.4
1818	Chittenden's Ammoniated Superphosphate	----	.18	2.51	2.69	1.6	6.10	2.78	1.51	10.39	9.0	8.88	7.0	2.68	2.0	5.44	35.00	26.32	32.9
1849	Wilkinson's Econ'm'al Bone	----	1.91	.28	2.19	.8	5.61	1.66	1.27	8.54	6.0	7.27	----	4.48	2.0	11.11	32.0 0	24.06	33.0
1714	Victor Phosphate, A1	----	.18	2.06	2.24	2.3	8.32	1.43	1.10	10.85	----	9.75	8.5	2.28	3.5*	.09	35.00	26.27	33.2
1777	Buffalo Ammoniated Superphosphate	----	----	3.14	3.14	2.9	8.08	1.64	1.24	10.96	----	9.72	8.0	1.52	1.0	.56	38.00	28.30	34.2
1677	Bradley's Superphosphate	.13	.44	2.23	2.80	2.3	8.58	1.79	1.62	11.99	----	10.37	9.0	2.07	1.0	1.85	38–40	28.86	35.1
1673	Quinnipiac Fish and Potash, Crossed fishes brand	----	.55	3.20	3.75	3.3	2.02	3.39	1.46	6.87	5.0	5.41	----	6.90	3.0	5.58	38.00	27.98	35.8
1766	Williams, Clark & Co's Fish and Potash	----	.16	3.58	3.74	3.0	.36	4.32	2.49	7.17	6.0	4.68	----	4.36	4.0	8.58	34.00	25.02	35.9
1765	Original Coe's Superphos'ate	----	----	2.24	2.24	2.1	7.70	2.52	1.14	11.36	11.0	10.22	9.0	1.23	----	2.02	35.00	25.45	37.5
1662	Cereal Fertilizer	----	----	1.18	1.18	1.2	9.96	1.71	.72	12.39	12.0	11.67	10.0	2.06	4.0*	2.79	34.00	24.70	37.6

* As Sulphate.

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

Station No.	Name or Brand.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	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.
1675	Soluble Pacific Guano	....	.45	1.93	2.38	2.00	7.31	2.01	2.61	11.93	....	9.32	8.0	2.50	2.00	2.84	$36–38	$26.65	38.8
1766	Williams, Clark & Co's Fish and Potash	....	....	3.27	3.27	3.3	.40	5.35	1.48	7.23	3.00	5.75	....	4.26	3.0	8.73	34.00	24.30	39.9
1768	Circle Brand Bone and Potash																		
1773	B. D. Sea-Fowl Guano	....	....	2.09	2.09	2.26	3.42	5.39	2.71	11.52	8.00	8.81	....	2.73	2.00	....	35.00	24.62	42.1
1838	Miles' Fish and Potash	....	.41	1.79	2.20	2.50	7.88	2.40	1.70	11.98	11.00	10.28	....	1.92	2.00	2.10	38.00	26.47	43.5
1663	Wilkinson's Ammoniated Superphosphate	....	....	2.53	2.53	2.5	6.15	2.17	1.47	9.79	....	8.32	5.0	2.73	4.0*	4.90	36.00	24.90	44.6
1749	Russel Coe's Ammoniated Bone Superphosphate	....	....	2.09	2.09	1.7	7.58	1.31	.20	9.09	....	8.89	....	5.14	2.00	7.82	38.00	25.69	47.8
1821	Quinnipiac Fish and Potash, Plain Brand	....	....	2.13	2.13	2.26	5.98	2.03	1.21	9.22	....	8.01	9.00	2.02	1.50	7.50	32–34	22.31	47.9
1850	Bowker's Fish and Potash	....	.46	2.43	2.89	2.00	.44	3.95	2.01	6.40	6.00	4.39	4.00	5.46	4.00	6.47	32.50-34	22.42	48.3
1664	Cook's Blood Guano	....	.08	2.67	2.75	2.5	2.55	2.36	2.06	6.97	8.00	4.91	....	4.25	4.00	9.86	33.00	21.85	51.0
1790	Mitchell's Standard Superphosphate	....	....	2.26	2.26	1.21	6.25	1.79	1.24	9.28	10.00	8.04	7.00	3.33	1.00	4.37	37–38	23.94	56.6
		....	....	1.12	1.12	2.06	7.36	3.46	.76	11.58	11.00	10.82	....	1.36	3.00	1.71	36.00	22.37	60.9
1784	Bowker's Fish and Potash	....	....	2.20	2.20	2.5	3.24	1.70	1.66	6.60	8.00	4.94	....	5.72	4.00	12.75	35.00	21.07	66.1
1740	Com Sense Fertilizer, No. 2	.71	.24	1.14	2.09	2.00	....	4.52	.73	5.25	4.00	4.52	....	4.93	3.00	4 67	35.00	18.80	86.1
1737	Charter Oak Fertilizer	1.94	.28	.77	2.99	1.65	trace	1.48	.77	2.25	2.25	1.48	....	2.65	2.00	....	30.00	15.77	90.2
1776	Com. Sense Fertilizer, No. 3	.91	none	.96	1.87	3.00	.19	2.76	2.01	4.96	5.00	2.95	....	4.15	3.00	3.70	40.00	15.80	153.1

* Sulphate.

FISH AND POTASH.

This brand of fertilizer has been a popular one in this State and for more ready comparison the several brands have been put by themselves on page 48, although they have been already tabulated with other ammoniated superphosphates. (For "Church's Fish and Potash D," see p. 37.)

Their average cost is $33.21, the average valuation is $24.78. The difference, $8.43 is 34 per cent. of the valuation. This shows that Fish and Potash this year, as in past years, has been relatively a more expensive fertilizer than other superphosphates.

The amount of phosphoric acid which these samples contain and the proportion of it that is insoluble shows that they are not all simple mixtures of pure fish scrap and potash salts as their name implies but contain more or less phosphate or superphosphate.

NITROGENOUS SUPERPHOSPHATES AND GUANOS.

Manufacturers' Samples.

In the table on page 49 will be found analyses of certain samples deposited at the Station last spring by manufacturers, in accordance with the requirements of the Fertilizer Law, each sample being accompanied with a statement that it is a fair average of the brand. The agents of the Station not having found these brands on sale it became necessary to analyze the only samples available.

The guarantee of No. **1815**, Harris' Superphosphate of Bone, (4.0 per cent. of nitrogen and 25.0 per cent. of phosphoric acid) is evidently that of ground bone and not of superphosphate. It was however filed at the Station as the manufacturer's statement and is therefore reproduced here.

Samples drawn and sent by private parties.

In the table on page 50 are analyses of samples sent to this Station by private parties. In most of these cases the Station has no guarantee that the samples were fairly taken and therefore no valuations have been given. On samples sent by private parties, a considerable number of analyses have also been made which are worthless because it appeared after the analyses were done that the samples had been improperly taken or wrongly labeled and thus valuable time was wasted which was greatly needed on other work. It is to avoid such a waste as far as may be, in the time to come, that the Station has adopted the regulations in regard to gratuitous analyses which are printed on page 21 of this report.

Fish and Potash.—Sampled by the Station.

	Chittenden's.	Kelsey's.	Pacific Guano Co's.	Bradley's Triangle, A.	Stearns' No. 1 Eagle Brand.	Quinnipiac Crossed Fishes Brand.	Williams, Clark & Co's.	Williams, Clark & Co's.	Miles'.	Quinnipiac Plain Brand.	Bowker's.	Bowker's.
	1799	**1736**	**1764**	**1772**	**1767**	**1673**	**1766**	**1766a**	**1838**	**1281**	**1850**	**1782**
Nitrogen as Ammonia	.96	.41	.30	.46	----	.55	.16	----	---	.46	.08	----
Nitrogen, Organic	3.51	2.93	2.59	3.43	3.07	3.20	3.58	3.27	2.53	2.43	2.67	2.20
Soluble Phosphoric Acid	1.85	1.12	5.42	1.67	3.04	2.02	.36	.40	6.15	.44	2.55	3.24
Reverted Phosphoric Acid	5.71	1.49	1.98	1.90	3.77	3 39	4.32	5.35	2.17	3.95	2.36	1.70
Insoluble Phosphoric Acid	.94	.22	2.38	1.13	4.00	1.46	2.49	1.48	1.47	2.01	2.06	1.66
Potash	5.32	3.29	4.45	6.22	5.01	6.90	4.36	4.26	2.73	5.46	4.25	5.72
Cost	$35.00	$21-21.50	$30–35.	$31-32	$35.00	$38.00	$34.00	$34.00	$36.00	$32.50-34	$33. 00	$35.00
Valuation	$32.08	$18.44	$26.77	$24.85	$27.62	$27.98	$25.02	$24.30	$24.90	$22.42	$12.85	$21.07
Nitrogen found	4.47	3.34	2.89	3.89	3.07	3.75	3.74	3.27	2.53	2.89	2.75	2.20
Nitrogen guaranteed	3.30	2.40	2.40	2.00	2.40	3 30	3.00	3.00	2.50	2.00	2.50	2.25
Phosphoric Acid found	8.50	2.83	9.78	4.70	10.81	6.87	7.17	7.23	9.79	6.40	6.97	6.60
Phosphoric Acid guaranteed	6.00	3.00	6.00	6.00	8.00	5.00	6.00	6.00	----	6.00	8.00	8.00
Potash found	5.32	3.29	4.45	6.22	5.01	6.90	4.36	4.26	2.73	5.46	4.25	5.72
Potash guaranteed	5.00	3.00	4.00	4.00	1.70	3.00	4.00	4.00	*4.00	4.00	4.00	4.00

* Sulphate.

Manufacturers' Samples of Superphosphates.

Station No.	Name or Brand.	Nitrogen in Nitrates.	Nitrogen in Ammonia.	Organic Nitrogen.	Total Nitrogen Found.	Total Nitrogen Guaranteed.	Phosphoric Acid.							Potash.		Chlorine.	Valuation per Ton.
							Soluble in Water.	Reverted.	Insoluble.	Total Phosphoric Acid.	Phos. Acid Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.		
1813	Bradley's Fish and Potash, Anchor Brand	----	.43	3.73	4.16	3.25	2.08	1.73	.69	4.50	5.00	3.81	3.00	4.31	3.00	9.15	$24.28
1842	Cook's Dissolved Ground Bone	----	----	----	----	----	9.46	3 43	.69	13.58	11.40	12.89	----	----	----	----	20.69
1817	Clark's Cove Guano Co's Unicorn Ammoniated Superphosphate	----	.11	1.90	2.01	1.80	5.68	3.32	2.96	11.96	10.00	9.00	8.50	3.22	2.25	1.45	25.76
1815	G. H. Harris & Son's Superphosphate of Bone	----	.56	1.58	2.14	4.00	5.88	----	.22	6.10	25.00	5.88	----	1.30	----	----	18.08
1862	G. W. Miles' Fish and Potash*	----	----	2.47	2.47	----	5.89	1.32	1.85	9.06	----	7.21	----	2.39	----	2.66	22.94
1666	G. W. Miller's Flour of Bone Phosphate	.75	----	1.81	2.56	----	1.12	10.24	.71	12.07	----	11.36	----	4.76	----	6.04	30.55
1839	Newton & Ludlam's Animal Bone	----	----	2.14	2.14	----	8.77	2.04	.93	11.74	----	10.81	----	1.77	----	4.42	26.44
1844	Preston's Ammoniated Bone Superphosphate	----	.24	2.64	2.88	2.40	7.13	2.47	2.28	11.88	----	9.60	9.00	.68	2.00	1.87	26.99

* This sample was drawn from a lot of 400 bags at G. W. Miles' factory, by Station Agent.

Superphosphates Sampled by Private Individuals.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Sampled and sent by
1829	Market Bone Fertilizer.	Adams & Thomas, Springfield, Mass.	Manufacturer.	Robt. Aitken, Shaker Station
1688	Bowker's Pure Dry Ground Fish.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Manufacturer.	M. S. Baldwin, Naugatuck.
1724	Bay State Fertilizer.	Clark's Cove Guano Co., New Bedford, Mass.	A. L. Chamberlain & Co., Fair Haven.	A. L. Chamberlain. Fair Haven.
1723	Unicorn Fertilizer.	Clark's Cove Guano Co., New Bedford, Mass.	A. L. Chamberlain & Co., Fair Haven.	A. L. Chamberlain, Fair Haven.
1719	Special Quality Darling's Animal Fertilizer.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	Earl Cooley, Berlin.	Earl Cooley, Berlin.
1856	G. W. Miles' Fish and Potash.	G. W. Miles, Milford.	C. H. Grant, Stafford.	C. H. Grant, Stafford.
1744	G. W. Miles' Fish and Potash.	G. W. Miles, Milford.	Manufacturer.	Clark W. Stowe, Milford.
1634	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport.	G. Humphreyville, Thomast.	C. H. Cables, Thomaston.
1863	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport.	J. S. Kirkham, Newington.	T. R. Atwood, Newington.
1628	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport.	J. & F. Beach, Branford.	J. & F. Beach, Branford.
1864	Chittenden's Fish and Potash.	National Fertilizer Co., Bridgeport.	J. S. Kirkham, Newington.	T. R. Atwood, Newington.
1681	Cereal Fertilizer.	Newton & Ludlam, New York City.	Manufacturer.	A. J. Briggs, Sherman.
1683	Cereal Fertilizer.	Newton & Ludlam, New York City.	Manufacturer.	A. J. Briggs, Sherman.
1706	Standard Superphosphate.	Standard Superphosphate Co., Duxbury, Mass.	Suffield Grange.	Allen Wilson, Suffield.
1619	Standard Superphosphate.	Standard Superphosphate Co., Duxbury, Mass.	Jas. Breck & Sons, Agents, Boston, Mass.	W. F. Andross, East Hartford.

Analyses of Superphosphates Sampled by Private Individuals.

Station No.	Name or Brand.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Organic Nitrogen	Total Nitrogen Found.	Nitrogen Guaranteed.	Phosphoric Acid. Soluble in Water.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Total Phosphoric Acid Found.	Phosphoric Acid Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Cost per Ton.
1829	Adams & Thomas' Market Bone Fertilizer	----	.48	3.18	3.66	3.15	4.50	4.52	.73	9.75	10.00	9.02	8.00	5.25	3.00	----	$38.00
1688	Bowker's Pure Dry Ground Fish	----	----	8.50	8.50	8.00	.88	4.38	2.59	7.85	----	5.26	----	----	----	----	†35.30
1724	Bay State Fertilizer	----	.78	1.69	2.47	2.10	9.71	.97	1.41	12.09	9.50	10.68	8.00	2.54	2.00	.64	40.00
1723	Unicorn Ammoniated Superphosphate	----	.21	1.84	2.05	1.80	7.44	2.40	2.23	12.07	10.00	9.84	8.50	2.76	2.25	.88	36.00
1719	Special Quality Darling's Animal Fertilizer	1.16	.43	2.84	4.43	3.29	4.62	4.78	1.78	11.18	10.00	9.40	----	5.97	4.00	5.19	40.00
1856	G. W. Miles' Fish and Potash	----	----	----	2.62	----	6.13	1.76	1.21	9.10	----	7.89	----	2.46	----	4.57	30.00
1744	G. W. Miles' Fish and Potash	----	.50	2.73	3.23	----	5.59	1.57	1.62	8.78	----	7.16	----	4.33	----	2.39	30.00
1634	Chittenden's Complete Fertilizer	----	1.44	3.24	4.68	3.30	6.69	3.33	.62	10.64	8.00	10.02	6.00	7.44	6.00	6.96	45.00
1863	Chittenden's Complete Fertilizer	----	1.72	2.81	4.53	3.30	5.20	2.72	2.44	10.36	8.00	7.92	----	7.22	6.00	6.15	45.00
1628	Chittenden's Complete Fertilizer	----	2.37	2.98	5.35	3.70	6.84	2.69	.60	10.13	8.00	9.53	6.00	6.20	6.00	----	45.00
1864	Chittenden's Fish and Potash	----	.60	4.52	5.12	3.30	2.56	3.47	1.69	7.72	6.00	6.03	----	6.29	5.00	5.62	35.00
1681	Newton & Ludlam's Cereal Fertilizer	----	----	2.09	2.09	1.20	9.15	1.24	1.16	11.55	12.00	10.39	----	1.31	*4.00	(?)	32.00
1683	Newton & Ludlam's Cereal Fertilizer	----	----	1.70	1.70	1.20	7.93	3.31	1.66	12.90	12.00	11.24	----	2.87	*4.00	(?)	32.00
1706	Standard Superphosphate	----	1.27	1.62	2.89	2.47	9.16	2.31	1.23	12.70	----	11.47	9.00	2.69	2.00	2.52	38.00
1619	Standard Superphosphate	----	----	2.85	2.85	2.47	7.65	2.13	1.58	12.36	11.00	9.78	9.00	2.51	2.00	----	38.00

* Sulphate. † In Naugatuck.

Spears' Perfect Fertilizer.

This article is said to have been sold in this State to some extent last year though no knowledge of it came to the Station. It was carefully looked for this year but not found. A sample sent by the New England Homestead last spring had the following composition:

Nitrogen	1.07
Phosphoric Acid	5.47
Potash	1.29
Sand and Silica	35.03
Carbonate of Lime	11.00

A liberal valuation would be $12.40 per ton. The cost is said to be $25.00 per ton.

Home-mixed Superphosphates.

The only sample of this class of goods which was sent to the Station this year accompanied with statements of cost of materials, formula by which it was compounded, etc., was from G. F. Platt, Esq., of Milford. The formula was as follows:

5000 pounds dissolved bone black.
4000 pounds blood and bone.
2000 pounds muriate of potash.
1000 pounds sulphate of ammonia.

The cost of the materials was stated to be $30.00 per ton, freight $2.00 and cost of mixing $1.00. The raw materials used were separately analyzed and from those results the composition which the mixture should have if made uniform and without loss is calculated and here compared with the analysis of the sample of the mixture itself sent by Mr. Platt.

	Mr. Platt's sample.	Calculated.
Nitrogen as ammonia	1.87	1.68
Organic nitrogen	2.93	2.46
Soluble phosphoric acid	7.05	
Reverted phosphoric acid	1.61	8.91
Insoluble phosphoric acid	.94	
Potash	9.27	8.86
Cost per ton	$36.63	$33.00
Valuation per ton	$38.83	$34.98

The difference between the actual and the calculated composition though not inconsiderable is perhaps as little as could be

expected and for the most part doubtless resulted from loss of moisture out of the raw materials during the mixing or after. The proportion of the ingredients found indicates that the mixing was effectual and that the sampling was carefully done. The per cents. of fertilizing ingredients existing in the sample in every case exceed those calculated from the composition of the materials used. The extent to which the sample had been concentrated by drying may be reckoned approximately by the following proportions based on the ratios of the percentages in the sample to the percentages in the raw materials.

1.68 : 1.87 : : 100 : 111
2.46 : 2.93 : : 100 : 119
8.91 : 9.60 : : 100 : 108
8.86 : 9.27 : : 100 : 105

Average 111

It thus appears that 111 pounds of the mixed materials, as separately analyzed, had become reduced by drying, to 100 pounds as represented by the sample. Therefore 100 pounds of the sample should be compared as regards cost and valuation with 111 pounds of the materials used in mixing it. Mr. Platt's Home-mixed Superphosphate considered as 12,000 pounds of the raw materials in the state of dryness which obtained when they were analyzed, was worth six times $34.98, and if the materials originally were in the same state of dryness, cost six times $33.00. On the other hand, if the samples of the materials [dissolved bone-black, blood and bone, muriate of potash, and sulphate of ammonia] had lost moisture before they were analyzed, so that, say 111 pounds of the original materials were reduced to 100, then evidently it would be 2,220 pounds of them to which the valuation $33.00 should apply instead of 2000 pounds.

Again, this Home-made Superphosphate, as represented by the sample analyzed [Mr. Platt's sample] is a lot of 10,810 pounds, costing $36.63 and worth $38.83 per ton.

Mr. Platt purchased his materials direct from manufacturers and at the lowest market rates.

Special Manures.

Samples drawn by Station agents.

The following table, pages 55 and 56 contains sixteen analyses of this class made on samples which are known to fairly represent the lots of goods from which they were taken. Of some brands there were several samples drawn in different places and the analysis was made on a mixture of equal weights of each of these samples as has already been explained on page 34.

In the table are three analyses of the Quinnipiac Potato Manure. It will be seen that **1672** represents the average of three samples drawn in three different places: Bristol, Plainville and Hartford. These three samples looked alike and as subsequent chemical analysis proved were essentially alike in composition. The other two samples, **1746** and **1665**, which were drawn in Bridgeport and Westport, were very unlike the three above mentioned in appearance and for that reason were not mixed with them but separately analyzed, and their separation from the others is justified by the analyses which are quite dissimilar. The manufacturer states that the first three samples represent but a small fraction of the Potato Manure put on the Connecticut market this year, the larger part being shipped to the southern part of the State.—

Cost and valuation.—The average cost of these Special Manures has been $42.56, the average valuation $36.70, and the difference between cost and valuation $5.86 or 16 per cent. of the valuation. The corresponding difference in the case of superphosphates was 24.3 per cent. The special manures on the average are higher priced, more concentrated and other things being equal, more economical to purchase.

Special Manures.

Samples drawn by private parties.

The Station has no guarantee that the following samples were drawn in accordance with its instructions and therefore does not vouch for them or assign any valuation.

1720. Bradley's Complete Manure for Grass and Grain Top Dressing.

1721. Bradley's Complete Manure for Potatoes and Vegetables.

1722. Bradley's Complete Manure for Corn and Grass.

All of the above were manufactured by the Bradley Fertilizer Co., 27 Kilby street, Boston. They were sampled and sent by L. H. Hall, Wallingford.

1865. Chittenden's Complete Fertilizer for Tobacco, made by the National Fertilizer Co., Bridgeport, sampled by T. R. Atwood from stock of J. S. Kirkham, Newington.

Special Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost per Ton.	Sampled by
1746	Quinnipiac Potato Manure.	Quinnipiac Fertilizer Co., N. London.	Berry & Sherman, Bridgeport.	$38.00	Station Agent.
1792	Mapes' Grass and Spring Top Dressing.	Mapes' Formula and Peruvian Guano Co., 158 Front St., New York.	Mapes' Branch, Hartford.	45.00	"
1665	Quinnipiac Potato Manure.	Quinnipiac Fertilizer Co., N. London.	E. A. Godfrey, Westport.	38.00	"
1793	Mapes' Tobacco Manure, Conn. Brand.	Mapes' Formula and Peruvian Guano Co., New York.	Mapes' Branch, Hartford.	48.00	"
1796	Mapes' Corn Manure.	Mapes' Formula and Peruvian Guano Co., New York.	" J. P. Barstow, Norwich.	44.00 44.00	" "
1794	Mapes' Tobacco Manure for use with Stems.	Mapes' Formula and Peruvian Guano Co., 158 Front St., New York.	"	48.00	"
1754	Potato, Hop and Tobacco Phosphate.	Buffalo Fertilizer and Chemical Works, Buffalo, N. Y.	W. G. Staples, Westport.	39.00	"
1781	Stockbridge Forage Crop Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. A. Paine, Danielsonville. Seymour & Bonhite, Ridgefield. Brewster & Burnett, Norwich.	45.00 45.00 45.00	" " "
1752	H. J. Baker's Tobacco Fertilizer.	H. J. Baker & Bro., 215 Pearl St, New York.	C. S. Smith, Kent, Ct.	45.00	"
1717	Mapes' Potato Manure.	Mapes' Formula and Peruvian Guano Co., 158 Front St., New York.	Dean & Horton, Stamford. Birdsey & Foster, Meriden. Mapes's Branch, Hartford.	48.00 47.50 46.00	" " "
1761	Potato Phosphate.	Williams, Clark & Co., Hanover Square, New York.	J. P. Root, Tolland. E. M. Jennings, Southport.	44.00 44.00	" "
1678	Stockbridge Vegetable Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. E. Leonard, Jewett City. Jas. Greenfield, New London. F. Ellsworth, Hartford.	45.00 45.00 45.00	" " "
1753	H. J. Baker's Corn Fertilizer.	H. J. Baker & Bro., 215 Pearl St., New York.	C. S. Smith, Kent.	45.00	"
1779	Stockbridge Grain Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston Mass.	Burtis & Mead, New Canaan.	45.00	"
1712	H. J. Baker's Potato Fertilizer.	H. J. Baker & Bro., 215 Pearl St., New York.	G. H. Alford, Winsted. W. W. Cooper, Suffield.	45.00 45.00	" "
1672	Quinnipiac Potato Manure.	Quinnipiac Fertilizer Co., N. London.	Usher & Tinker, Plainville. D. B. Judd, Bristol. Olds & Whipple, Hartford.	40.00 40.00 40.00	" " "

ANALYSES OF SPECIAL MANURES 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.				
1746	Quinnipiac Potato Manure	----	3.66	1.37	5.03	3.5	6.73	.70	.11	7.54	---	7.43	5.0	6.92	6.0	trace	$38.00	$37.69	.8
1792	Mapes' Grass and Grain Spring Top Dressing	.61	2.30	2.40	5.31	4.1	7.97	3.59	.73	12.29	7.0	11.56	----	7.82	5.0	7.10	45.00	44.16	1.9
1665	Quinnipiac Potato Manure	----	2.08	1.99	4.07	3.2	4.12	4.22	.81	9.15	----	8.34	5.0	6.92	6.0	.60	38.00	35.29	7.6
1793	Mapes' Tobacco Manure, Conn. Brand	.65	2.21	2.85	5.71	4.7	7.96	1.35	.38	9.69	7.7	9.31	----	8.08	7.7	.44	48.00	44.00	9.1
1796	Mapes' Corn Manure	.63	1.37	2.35	4.35	3.7	8.18	3.67	.69	12.54	10.0	11.85	----	6.62	6.0	5.39	44.00	40.03	9.9
1794	Mapes' Tobacco Manure for use with Stems	.29	3.55	2.06	5.90	5.3	8.20	2.80	.87	11.87	10.5	11.00	----	3.86	3.5	.47	48.00	43.13	11.3
1754	Potato, Hop and Tobacco Phosphate	----	----	3.05	3.05	2.0	8.52	2.56	.72	11.80	----	11.08	8.0	4.43	3.5	3.80	39.00	32.04	21.7
1781	Stockbridge Grass Top Dressing	----	3.01	2.30	5.31	5.5	8.23	1.18	.60	10.01	6.0	9.41	5.0	3.09	2.5	3.49	45.00	36.89	21.9
1752	H. J. Baker's Tobacco Fertilizer	----	3.80	1.37	5.17	4.5	4.06	1.17	.21	5.44	----	5.23	4.0	9.03	8.0	1.19	45.00	36.65	22.7
1717	Mapes' Potato Manure	.57	1.72	1.60	3.89	3.7	6.61	3.51	.98	11.10	8.0	10.12	----	7.39	6.0*	.62	46.48	38.27	22.8
1761	Williams, Clark & Co's Potato Phosphate	----	2.06	1.58	3.64	3.3	6.64	1.46	.31	8.41	7.0	8.10	----	8.42	15.0*	.49	44.00	35.09	25.4
1678	Stockbridge Vegetable Manure	----	1.19	2.06	3.25	3.3	10.32	1.71	.81	12.84	8.0	12.03	----	3.97	5.0	4.26	45.00	34.43	30.7
1753	H. J. Baker's Corn Fertilizer,	----	3.37	1.15	4.52	5.0	6.24	.63	trace	6.87	----	6.87	6.0	8.32	7.0	6.57	45.00	34.37	30.9
1779	Stockbridge Grain Manure	----	----	3.32	3.32	3.7	9.54	1.14	1.17	11.85	7.0	10.68	6.0	5.88	4.0	6.16	45.00	33.96	32.5
1712	H. J. Baker's Potato Fertilizer	----	3.00	.59	3.59	3.3	5.79	.47	trace	6.26	----	6.26	5.0	10.13	10.0	3.68	45.00	33.01	36.3
1672	Quinnipiac Potato Manure	----	.82	2.67	3.49	3.7	3.97	2.58	.58	7.13	----	6.55	5.0	6.59	6.0	8.11	40.00	28.28	41.4

*As Sulphate.

ANALYSES.—See page 4.

	1720	1721	1722	1865
Nitrogen as nitrates	3.45	----	.43	----
Nitrogen as ammonia	----	1.13	1.98	----
Organic nitrogen	.38	3.04	2.69	2.69
Soluble phosphoric acid	6.22	9.70	8.61	6.68
Reverted phosphoric acid	.96	.33	.14	2.69
Insoluble phosphoric acid	.62	.13	.13	1.75
Potash	6.06	6.65	8.91	5.77
Chlorine	2.30	trace	trace	.58
Cost	$45.00	45.00	45.00	45.00

BONE MANURES.

Samples drawn by Station Agents.

(See tables of analyses, pages 58 and 59).

Leaving out of account two exceptional articles, namely: E. F. Coe's Bone and Green's Common Bone, the average cost of the fourteen genuine samples is $36.14 and the average valuation, $38.24, about two dollars higher. The valuation of bone is designed to correspond approximately with the average selling price through the State. This year apparently it has slightly exceeded it. The method of valuation of bone fertilizers which must necessarily be based upon their degree of fineness as well as upon their chemical composition is fully explained on page 29.

Some of the analyses require special notice. Nos. 1733, Peter Cooper's Bone Dust and 1657, Green's Pure Fine Bone Dust, are bone from which the nitrogenous matter has been largely extracted probably in the manufacture of glue. Because of the removal of this nitrogenous matter the bone is relatively richer in phosphoric acid. No. 1747, Shoemaker's Swift Sure Bone Meal, has been quite perfectly freed from grease, the manufacturer having extracted it with benzine by a patented process. No. 1655, Lister's Celebrated Ground Bone, contains salt-cake which is added as a preservative. The bone has the full guaranteed amount of nitrogen and phosphoric acid. No. 1654, E. F. Coe's Ground Bone, is a mixture of bone and potash salts. No. 1656, Green's Common Bone, was found on sale in Southport. It is a mixture of some bone with oyster shells or other form of carbonate of lime and also contains 25 per cent. of water. Its cost was $25.00 or nearly twice its value. It was offered for sale without any guarantee.

Bone Manures.—Sampled by Station.

Station No.	Name or Brand.	Manufacturer.	Dealers.	Cost per ton.	Sampled and sent by
1733	Peter Cooper's Pure Bone Dust.	Peter Cooper's Glue Factory, 16 Burling Slip, New York City.	Apothecaries Hall, Waterbury.	$32.00	Station Agent.
1727	Bosworth's Ground Bone.	Bosworth Bros., Putnam, Ct.	Brewster & Burnett, Norwich.	34.00	" "
1747	Shoemaker's Swift Sure Bone Meal.	M. L. Shoemaker & Co., Philadelphia, Penn.	Manufacturers. J. P. Barstow, Norwich.	34.00 41.00	" " " "
1670	Americus Brand Pure Bone Meal.	Williams, Clark & Co., Hanover Sq., New York.	F. Ellsworth, Hartford. Strong & Backus, Colchester. Usher & Tinker, Plainville.	43.00 36.00 38.00	" " " " " "
1657	Jas. Green's Pure Fine Bone Dust.	Jas. Green, New York City.	E. M. Jennings, Southport. Chas. Jennings & Son, Southport.	38.00 32.00	" " " "
1820	Rogers & Hubbard Co's Pure Ground Bone, Grade AX.	Rogers & Hubbard Co., Middletown.	Wilson & Burr, Middletown.	34.00	" "
1775	L. B. Darling's Fine Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	W. W. Cooper, Suffield.	41.00	" "
1778	Buffalo Fertilizer Co's Pure Ground Bone.	Buffalo Fertilizer and Chemical Works, Buffalo, N. Y.	J. E. Leonard, Jewett City.	38.00	" "
1653	Quinnipiac Bone Meal.	Quinnipiac Fertilizer Co., New London	E. A. Godfrey, Westport.	38.00	" "
1837	Ground Raw Knuckle Bone, Grade Meal.	Rogers & Hubbard Co., Middletown.	Southmayd & Gardiner, Middletown.	39.00	" "
1718	Pure Raw Knuckle Bone, Grade "A," Extra Fine.	Rogers & Hubbard Co., Middletown.	J. P. Barstow, Norwich. S. J. Hall, Meriden. Strong & Backus, Colchester.	38.00 38.00 37.00	" " " " " "
1739	Peck Bro's Pure Ground Bone.	Peck Bros., Northfield, Ct.	Apothecaries Hall, Waterbury.	35.00	" "
1655	Lister's Celebrated Ground Bone.	Lister Bros., Newark, N. J.	W. G. Staples, Westport.	29.00	" "
1783	Darling's Ground Bone, Eagle Brand.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	Olds & Whipple, Hartford. W. W. Cooper, Suffield.	40.00 36.00	" " " "
1654	E. Frank Coe's Ground Bone.	E. Frank Coe, 16 Burling Slip, New York.	S. Banks, Southport.	28.00	" "
1656	Jas. Green's Common Bone.	Jas. Green, New York City.	Chas. Jennings, Southport.	25.00	" "

Analyses of Bone Manures.—Sampled by Station.

Station No.	Name or Brand.	Nitrogen.	Phos. Acid.	Potash.	Finer than $\frac{1}{50}$ inch.	Finer than $\frac{1}{25}$ inch.	Finer than $\frac{1}{12}$ inch.	Finer than $\frac{1}{6}$ inch.	Coarser than $\frac{1}{6}$ inch.	Cost per ton.	Valuation per ton.	Percent'ge difference between cost and valuation.
1733	Peter Cooper's Pure Bone Dust	1.61	30.64	----	53	15	20	12	--	$32–34	$42.22	----
1727	Bosworth's Ground Bone	4.30	21.88	----	71	21	6	2	--	34.00	42.88	----
1747	Shoemaker's Swift Sure Bone Meal	6.45	19.95	----	71	23	6	--	--	41–43	47.56	----
1670	Americus Brand Pure Bone Meal	4.31	19.40	----	56	23	19	2	--	36–38	38.06	----
1657	Jas. Green's Pure Fine Bone Dust	1.16	26.45	----	47	22	16	11	4	32.00	35.05	----
1820	Rogers & Hubbard's Pure Ground Bone, Grade AX	4.26	20.36	----	37	24	33	6	--	34.00	36.74	----
1775	L. B. Darling's Fine Ground Bone	2.59	25.95	----	62	25	13	--	--	40.00	41.96	----
1778	Buffalo Fertilizer Co's Pure Ground Bone	3.87	21.80	----	58	22	16	4	--	38.00	39.78	----
1653	Quinnipiac Bone Meal	4.22	22.93	----	33	24	40	3	--	38.00	39.36	----
1837	Ground Raw Knuckle Bone, Grade Meal	3.93	24.72	----	28	22	50	--	--	39.00	40 02	----
1718	Pure Raw Knuckle Bone, Grade "A" Ex. Fine	3.96	25.18	----	23	18	33	26	--	37–38	37.99	----
1739	Peck Bro's. Pure Ground Bone	4.12	20.92	----	21	20	33	22	4	35.00	33.50	4.5
1655	Lister's Celebrated Ground Bone	3.50	14.12	----	35	22	28	15	--	29.00	26.47	9.5
1783	Darling's Ground Bone, Eagle Brand	2.79	21.22	----	40	28	22	10	--	36–40	33.73	12.7
1654	E. Frank Coe's Ground Bone	2.95	12.11	2.13	48	18	16	10	8	28.00	24.62	13.7
1656	Jas. Green's Common Bone	1.97	7.78	----	26	15	16	19	24	25.00	12.90	93.8

Analyses of Manufacturers' Samples of Bone Manures.

Station No.	Name or Brand.	Nitrogen.	Phos. Acid.	Finer than 1/50 inch.	Finer than 1/25 inch.	Finer than 1/12 inch	Finer than 1/6 inch.	Coarser than 1/6 inch.	Valuation per ton.	Cost per Ton.
1814	P. W. Bennett's Ground Bone	3.32	24.66	16	14	33	36	1	$33.79	Not stated.
1816	G. H. Harris & Son's Ground Bone	4.15	19.61	5	9	16	32	38	25.43	" "
1843	National Fertilizer Co's Fine Animal Bone	6.28	16.94	51	19	17	13	..	39.64	" "
1845	Preston Fertilizer Co's Ground Bone	3.62	9.84	33	26	20	11	10	21.33	" "
1846	E. Smith's Ground Bone	4.10	21.53	31	29	24	16	..	36.65	" "

Bone Manures.—Sampled by Private Individuals.

Description of Samples.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Sampled and sent by
1651	H. J. Baker's Strictly Pure Bone	H. J. Baker & Bro., 215 Pearl st., New York City	J. J. Alvord, Green's Farms	John H. Jennings, Green's Farms
1618	Howard Co's Pure Bone	Howard Co, New York City		Chas. Fairchild, Middletown
1650	Williams, Clark & Co's Americus Brand Pure Bone Meal	Williams, Clark & Co., Hanover Square, New York	E. M. Jennings, Green's Farms	John H. Jennings, Green's Farms

Analyses and Valuations.

Station No.	Name or Brand.	Nitrogen.	Phos. Acid.	Finer than 1/50 inch.	Finer than 1/25 inch.	Finer than 1/12 inch.	Finer than 1/6 inch.	Coarser than 1/6 inch.	Cost per ton.
1651	H. J. Baker's Strictly Pure Bone	3.80	19.38	61	38	1	--	--	$35.00
1618	Howard Co's Pure Bone	3.93	26.26	100	--	--	--	--	40.00
1650	Williams, Clark & Co's Americus Brand Pure Bone Meal	4.40	18.90	51	25	22	2	--	38.00

A Statement.

Early in the last season the Station received from two different parties in one town, samples of a bone manure with the usual guaranteed analysis and costing $35.00 per ton. Analysis showed the bone to be of poor quality, mixed with salt cake and not worth more than $20.00 per ton. The results were reported as usual both to the seller and the purchasers. The seller at once came to the Station and stated that the bone had been purchased by him for his private use at a low figure and stored temporarily for convenience in his warehouse; that his shipping clerk, perhaps by mistake, had shipped this bone instead of his regular article to these two customers; that the clerk had been discharged and that he, the seller, had offered to make any settlement with the purchasers which would suit them. He further represented that the publication of these analyses would greatly and unjustly damage his business and requested that they be withheld. The Station corresponded with the two purchasers, both of whom expressed themselves as not caring to have the analyses published. It was therefore decided to withhold the analyses from publication if no further instances of the kind should be brought to our notice.

Cotton Seed Meal.

1691. Cotton Seed Meal sampled by Station Agent from stock of Olds & Whipple, Hartford:

ANALYSIS.

Nitrogen	7.29
Phosphoric Acid	1.84
Potash	2.17
Cost per ton	$25.00
Valuation per ton	$29.21

Cotton Seed Meal is considerably used as a fertilizer in the tobacco growing region of this State, and to some extent as cattle food. It is one of the most concentrated of our cattle foods, and excessive use of it is injurious to cattle, while an amount that does not seriously injure cows is believed to affect the flavor of butter unfavorably. Rationally used, however, it is one of the cheapest and best cattle foods, and as the analysis shows, has a higher manurial value than any other.

Castor Pomace.

1715. Castor Pomace made by H. J. Baker and Bro., N. Y. A mixture of two samples drawn in May last, one from six bags in a stock of sixty bags, at New Milford; the other from five bags in a stock of one hundred and fifty bags at Usher & Tinker's, Plainville. Sampled by Station Agent.

1823. H. J. Baker's Castor Pomace. Sample drawn Aug. 3d from one bag by Buckland & Hardin, of Glastonbury, and analyzed at request of manufacturers.

1734. Castor Pomace made by Collier White Lead and Oil Co., St. Louis, Mo. A mixture of two samples drawn by Station Agent early in May last. One sample from eight bags in a stock of eighty bags at F. Ellsworth's, the other from four bags in a stock of fifty bags at Olds and Whipple's, both of Hartford.

1824. Collier Castor Pomace. Sample drawn by Station Agent Aug. 4th, from fourteen bags in a stock of about four hundred and fifty bags at F. Ellsworth's.

1785. Collier Castor Pomace. A sample drawn from one bag by W. F. Andross, East Hartford, in July last.

Analysis and Valuations.

	1715	1823	1734	1824	1785
Water	9.23	9.13	8.83	9.34	9.94
Organic and volatile matters	84.93	85.53	82.74	83.70	81.62
Ash	5.84	5.34	8.43	6.96	8.44
	100.00	100.00	100.00	100.00	100.00
Insoluble in acids	1.10	.34	3.11	1.98	3.27
Nitrogen	4.76	4.48	5.54	4.99	4.89
Phosphoric Acid	1.46	1.54	1.86	1.42	1.44
Potash	.95	.93	1.07	1.07	1.08
Cost per ton	$24.00	19.00	20.00	19.00	----
Valuation per ton	$19.03	18.18	23.45	19.87	19.58

Both brands of Pomace are inferior in quality to the samples of the same brands analyzed last year and the year before. In the opinion of the manufacturers this is due to the fact that, owing to an insufficient supply of domestic seed, some foreign seed has been used which is not so clean nor of as good quality as the domestic. The samples of Collier Pomace contain some sand, and 1824 and 1785 contain besides small fragments of quartz and lime stone, which the manufacturers state came in the Calcutta Seed and were not noticed by them till they appeared in the pomace. Steps are said to have been taken to remove this foreign matter by screens before crushing the seed. The reduction in the per cent. of nitrogen, due to the presence of 5 per cent. of sand, etc., would be about 0.30 per cent.

Nitrate of Soda.

1833. Sampled by Station Agent from stock of Mapes' Branch, Hartford.

1835. A mixture of two samples of nitrate. One is from the stock of Olds and Whipple, Hartford; price, $3.15 per 100 pounds. The other from stock of Wilson and Burr, Middletown; price, $56 per ton. The nitrate at both places was from the Quinnipiac Fertilizer Co., New London, and the samples were drawn by Station agents.

1840. From stock of the Rogers and Hubbard Co., Middletown. Manufacturer's sample.

1758. From stock of Wilson and Burr, Middletown. Sampled by M. E. Parmelee, Killingworth.

Analysis.

	1833	1835*	1840	1758
Nitrogen	16.06	15.95	16.09	16.06
Equivalent Nitrate of Soda	97.52	96.88	97.69	97.48
Chlorine	.35	.31	.30	----
Sulphuric Acid	.15	.22	.11	----
Moisture	1.63	2.22	1.61	----
Cost per ton	$63.00	56.00 & 63.00		57.00
Nitrogen costs per pound	19.6 cts.	17.5 & 19.7 cts.		17.7 cts.

* Mixture of two samples, hence two prices are given.

Sulphate of Ammonia.

1832. From the Mapes' Branch, Hartford. Sampled by Station Agent.

1685. From the Bowker Fertilizer Co., Boston. Sampled and sent by M. S. Baldwin, Naugatuck.

1786. From C. Meyer, Jr. Sampled and sent by M. S. Baldwin, Naugatuck.

1627. From C. Meyer, Jr., Maspeth, Long Island. Sampled by Station Agent from stock purchased by J. J. Webb, Hamden.

1643. From C. Meyer, Jr. Sampled and sent by G. F. Platt, Milford.

Sulphate of Ammonia.

	1832	1685	1786	1627	1643
Nitrogen	19.93	20.86	20.81	20.09	20.13
Equivalent to Ammonia	24.20	25.33	25.27	24.50	24.40
Cost per ton	$78.00	70.00	72.82	----	----
Nitrogen costs per pound	19.5 cts.	16.8 cts.*	17.4 cts.	----	----

* In N. Y.

Potash Salts.

Sulphate of Potash.

1686. Sampled and sent by M. S. Baldwin, Naugatuck. From lot purchased of the Bowker Fertilizer Co., N. Y.

1788. Sampled and sent by M. S. Baldwin, Naugatuck. From lot purchased of C. Meyer, Jr., Maspeth, Long Island.

Both the above are double sulphate of potash and magnesia, or "manure salt."

Muriates.

1831. From stock of Mapes Branch, Hartford.

1834. Sold by the Quinnipiac Fertilizer Co., New London. From stock of Wilson and Burr, Middletown.

1836. Sold by Williams and Clark, N. Y. From stock of E. M. Jennings, Southport.

1624. From lot purchased by J. J. Webb, Hamden.

The above were sampled by the Station Agent.

1841. Stock sold by Rogers and Hubbard Co., Middletown. Sampled by the dealers.

1642. Sampled by G. F. Platt, Milford, from stock purchased of C. Meyer, Jr., Maspeth, L. I.

1787. Sampled by M. S. Baldwin, Naugatuck, from stock purchased of C. Meyer, Jr.

1757. Sampled by M. E. Parmelee, Killingworth, from stock of the Rogers and Hubbard Co., Middletown.

1759. Sampled by M. E. Parmelee, from stock of Wilson and Burr, Middletown.

	1686	1788	1831	1834	1836	1624	1841	1642	1787	1757	1759
Potash	23.61	23.21	49.16	48.24	52.32	51.66	52.66	53.46	52.12	54.46	39.75
Equivalent Muriate of Potash	----	----	77.9	76.4	82.9	81.9	83.4	84.6	82.03	86.2	63.0
Equivalent Sulphate of Potash	43.6	41.9	----	----	----	----	----	----	----	----	----
Cost per ton	$37.30*	----	45.00	42.50	45.00	----	----	----	45.70*	42.50	42.50
Potash costs per pound	cts. 7.9	----	cts. 4½	cts. 4.4	cts. 4.3	----	----	----	cts. 4.38	cts. 3.9	cts. 5.4

* In Naugatuck.

Following is a complete analysis of a sample of muriate of potash drawn by C. P. Augur, Whitneyville, from stock purchased from R. B. Bradley & Co., New Haven.

Potash*	52.43
Soda	5.38
Lime	.53
Magnesia	1.77
Chlorine	44.87
Sulphuric Acid	3.38
Insoluble in water	.65
Water, Carbonic Acid and loss	1.10
	110.11
Deduct Oxygen equivalent to Chlorine	10.11
	100.00

* The equivalent muriate of potash is 82.99 per cent.

Cotton Hull Ashes.

1667. Very light colored. **1669.** Dark Colored. Both from stock of W. W. Cooper, Suffield. Sampled and sent by F. B. Hatheway, Windsor Locks.

1594. Light colored ashes, **1593**, medium shade, **1595** dark colored ashes, from Ariel Mitchelson, Tariffville.

1668. Fine ground cotton hull ashes, stock of R. E. Pinney, Suffield, sampled by F. B. Hatheway, Windsor Locks. This sample represents stock which had been ground in a mill to make it fine and uniform.

1632. From stock of R. A. Parker, Warehouse Point, sampled and sent by George Watson, Warehouse Point.

1648. From stock of R. A. Parker, sampled and sent by him. From same lot of 1½ tons as **1632.**

1649. From stock of R. A. Parker, sampled and sent by J. B. Noble, East Windsor Hill.

1700. From Stock of Olds & Whipple, Hartford, sampled and sent by E. N. Welch, Forestville.

1690. From stock of W. W. Cooper, Suffield, received by him from Olds & Whipple, Hartford, sampled by Station agent.

The analyses represent the variations in quality which occur in Cotton Hull Ashes in the Connecticut market. The first five analyses illustrate the fact to which attention has been repeatedly called that ashes of light color are richer in potash than dark colored ashes. The ashes as received from the south are not uniform in quality. The contents of actual potash in different bags often varies five to ten per cent. To insure a fair sample at least a ton of the stock must be worked over and thoroughly mixed.

COTTON HULL ASHES.—ANALYSES AND VALUATIONS.

	1667.	1669.	1594.	1593.	1595.	1668.	1632.	1648.	1649.	1700.	1690.
Soluble phosphoric acid			.17	.56	2.57	1.70	.90	.74	.93	4.03	.46
Reverted phosphoric acid	5.68	10.77	5.60	4.88	4.31	9.78	5.16	5.46	8.19	20.86	7.39
Insoluble phosphoric acid			.16	.29	1.50	.94	1.10	1.02	.59	1.01	2.08
Potash soluble in water	27.81	22.08	28.54	26.34	20.59	24.46	12.78	14.55	23.97	10.47	22.76
Cost per ton	$35.00	35.00				35.00	35.00		35.00		35.00
Valuation per ton	$30.59	24.29	40.12	37.31	33.83	44.86	23.67	25.77	40.39	49.63	38.12

Below are given the average composition of Cotton Hull Ashes as well as the maximum and minimum figures, derived from 20 analyses which have been made at this Station.

	Minimum.	Maximum.	Average.
Phosphoric acid soluble in water	.17	2.57*	1.29
" " ammonium citrate	4.18	9.78*	6.67
" " only soluble in acid	.16	3.34	1.22
Potash soluble in water	12.78	32.52	22.94

* Omitting No. 1700.

UNLEACHED WOOD ASHES.

1592. Hard wood ashes sent by C. W. Barbour, Kensington, cost, 12.50 per ton.

1633. From Charles Stevens, Napanee, Canada, guaranteed to contain 7 per cent. of potash, sampled and sent by C. B. Meeker, Westport.

1699. From James Hartness, Detroit, Mich., sampled and sent by N. S. Pratt, Cheshire. Cost, 21 cents per bushel of 40 pounds, delivered in Cheshire.

ANALYSES.

	1592.	1633.	1699.
Potash soluble in water	7.26	4.17	5.56
Phosphoric acid	1.73	1.39	1.31
Sand and insoluble matters	----	----	14.96
Water	----	----	15.25

Unleached Canada ashes of average quality contain 5.7 per cent. of potash and 1.2 per cent. of phosphoric acid. Ashes made largely from our hard woods are somewhat richer both in phosphoric acid and potash.

LEACHED CANADA ASHES.

1647. Stock of Nelson Alvord, Southport. Sampled and sent by W. H. Burr, Westport.

1829. Stock of Isaac Wardwell, New Canaan. Sampled and sent by C. F. Olmstead, master New Canaan grange. Cost 17 cents per bushel by the car load.

1848. Stock of Horace C. Bristol, Cheshire. Cost, $5.50 per ton. Sampled and sent by S. A. Smith, Cheshire.

ANALYSES.

	1647.	1829.	1848.
Water	24.05	33.90	33.89
Insoluble matters	25.25*	15.98	16.37
Potash	.54	.83	1.13
Phosphoric acid	1.36	1.28	1.36

* Mostly broken crockery, glass and nails.

The average composition of leached ashes as well as the maximum and minimum figures, derived from twelve analyses formerly made at this Station is as follows :

	Minimum.	Maximum.	Average.
Potash	.54	1.54	1.12
Soda	.48	1.30	.67
Lime	24.37	34.65	28.46
Magnesia	2.10	3.22	2.69
Oxide of iron	.82	4.16	2.07
Phosphoric acid	.88	2.12	1.47
Sulphuric acid	.10	.20	.11
Water	24.05	39.65	31.09
Carbonic acid	14.99	23.90	14.66
Insoluble matter—sand, coal, etc.	7.62	25.25	13.79
Undetermined and loss			3.87
			100.00

The value of ashes is not exclusively or chiefly in the phosphoric acid and potash which they contain. Their action on the soil is largely indirect—as an amendment. The determinations of potash and phosphoric acid serve to show however whether the sample is of the usual quality.

Tobacco Stems.

1867. A sample of Tobacco Stems taken from a bale kindly given to the Station for the purpose by F. Ellsworth, Hartford. The bale was selected by a Station Agent from a cargo landed in New Haven *en route* to Hartford, and was pulled to pieces to secure a perfectly satisfactory sample of the whole.

Analysis.

	1867
Water	19.83
Organic and volatile matters*	63.30
Potash	7.66
Soda	.17
Lime	4.26
Magnesia	.87
Oxide of iron	.20
Sulphuric acid	.44
Phosphoric acid	.75
Chlorine	.21
Soluble Silica	.64
Sand	1.67
	100.00

* Containing Nitrogen, 1.96.

The cost of Tobacco Stems has been from $10.50 to $12.50 per ton during the year.

Star Fish.

Star fish which are the most destructive pest of the oyster beds on our coast are brought ashore in considerable quantity by boats that are engaged in removing them by dredges from the beds. They have been composted and used as manure to some extent. The following analysis was made on Star fish kindly supplied by J. and G. H. Smith, 150 Long Wharf, New Haven.

The Stars were taken immediately after being landed. For comparison the analysis of horse manure of average quality is also given.

	Star Fish.	Horse Manure.
Water	68.78	71.30
Organic matter	15.13	25.40
Containing nitrogen	[1.72]	[.58]
Ash	16.09	3.30
	100.00	100.00

The ash contains—

Potash	.48	.54
Soda	.31	.10
Lime	7.22	.21
Magnesia	.63	.14
Oxide of iron	.12	.11
Phosphoric acid	.25	.28
Sulphuric "	.32	.07
Carbonic "	5.81	..
Chlorine	.47	.04
Sand and silica	.59	1.21
	16.20	3.25
Deduct oxygen equivalent to chlorine	.11	
	16.09	

The analyses indicate that the fresh star fish contain about as much phosphoric acid and potash and three times as much nitrogen as average horse manure. The percentage of water is not very different. Horse manure contains 10 per cent. more of organic matter which on some lands has considerable value as an amendment, while the Star fish supply about 12 per cent. of useful carbonate of lime. The organic matter of the Star fish rapidly liquifies and decays and its nitrogen quickly becomes available as plant food. The organic matter of horse manure is largely vegetable fiber that has resisted digestion and requires considerable time to decay away. The nitrogen of horse manure is accordingly much less rapidly effective though more durable in its action than that of the Star fish.

Hen Manure.

A sample of hen manure was sent to the Station by Hon. T. S. Gold, with the following explanations: "The sample of hen manure was supposed to represent the common article as it is found among farmers. The fowls occupied two places, one quite dry, the other a basement quite damp. It was put in barrels and exposed to a moderate rain, imperfectly covered or entirely uncovered, but there was not sufficient wet to cause leaching. The whole lot, five barrels, estimated at half a ton, was thoroughly mixed in a cart and sampled. The rain accounts for the large per cent. of water, and while it reduces its value per ton, did not injure its total value, as it was used soon and did not heat. The number of fowls varied, but averaged about forty, besides chickens. They were only partially confined to their yards, but more than they are ordinarily. I hope you will examine a sample furnished by some of the poultry men. Let the weight be taken of the whole product for the year from a flock confined to their quarters. This sample represents what the farmer may find as an ordinary result where his poultry are not entirely confined."

The Station will be glad to analyze a sample taken in the way that Mr. Gold has described. Following is the result of the analysis made on the sample sent by Mr. Gold:

Water	56.62
Organic and volatile matters	16.57
[Containing nitrogen as ammonia, .82; Organic nitrogen, .56; Total nitrogen	1.38]
Ash or mineral matter	26.81
	100.00

The ash contains:

Potash	.69
Soda	.31
Lime	2.10
Magnesia	.99
Oxide of iron	1.29
Phosphoric acid	.84
Sulphuric acid	.38
Chlorine	.06
Sand and earth	20.15
	26.81

Peat and Swamp Muck.

1604. Dried Peat Dust. Prepared and sent to the Station by Dennis Tuttle of New Haven.
1830. Swamp Muck sent by T. D. Barclay, Centerbrook.
1847. Swamp Muck sent by Elijah Woodward, Torrington.

Analyses of Swamp Muck.

	1604	1830	1847
Water	13.60	59.90	59.72
Organic and volatile matters	68.08	10.80	9.06
[Containing nitrogen	1.43	.51	.25]
Ash	18.32	29.30	31.22
	100.00	100.00	100.00

In the ash are contained:

	1604	1830	1847
Matters insoluble in acid	14.82	26.38	27.40
Oxide of iron	1.32		1.20
Lime	.40	.49	.46
Magnesia		.20	
Phosphoric acid	.13	.22	.08
Other matters	1.65	2.01	2.08
	18.32	29.30	31.22

The dry material contains:

	1604	1830	1847
Organic and volatile matter	78.82	27.10	22.46
[Containing nitrogen	1.65	1.27	.62]
Ash	21.18	72.90	77.54
	100.00	100.00	100.00

The ash reckoned on dry matter contains:

	1604	1830	1847
Matters insoluble in acid	17.14	65.75	67.95
Oxide of iron	1.52		2.97
Lime	.46	1.24	1.14
Magnesia		.50	
Phosphoric acid	.15	.55	.20
Other matters	1.91	4.86	5.28
	21.18	72.90	77.54

Deposit Underlying Peat.

1866. Sent by S. B. Belden, Springdale, who writes that it occurs under peat in a swamp, does not burn, but turns white when heated and can then be sawed into excellent crayons for the blackboard. The sample contained:

	1866
Water and organic matter	21.23
Matters soluble in acid	3.08
Silica	75.69
	100.00

The silica is chiefly "infusorial silica" which consists of the skeletons of a low order of aquatic vegetable growth. When free from sand it makes an excellent polishing powder.

SALT.

A sample of salt produced in the manufacture of saltpeter and sent by Harvey Elliott of North Guilford, had the following composition:

Water	5.77
Muriate of potash	1.49
Salt	90.19
Sulphates of lime and magnesia	2.55
	100.00

The actual potash present was .96 per cent. There was also a mere trace of nitric acid.

REVIEW OF THE FERTILIZER MARKET.*

NITROGEN.

Nitrogen of Organic Matters.

In dried blood at wholesale nitrogen was quoted in New York at about 14.1 cents per pound from the first of December, 1885, till the last of February following. During March and April it sold at 14.9 cents, declined in May to 14.6, and in June to 13.9 cents per pound, which was the lowest figure reached during the year. Since then it has remained quite steady at 14 to 14.4 cents per pound.

In Azotin the New York *wholesale price* of nitrogen was 13.9 cents in December, 1885. It rose steadily to 14.8 cents in March, and 15.6 cents in April. It then declined steadily to 14.4 cents in July where it has remained ever since.

Dry Ground Fish was quoted at $29 per ton till May and since then no quotations have been given. At that price the wholesale cost of nitrogen in this material would be about 13 cents per pound.

Taking the year through the wholesale cost of nitrogen in the articles above-named has been about 14.6 cents per pound.

* For the year ending December 1st, 1886.

In the form of Cotton Seed Meal and Castor Pomace, organic nitrogen has sold at retail in this State during the year for from 14.1 to 22.2 cents per pound. The average has been 17.1 cents.

Nitrogen of Ammonia Salts.

At wholesale in New York, nitrogen in this form was quoted at about 14.9 cents per pound in December, 1885. It rose to 15.2 cents in February, 15.8 cents in March, and 16.4 cents in April. In May it declined to 15.8 cents and fell steadily to 14.4 cents in September. At present it is quoted at 14.7 cents per pound. The average wholesale cost through the year has been not far from 15 cents per pound. It has retailed in Connecticut for from 16.8 to 19½ cents per pound.

Nitrogen of Nitrate of Soda.

Nitrogen in this form was sold *at wholesale* in New York at 16 cents per pound in December of last year. It declined to 15.3 cents in February, rose in March to 16, and in May to 16.4 cents. It then declined rapidly to 13.7 cents in September and 12.7 cents at the time of this writing, a lower figure than it has ever reached before within our observation. It has retailed in the State at 17.7 cents to 19.7 cents per pound.

PHOSPHATIC MATERIALS.

Refuse Bone Black which sold at wholesale for $17.50 in December of last year, rose to $18.50 in February and has remained there ever since.

Ground Bone has been quoted at $29.50 during the whole of the past year.

There has been no change during the year in the quotations, either of *Charleston rock, f. o. b. New York*, or of *Sulphuric acid* 60°.

POTASH.

In Muriate of Potash.

Potash at wholesale in this form was quoted in New York in December of last year at 3.38 cents per pound. It rose in February to 3.48 cents and to 3.63 cents in March. It declined to 3.41 cents in May, 3.31 in July and is now quoted at 3.41. It has retailed during the year in this State for 3.9 cents to 5.4 cents per pound.

In Kainit.

Potash in Kainit at wholesale has cost during the year from 2.87 cents to 3.23 cents.

To recapitulate:

The fertilizer market, so far as we have been able to learn, has been subject to the usual temporary fluctuations, but there has been no considerable and permanent change in the market price of any of the standard raw materials from which mixed goods are made. 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 be helpful in the examination of the market quotations, and will also serve to 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 dried blood 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 it is quoted at $2.25 per unit, a ton of it will cost $8\frac{1}{2} \times 2.25 = 19.13$.

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

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

Ammonia at	$4.00	per unit	is equivalent to	nitrogen at	24.3	cts.	per lb.
"	3.90	"	"	"	23.7	"	"
"	3.80	"	"	"	23.0	"	"
"	3.70	"	"	"	22.4	"	"
"	3.60	"	"	"	21.8	"	"
"	3.50	"	"	"	21.2	"	"
"	3.40	"	"	"	20.6	"	"
"	3.30	"	"	"	20.0	"	"
"	3.20	"	"	"	19.4	"	"
"	3.10	"	"	"	18.8	"	"
"	3.00	"	"	"	18.2	"	"
"	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	"	"

Commercial sulphate of ammonia contains on the average 20.5 per cent. of nitrogen, though it is found to vary considerably in quality. When it has that amount of nitrogen (equivalent to 24.3 per cent. of ammonia),

At 5	cents per lb.	Nitrogen	costs	24.4	cents per lb.
" 4⅞	"	"	"	23.7	"
" 4¾	"	"	"	23.1	"
" 4⅝	"	"	"	22.5	"
" 4½	"	"	"	21.9	"
" 4⅜	"	"	"	21.3	"
" 4¼	"	"	"	20.7	"
" 4⅛	"	"	"	20.1	"
" 4	"	"	"	19.5	"
" 3⅞	"	"	"	18.9	"
" 3¾	"	"	"	18.3	"
" 3⅝	"	"	"	17.6	"
" 3½	"	"	"	17.0	"
" 3⅜	"	"	"	16.4	"
" 3¼	"	"	"	15.8	"
" 3⅛	"	"	"	15.2	"
" 3	"	"	"	14.6	"

Commercial nitrate of soda averages 95 per cent. of the pure salt or 15.6 per cent. of nitrogen.

If quoted at	$3\frac{5}{8}$	cents per lb.	Nitrogen costs		23.2	cents per lb.
"	$3\frac{1}{2}$	"	"	"	22.3	"
"	$3\frac{3}{8}$	"	"	"	21.5	"
"	$3\frac{1}{4}$	"	"	"	20.8	"
"	$3\frac{1}{8}$	"	"	"	19.9	"
"	3	"	"	"	19.2	"
"	$2\frac{7}{8}$	"	"	"	18.3	"
"	$2\frac{3}{4}$	"	"	"	17.6	"
"	$2\frac{5}{8}$	"	"	"	16.9	"
"	$2\frac{1}{2}$	"	"	"	16.0	"
"	$2\frac{3}{8}$	"	"	"	15.2	"
"	$2\frac{1}{4}$	"	"	"	14.4	"
"	$2\frac{1}{8}$	"	"	"	13.6	"
"	2	"	"	"	12.8	"

Commercial muriate of potash usually has 80 per cent. of the pure salt, or $50\frac{1}{2}$ per cent. of actual potash.

If quoted at	2.00	cts. per lb.	Actual potash costs		3.96	cts. per lb.
"	1.95	"	"	"	3.86	"
"	1.90	"	"	"	3.76	"
"	1.85	"	"	"	3.66	"
"	1.80	"	"	"	3.56	"
"	1.75	"	"	"	3.46	"
"	1.70	"	"	"	3.36	"
"	1.65	"	"	"	3.26	"
"	1.60	"	"	"	3.16	"
"	1.55	"	"	"	3.06	"
"	1.50	"	"	"	2.96	"

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since May, 1883. The price given for each month is the average of the four weekly quotations in that month. Sulphate of ammonia is assumed to contain 20.5 per cent. and nitrate of soda 15.6 per cent. nitrogen, and muriate of potash $50\frac{1}{2}$ per cent. of actual potash or 80 per cent. of the pure salt.

		Cost of Nitrogen at Wholesale in				Cost of Potash at Wholesale in
		Blood. cts. per lb.	Azotin or Ammonite. cts. per lb.	Nitrate of Soda. cts. per lb.	Sulphate of Ammonia. cts. per lb.	Muriate of Potash. cts. per lb.
1883.	May	18.2	18.9	16.3	20.1	3.34
	June	17.8	18.9	16.3	20.0	3.36
	July	17.2	18.9	15.6	19.0	3.23
	August	16.0	18.9	15.3	18.6	3.18
	September	15.3	17.0	14.8	17.6	3.21
	October	15.0	15.2	14.8	17.3	3.12
	November	14.5	15.2	15.2	16.4	3.20
	December	14.4	17.0	15.2	16.4	3.22
1884.	January	12.9	13.2	14.8	16.4	3.28
	February	13.2	13.7	14.3	15.0	3.23
	March	13.6	13.7	14.2	14.6	3.34
	April	13.6	13.6	14.0	14.6	3.38
	May	14.0	13.9	14.4	15.3	3.44
	June	13.9	13.5	13.8	14.6	3.36
	July	13.2	13.5	14.2	14.9	3.37
	August	13.6	13.3	14.3	14.7	3.36
	September	12.8	13.3	14.4	14.4	3.28
	October	12.9	13.2	14.3	14.8	3.38
	November	12.4	12.6	14.4	15.2	3.26
	December	12.1	12.8	14.4	15.2	3.32
1885.	January	12.3	13.0	14.1	15.2	3.32
	February	12.6	13.4	14.4	15.2	3.36
	March	13.4	13.7	13.2	15.2	3.58
	April	13.6	13.7	13.2	15.2	3.51
	May	14.3	13.7	14.1	15.2	3.54
	June	13.9	13.7	14.0	15.2	3.36
	July	13.6	13.6	14.0	15.0	3.31
	August	13.8	13.6	15.0	14.9	3.34
	September	13.4	13.5	15.6	14.8	3.36
	October	13.4	13.5	16.0	14.8	3.36
	November	13.8	13.5	15.6	14.8	3.38
	December	14.1	13.9	16.0	14.9	3.39
1886.	January	14.0	14.2	15.6	15.1	3.38
	February	14.2	14.3	15.2	15.2	3.46
	March	14.9	14.7	16.0	15.8	3.64
	April	14.9	15.7	16.1	16.4	3.56
	May	14.6	15.4	16.4	15.8	3.41
	June	13.9	14.7	15.6	14.6	3.32
	July	14.2	14.4	14.9	14.6	3.31
	August	14.1	14.4	14.0	14.5	3.31
	September	14.1	14.4	13.7	14.4	3.40
	October	14.4	14.4	13.2	14.6	3.41
	November	14.0	14.4	12.7	14.7	3.41

ANSWERS TO CORRESPONDENTS.

Action of Plaster (Gypsum) on Manure.

A correspondent writes: "Various claims made by dealers interested in the sale of gypsum or land plaster lead me to ask the following questions:

1. Does plaster have a strong affinity to nitrogen?
2. Is sulphate of ammonia less volatile and therefore less liable to waste than carbonate of ammonia?
3. Does plaster sprinkled in stables and on manure heaps, and in privy vaults check the waste of ammonia, and thereby add materially to the value of the manure heap?
4. Is there ordinarily much loss of ammonia in stables where no absorbent is used?
5. Does dry loam sprinkled on manure answer as well to retain the ammonia and hold it till wanted by the plants?
6. Does the carbonate of lime found in the plaster from certain sections tend to counteract the good effects produced by the application of sulphate of lime, either by rendering the plant food more volatile, or by neutralizing the good effects of the sulphate?
7. Does plaster mixed with manure hasten or check decomposition?"

To this correspondent was replied essentially as follows:

1. Plaster has no strong affinity for *nitrogen*. When dissolved in water it will absorb and retain carbonate of ammonia. Plaster is sulphate of lime, and in presence of water is decomposed by carbonate of ammonia. Sulphate of ammonia and carbonate of lime are formed by this double decomposition.
2. Carbonate of ammonia is volatile at ordinary temperatures; the strong ammoniacal odor of stables and urinals is due to it. Sulphate of ammonia is not volatile, hence:
3. Plaster sprinkled on moist manure heaps and on stable floors wet with urine does prevent loss of ammonia.
4. How great the loss of ammonia may be in stables, etc., it is not easy to say. An amount of ammonia can be smelled which is very small, and might not pay for the saving, but no doubt the loss under some circumstances, particularly in summer weather, is considerable. Another advantage of using plaster in stables is this, that the air which the animals breathe is kept sweeter and more wholesome.

5. Loam is a very excellent deodorizer and absorbent of ammonia. It would have to be used in much larger quantity than gypsum, and would therefore increase very considerably the weight of the manure to be handled.
6. Carbonate of lime in plaster simply dilutes it. The fixation of ammonia is caused solely by the sulphate of lime; the less sulphate of lime present the less the efficiency of the plaster as an absorbent.
7. The amount of plaster which would be added to manure to prevent loss of carbonate of ammonia would probably not retard the decomposition of the manure.*

To Increase Stiffness of Straw.

To the question: What may be added to "fish and potash" to make it a more complete fertilizer for rye which has suffered from want of stiffness in the straw, the answer is, to try lime in some form. Oyster shell screenings or cheap lime of any kind—20 or 30 bushels to the acre may be used. Old wall plaster or common mortar crushed, or leached ashes which are mostly carbonate of lime would do as well. An application of lime at this time of year (November) broadcasted on the growing rye would be safe. Many English farmers, years ago, had the habit of using two or three bushels of salt to the acre on grain crops, as they said, to stiffen and brighten the straw. It is however probable that the fish and potash contains enough salt to make that application unnecessary. This recommendation is made in the hope but not in the full assurance that it will be of service.

Potato Scab.

In reference to an inquiry as to the cause and cure of potato scab the results to which German investigators have arrived are

* According to Dr. C. H. Meyer-Altenburg, the use of 2 or 2½ pounds of plaster to 100 pounds of stable manure perceptibly checks decomposition when access of air to the manure is prevented by building it up into cubical heaps, which are thoroughly trodden down and frequently watered with the urine and drainings collected in a cistern close at hand. Under such conditions it is stated that a manure heap 6 feet high settled but 2 inches during a summer, while a similar heap without plaster settled 7 inches. The heap of plastered manure is said to have settled but 6 inches during an entire year, and at the end of that time to have retained its fresh appearance and greenish color. Under the ordinary treatment which manure receives such a preservative effect does not appear to have been noticed.

of interest. In the Station Report for 1877, p. 67, will be found a short article on this subject and what follows is in part a repetition of statements there printed.

The skin of the healthy potato tuber consists of a layer of cork cells of uniform thickness and when the skin is injured or a portion of it cut away, the wound heals by the formation of a new layer of cork which reproduces itself in a manner very similar to what takes place when the skin of an animal forms again over a wound. When the potato tuber grows in water or when the soil is kept unduly wet, the cork layer increases in thickness at various points producing a multitude of little warts upon the surface. Where these warts occur the cuticle is less resistant than otherwise and decay of the tissue underneath is likely to take place. If the excess of water about the tuber continues for a considerable time, decay sets in and the starch and tissues of the tuber become discolored. When under favorable conditions decay is arrested the cork layer forms between the decayed and the healthy parts of the potato and the potato is "scabby."

This affection of the potato is accordingly the result of excess of moisture, either because the soil is wet from situation or because of its texture or on account of the occurrence of a protracted period of wet weather. Stable manure and other fertilizers influence it as they affect the state of moisture in the soil. Stable manure may also aggravate the disease by filling the soil with the spores or seeds of moulds or fungi which taking root in the injured cork layer may favor decomposition of the tuber and protract the healing process." Saline fertilizers, like potash salts, may antagonize scab by hindering the growth of fungi.

ON THE AGRICULTURAL VALUE OF HORN DUST AND OF HORN AND HOOF.

In the last Report an account was given of some experiments on methods of testing the agricultural value of nitrogen in mixed fertilizers founded on their solubility in pepsin solution and on the rapidity of their decay in the presence of ferments which induce putrefaction. All the raw materials which are likely to be incorporated with mixed fertilizers were tested by these two methods. The results were briefly these:

1. Seventy-five per cent. or more of the nitrogen of dried blood, cotton seed, castor pomace and maize-refuse, under the conditions of the experiment, was soluble in pepsin solution.

2. Fifty-two per cent. or more of the nitrogen of fish, tankage, horse meat, etc., and of bone was soluble.

3. In no case was more than thirty-six per cent. of the nitrogen of leather (roasted, steamed or extracted with benzine), soluble, and the nitrogen of horn shavings, horn dust, ground horn and hoof, cave guano, felt waste and wool waste was considerably less soluble than that of leather.

It was in the next place desirable to learn whether the solubility of nitrogen in pepsin solution, under the conditions here employed, bore any general relation to the actual availability of the nitrogen as plant food. During the last season some vegetation experiments have been made at this Station on the availability of the nitrogen in "horn dust" and in "horn and hoof" as compared with that of nitrogen in the form of dried blood.

A requisite condition for the success of any vegetation experiments, whether in the field or plant house, as has been pointed out by Hellriegel, Wagner and others, is that the factor of production which is under experiment should be in relative minimum as regards every other factor. For example, in the case in hand, the fertilizing effect of nitrogen in various forms is to be studied, being measured by the amount of crop produced. Nitrogen then must at all times be in a minimum, as regards the other factors of crop production. But suppose that at some time during the experiment the crop suffers from drought. Water is then at a relative minimum. During this time it is water and not nitrogen that limits the growth of the crop. The crop which had grown best previously when nitrogen controlled production, now suffers most because its more abundant foliage exhausts more rapidly and completely the water of the soil, and it may be that the plants will be "burned" by the richer nitrogenous manure while the crop supplied with the less valuable nitrogenous matter will fare better. In any event the result will be of no value. Or again suppose the land experimented upon cannot furnish the amount of potash necessary for a maximum crop of the kind under experiment. Then crop production is conditioned on the potash present and may be very little if at all affected by the application of nitrogen. On such land dried blood might produce very little more than leather. In all cases the experimenter must prove that all other factors of crop production are in relative maximum to the one factor under investigation.

The experiments to be described were made in pots of a kind which has been proposed and used by Wagner. Each consists of a cylinder of galvanized iron twenty inches high and ten inches inside diameter. The cylinder has handles set on the sides some ways below the rim and has a row of perforations around it one-eighth of an inch from the bottom. This cylinder is soldered into the middle of a galvanized iron pan three inches deep and fourteen and a half inches in diameter. Through the bottom of this pan, an inch from the edge, pass two tubes, one being flush with the bottom of the pan inside, the other rising two inches. Both project 1½ inches below the bottom. The first is used only for washing out the pot and at other times is corked; the other is the overflow tube. The pot is finished by soldering on a collar between the upper edge of the pan and the outside of the cylinder. Through this collar passes a tube by which water can be poured into the pan or reservoir. When water is poured in it will rise in the reservoir and through the perforations into the cylinder to the height of two inches and if more is poured in it will then run off through the overflow. When the pots are full of earth there will be water standing 18 inches below the surface and if they are daily cared for there can be no lack of water. A heavy rain will saturate the soil and the excess will run off through the overflow into a bottle placed below to receive it. The pots were painted white on the outside so as to absorb as little of the sun's heat as possible and within were coated with the best quality of asphalt to prevent rusting. During the experiment they stood on a low table that ran nearly due east and west and which was unshaded during the entire day. On a board below the table bottles numbered to correspond with the pots were so placed as to receive all the overflow.

Earth for the experiments was taken from under sod which had not been fertilized for years and on which applications of nitrogenous manure always had a marked effect. It is a light drift soil overlying "red rock" (coarse conglomerate sandstone,) and has little natural fertility. This earth was sifted to remove stones and roots and was very thoroughly mixed.

The filling of the pots required considerable care to insure that the earth was uniformly packed in all the pots. For this end the following method was adopted. The bottom of each of the 24 pots in the series was covered with rather fine gravel (2½ to 5½mm diameter) to the depth of one inch and then into each of the pots was weighed 10 pounds of earth or one-sixth of the total quantity required. This was evenly spread and gently pressed down, with a block of wood fitted with a handle for the purpose, until the layer of earth was just three inches thick as was determined by measuring the distance from its surface to the rim of the pot. A second layer was put in each pot in the same way and then a third. All the pots were now half full. For the first pot in the series the total quantity of earth needed to finish filling it was next weighed out and to this was added the fertilizer to be used. The two were very carefully and thoroughly mixed together. Then one-third of this mixture was weighed into the pot, pressed down as already described and afterwards the other two portions in the same way. In like manner all the other pots were prepared. As soon as the pots were ready the reservoirs were filled with water and were thereafter filled every morning during the entire period of growth. After a rain the water that had percolated through the soil was first used.

The water used in these experiments was city water containing between 4 and 5 grains of solid matters to the gallon and two to five parts of "albuminoid ammonia" in one hundred million of water. Previous to use it was passed through a filter of sand and wood charcoal.

The crop grown was Welcome Oats from seed bought of a seedsman in New Haven. The seed was counted out in lots of twenty kernels, and each lot was weighed and only those were used which were almost identical in weight. The kernels weighed together about 0.5 gram and contained .013 grams of nitrogen. To plant the seed in a perfectly uniform way in the different pots a disc of wood was prepared having twenty equidistant holes. This was laid on the surface of the soil in the pot, through the holes the seed was put on the soil, the disc was removed and a weighed amount of soil was spread over the seed covering it to a depth of three-quarters of an inch. This last stratum of earth was gently packed.

Each pot received 2.28 grams of muriate of potash, containing 52 per cent. actual potash, and the same quantity of bone black superphosphate with 17 per cent. available phosphoric acid. These quantities are equivalent to an application of about 400 pounds of muriate and 400 pounds of superphosphate per acre.

The nitrogenous matters used in the experiment were as follows: Dried blood containing 13.40 per cent. of nitrogen, ground horn and hoof containing 13.54 per cent., and horn shavings containing 15.37 per cent. All these materials were ground to a fine powder that would readily pass a one-fiftieth inch sieve. They are the identical samples which were used last year in the digestion experiments with pepsin above referred to. The amounts of these nitrogenous matters used, and the equivalent nitrogen can be seen by reference to the next table. All the weights given are in grams.

The applications of nitrogen are equivalent to 20, 40 and 60 pounds of nitrogen per acre, or about what would be supplied in 240, 480 and 720 pounds of dry ground fish.

The object in using these different quantities of nitrogen instead of a uniform quantity in all, is this: If nitrogen had been applied at the rate of 60 pounds per acre there would be no proof that this was not an excessive amount. In that case nitrogen might not have been in a relative minimum. But on the present plan the increased yield of 40 pounds over 20 shows that the former quantity was not excessive; the increase made by 60 pounds over 40 pounds again shows that 40 pounds was not excessive.

The pots were filled on the 29th and 30th of April last, and the oats were planted on May 3rd. A week after planting they were thinned so that each pot had 18 plants only. This was done to keep the series alike, as in one pot only 18 seeds produced plants. The oats grew thriftily up to the time of flowering, when smut appeared on one or two plants in all the pots but Nos. 77, 79, 86 and 89. Most of the crops did not seem to be seriously damaged. No. 84 was considerably injured, four of the stalks being badly infected with smut. The oats were harvested on the 21st of July before all were perfectly ripe. This was necessary, as in some pots the seeds had began to fall. The details with regard to the fertilizers applied, and the crops harvested, are given in the first table on the following page.

Certain points require special mention before proceeding to a discussion of the general results. The first six pots of the series received no addition of nitrogen, and show the capacity of the soil itself for production under the conditions of the experiment. The first two numbers, 73 and 74, should be left out of the account as they stood at the end of the row, and for that reason were differently exposed than the others to light and heat. The other end of the row was protected by another series of pots. The total yield from .342 grams of blood-nitrogen would have probably been much larger but that one of the pots, No. 84, which received this dose of nitrogen was much more seriously attacked

No.	Weight of Nitrogenous Fertilizer added. (The seed in each pot contained 0.013 grams of Nitrogen)	Weight of Nitrogen added in the fertilizer.	Dry weight of crop.	Total weight of nitrogen in the crop.
73	None.	None.	(21.8)	(.1762)
74	"	"	(19.9)	(.1730)
75	"	"	23.4	.2042
76	"	"	25.1	.2112
77	"	"	22.4	.2055
78	"	"	22.9	.2050
79	.8508 of dried blood.	.114	29.6	.2378
80	.8508 "	.114	29.7	.2410
81	1.7015 "	.228	32.7	.2816
82	1.7015 "	.228	33.3	.3173
83	2.5524 "	.342	41.6	.3844
84	2.5524 "	.342	35.4*	.3139
85	.8419 ground horn and hoof.	.114	24.1	.2056
86	.8419 " "	.114	26.0	.2346
87	1.6838 " "	.228	26.5	.2411
88	1.6838 " "	.228	28.6	.2528
89	2.5257 " "	.342	33.1	.2886
90	2.5257 " "	.342	32.7	.2808
91	.7417 horn shavings.	.114	22.5	.2073
92	.7417 " "	.114	19.4	.2457
93	1.4834 " "	.228	26.1	.2280
94	1.4834 " "	.228	28.5	.2534
95	2.2251 " "	.342	32.3	.3140
96	2.2251 " "	.342	32.8	.2870

* Most seriously attacked by smut.

by smut than any other. No reason can be assigned for the fact that the yield in pots Nos. 91 and 92 was less than in those that had received no nitrogen.

The average yield of the four pots which received no addition of nitrogen, Nos. 75, 76, 77 and 78, was 23.5 grams.

The general results of the experiment are given in the following tables. The total weight of crop given in each case is the sum of the weights of the crops in the two pots which had like quantities of the same nitrogenous fertilizer. The weights are expressed in grams. (See table on page 86.)

A comparison of these results brings out the following facts: With the minimum dose of nitrogen (.228 gram in the two pots) blood-nitrogen caused an increase of crop over that of the unfertilized pots about four times as large as that caused by horn-nitrogen. When this minimum dose of nitrogen was doubled, the increase caused by blood-nitrogen was about two and a half times as much as that caused by a like quantity of horn-nitrogen. With the treble dose of nitrogen the increase from blood-nitrogen was only about one and three-quarters times as much as from

YIELD OF DRY MATTER IN CROP.

[Yield without added nitrogen was 47 grams.]

Nitrogen in each two pots.*	Total Yield.			Total gain over unmanured.			Per cent. gain over unmanured.		
	Blood.	Horn and Hoof.	Horn Shavings.	Blood.	Horn and Hoof.	Horn Shavings.	Blood.	Horn and Hoof.	Horn Shavings.
.228	59.3	50.1	41.9	12.3	3.1	-5.1	26.2	6.6	-11.0
.456	66 0	54.9	54.6	19.0	7.9	7.6	40.4	17.0	16.2
.684	77.0	65.8	64.1	30.0	18.8	17.1	63.8	40.0	36.4

YIELD OF NITROGEN IN CROP.

[Yield of nitrogen in pots without nitrogenous fertilizer added was .413.]

Nitrogen in each two pots.*	Total Nitrogen.			Total Nitrogen gain over unmanured.			Per cent. gain of Nitrogen over unmanured.		
	Blood.	Horn and Hoof.	Horn Shavings.	Blood.	Horn and Hoof.	Horn Shavings.	Blood.	Horn and Hoof.	Horn Shavings.
.228	.4788	.4402	.4530	.0658	.0272	.0400	15.9	6.5	9.7
.456	.5989	.4939	.4814	.1859	.0809	.0684	45.0	19.6	16.5
.684	.6983	.5694	.6010	.2853	.1564	.1880	69.1	37.8	45.5

horn-nitrogen. Or otherwise expressed, in this experiment an application of nitrogen at the rate of twenty pounds per acre in the form of blood produced four times as much *increase of crop over unmanured land* as the same amount of horn-nitrogen. When nitrogen at the rate of forty pounds per acre was applied in the form of blood, the increase was two and a half times as much as that got from the same amount of nitrogen in the form of horn, and when sixty pounds of nitrogen were applied the increase of crop caused by blood-nitrogen was only one and three-quarters as much as that caused by horn-nitrogen. If we consider the increase of *nitrogen* of the crop, 20 pounds per acre of blood-nitrogen gave nearly twice as much increase as the same

* This does not include .026 grams of nitrogen contained in the seed which was added to both manured and unmanured pots.

amount of horn-nitrogen, 40 pounds of blood-nitrogen gave two and a half times as much increase as the same quantity of horn-nitrogen, and 60 pounds of blood-nitrogen gave one and two-thirds as much increase as the same quantity of horn-nitrogen.

The crop-producing power of the nitrogen of blood and of horn becomes then more nearly alike as the amount of nitrogen applied is increased. The reason is obvious. Since a portion of the nitrogen of horn is available, it is possible to add enough of it to supply all that a maximum crop requires. With each successive increase in the amount applied the production of a maximum crop is more nearly attained, and hence the difference in availability between it and blood will grow smaller. Moreover when the amount of decomposing organic matter in the soil is increased to a certain limit—and the limit is reached sooner with an easily decomposable material like blood than with an inert one like horn, —the crop production is checked by the too rapid decay in the soil so that if the nitrogen additions were increased in the same ratio as in these experiments it might easily happen that the horn would give a larger yield than the blood for the reason that the excessive amount of blood added would "burn" the crop.

It is noticed that with the smallest application of horn shavings the yield of dry matter, viz: 41.9 grams, was less than that, obtained (47 grams), from the unmanured pots. Nevertheless the nitrogen (.453) in the smallest crop was not only greater than that, (.413), of the crop to which no nitrogen was added, but also noticeably exceeded the amount of nitrogen (.4402), in the larger crop obtained from a corresponding quantity of horn and hoof. These anomalies no doubt depend on irregularities of growth partly due to the seed and to "accidental" (that is unknown), circumstances or conditions. It should be remembered that the plants when harvested had not equally ripened. The ripening process, as is well known, is in part a growth of the upper organs of the plant at the expense of the lower. It is perhaps probable that the "crops," that is the cropped parts, showed a wider variation than the entire plants would have shown in consequence of this unequal distribution of dry matter in root and "crop" due to differences of ripeness at the time of harvesting. The ratio of increase of crop produced by the different doses of nitrogen, over the amount of crop in the pots to which no nitrogen was added, calling the increase produced by blood-nitrogen in each case 100, is as follows:

RELATIVE INCREASE OF DRY MATTER IN THE CROP.

Nitrogen added.	Blood.		Horn and Hoof.		Horn Shavings.
.228	100	:	25.2	:	----
.456	100	:	41.6	:	40.0
.684	100	:	62.6	:	57.0
Average,	100	:	46.5	:	48.5

RELATIVE INCREASE OF NITROGEN IN THE CROP.

.228	100	:	41.3	:	60.8
.456	100	:	43.5	:	36.7
.684	100	:	54.8	:	65.9
Average,	100	:	46.5	:	54.4

The results are too irregular to justify any fine conclusions, but the average increase both of dry matter and of nitrogen is seen to be twice as much in the case of blood-nitrogen as in that of horn-nitrogen. This result is to be understood as applying to these materials in a high state of pulverization whereas horn as ordinarily used, is very much coarser and therefore less active than blood.

With these results we may here compare the outcome of the laboratory experiments made last year upon these same materials in the same state of pulverization. The relative solubility of the three materials—

	Blood.		Horn and Hoof.		Horn Shavings.
In pepsin solution was------	100	:	28.9	:	23.0
After putrefaction was------	100	:	40.9	:	27.8

Our vegetation experiments give on the whole a higher fertilizing value than would be inferred from their solubility under the peptic and putrefactive ferments. It is to be considered however that in the vegetation-experiments the materials were undergoing solution or alteration for 11 weeks while in the laboratory experiments the action of the ferment lasted from 24 hours to 2 weeks.

In these experiments both "horn and hoof" and "horn shavings" proved to be of very inferior value as fertilizers in comparison with dried blood. On soil of an entirely different character the results might have been different and yet it is probable that on any soil where the conditions were all suitable for the one factor of nitrogen to have a controlling influence on crop production, the result would not have been *essentially* different from this. Horn shavings are used and prized as a fertilizer. They are cheap, can therefore be used in large quantity, they lighten a

heavy soil as long manure would do and they furnish nitrogen durably to the crop. The station valuations for blood-nitrogen and horn-nitrogen are respectively 17 and 9 cents per pound. The ratio of these prices is as 100 : 52.9. The average increase of crop by both horn-fertilizers in our pot-experiments bears to that given by blood the ratio of 100 : 47.5. The average increase of nitrogen in the crops, from use of the same, is 100 : 50.5. The pot-experiments therefore on the whole confirm the justness of the Station Valuations in respect to the relative worth of these two sources of nitrogen.

ANALYSES OF FEEDING STUFFS.

EXPLANATIONS CONCERNING THE ANALYSIS, VALUATION AND ECONOMICAL USE OF FEEDING STUFFS.*

In order to feed animals most rationally and economically it is necessary to know:

1st. The composition of the feeding stuffs which make up their ration.

2nd. What percentage part of the different ingredients of these feeding stuffs can be digested by the animals.

3rd. How many pounds of the digestible materials must be daily supplied to each animal in order to get the maximum production of milk, of flesh, of wool, or of work; or in order to keep the animal, if at rest, simply in good condition.

I.—THE COMPOSITION OF FEEDING STUFFS.

This is determined by chemical analysis. On subsequent pages is given in tabular form the average composition of the feeding stuffs commonly used in this country, compiled exclusively from American analyses. In the first column of these tables is stated the total number of analyses from which the average was obtained. The probable accuracy of the average increases with the number of analyses on which it is based.

As it is very desirable to know within what limits the composition of each fodder is likely to vary, the maximum and minimum amounts of each ingredient have also been inserted in the table.

The following explanations may be helpful to the ready understanding of these tables.

* Reprinted with minor changes from the Report for 1885.

Explanations of Analyses of Feeding Stuffs.

The analysis gives the percentage amounts of Total Dry Matter, Albuminoids or Protein, Crude Fat, Nitrogen-free Extract, Fiber and Ash.

Total Dry Matter is what remains of a feeding stuff when all the water it contains is removed. However dry a feeding stuff may appear to be, it always contains a considerable and variable proportion of water which is invisible and imperceptible to the senses, but which can be driven out by heat and which the perfectly dried fodder recovers more or less fully when exposed to the air. This amount of water thus present in feeding stuffs is constantly changing with the temperature and dryness of the air to which they are exposed, and accordingly no proper comparison of different foods is possible unless the proportions of water they contain is known and comparison is made on perfectly dry or water-free substance.

In the Station laboratory, water is expelled and the amount of Dry Matter determined by heating a weighed quantity of the feeding stuff at 212° Fahr. in a stream of hydrogen gas until no further loss of weight occurs.

Albuminoids (*or Protein*) is a general term which includes all those nitrogenous materials of a feeding stuff which bear a general resemblance in composition and properties to egg albumin (white of egg), flesh fibrin (lean meat), and milk casein (curd). The quantity of albuminoids is usually estimated by multiplying the per cent. of nitrogen present by 6¼. This method is based on the fact that the albuminoids all contain not far from sixteen per cent. of nitrogen, which figure multiplied by 6¼ gives 100 per cent. or the total amount of albuminoid corresponding to the nitrogen. Some of the albuminoids contain indeed less and some more than this per cent. of nitrogen, but, for practical purposes, the assumption of sixteen per cent. is sufficiently exact in most cases.

It is believed that the vegetable albuminoids do not greatly differ in nutritive effect or at least, since each feeding stuff commonly contains a mixture of several distinct albuminoids, the *digestible portions* of these various mixtures do not widely differ in nutritive value.

Besides albuminoids, certain feeding stuffs, chiefly root crops, and immature parts of plants, such as hay from young grass, contain a portion of their nitrogen in an entirely different form; as

Composition of American Feeding Stuffs.

Name.	Analyses.	Total Dry Matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen-free Extract.			Fiber.			Ash.
		Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	
GREEN FODDER.																	
Maize Fodder	48	7.1	30.9	19 02	.6	3.0	1.63	.1	.9	.41	3.2	19.7	10.62	1.9	11.4	5.23	1.13
Maize Fodder, ensilaged	53	12.3	29.2	19.54	.9	2.8	1.51	.2	1.8	.70	5.1	16.5	10.21	4.0	10.0	5.77	1.35
Sorghum	5	13.6	28.4	23.92	1.0	1.4	1.16	.2	.4	.33	5.3	27.0	14.87	5.5	8.5	6.65	.91
Sorghum, ensilaged	5	22.0	28.1	24.17	.6	.9	.75	.1	.4	.28	13.8	19.0	15 82	5.9	6.8	6.28	1.04
Rye fodder	6	21.9	25.3	24 72	2.3	3 0	2.61	.2	.7	.56	4.9	12.4	6.94	4.9	14.9	12.73	1.88
Rye fodder, ensilaged	1	....	....	19.25	....	....	2.42	....	....	.27	....	....	9.18	....	....	5.76	1.62
Clover	1	....	....	26.67	....	....	4.09	....	....	.69	....	....	11.61	....	....	8.12	2.16
Clover, ensilaged	3	21.5	27.4	23.73	3.0	3.8	3.34	.9	1.1	1.02	8.1	11.4	10.21	5.1	8.6	6.66	2.50
Cow pea vines, green and succulent, with pods	3	14.0	27.2	19.69	1.9	3.3	2.70	.2	.6	.47	5.3	8.5	7.41	2.9	15.3	7.22	1.89
Cow pea vine, ensilaged	1	....	....	18.36	....	....	2.40	....	....	.80	....	....	7.60	....	....	5.57	1.99
Soy bean, entire crop	3	29.6	30.7	30 13	2.2	3.9	3.34	.9	1.6	1.16	14.2	16 0	14.88	7.9	8.9	8.36	2.39
Beet leaves	1	....	....	11.16	....	....	2.74	....	....	.60	....	....	2.49	....	....	2.50	2.83
Carrot leaves	1	....	....	16.70	....	....	4 26	....	....	.86	....	....	5.99	....	....	2.25	3.34
Cabbage, ensilaged	1	....	....	12.39	....	....	1.19	....	....	.93	....	....	4.52	....	....	1.59	4 16

Composition of American Feeding Stuffs—*Continued.*

Name.	Analyses.	Total Dry Matter. Min.	Max.	Aver.	Albuminoids or Protein. Min.	Max.	Aver.	Crude Fat. Min.	Max.	Aver.	Nitrogen-free Extract. Min.	Max.	Aver.	Fiber. Min.	Max.	Aver.	Ash.
Hay and Dry Coarse Fodder.																	
Clover hay	25	78.2	92.0	87.44	8.9	20.8	12.61	1.5	4.3	2.48	35.0	45.5	39.62	15.6	33.7	26.63	6.10
Hay containing much clover	8	85 5	88.6	86.06	6.4	14.4	10.41	1.5	3.3	2.59	35.8	45.2	41.59	19.7	29.5	25.97	5.50
Timothy hay. [*Phleum pratense*]	40	84.5	92.9	88.93	4.2	9 6	6.02	1.0	3.4	2.16	39.2	58.5	45.82	22.7	38.5	30.89	4.06
Red top [*Agrostis vulgaris*]	1	----	----	90.16	----	----	7.25	----	----	1.95	----	----	46.52	----	----	27.45	6.99
Timothy and Red top	10	85.7	91.8	87.64	4.8	9.0	6.52	1.5	2.7	2.00	38.5	48.9	44.15	24.7	38.4	30.17	4.80
Orchard grass hay, [*Dactylis glomerata*]	1	----	----	88.20	----	----	8.17	----	----	2.26	----	----	33.54	----	----	38.33	5.90
Hungarian grass hay	6	91.3	95.1	93.55	5.6	8.8	6.79	2.1	3.5	2.55	46.9	50.9	49.69	26.4	31.3	29.09	5.43
Barley hay, (Seed in milk)	1	----	----	89.75	----	----	9.21	----	----	2.47	----	----	47.49	----	----	26.14	4.44
Oat hay, (Seed in milk)	2	90.4	91.3	90.85	7.8	9.9	8.90	2.4	3.1	2.74	41.6	48.0	44.79	25.1	31.0	28.07	6.48
High meadow hay	2	88.7	89.4	89.02	6.8	8.3	7.57	2.0	2.5	2.25	46.9	47.5	47.19	24.3	25.2	25.78	6.23
Hay from mixed meadow grasses	9	81 0	87.0	84 52	4.9	7.9	6.24	1.4	2.7	2.05	34.4	47.3	40.43	23.7	35.9	31.09	4.71
Low meadow hay	10	85.5	93.6	89.50	4.6	10.4	7.70	.7	3.6	2.20	39.8	55.2	43.60	21 4	40.0	30.20	5.80
Salt marsh hay	11	81.4	92.8	89.53	4.3	7.8	5.90	1.6	3.1	2.32	34.1	53.7	42.42	27.0	37.9	31.47	7.42
Maize stover	5	75.0	84.7	80.44	4.3	8.3	5.89	1.3	1.9	1.57	36.5	46.2	41.56	23.4	27.2	25.61	5.79
Maize fodder, field cured	6	60.6	77.1	67.95	3.4	5.0	4.29	.7	1.6	1.24	30.5	40.8	35.96	18.7	25.2	22.14	4.32
Buckwheat straw	2	89 5	89.6	89.55	3.3	4.4	3.85	1.4	1.7	1.56	32.1	34.5	33.28	44.9	46.8	45.88	5.05
Oat straw	4	87.5	93.5	90.38	2.3	5.1	3.51	1.0	3.2	2.21	26.4	44.3	36.09	35.2	56.0	43.37	5.20
Rye straw	2	87.5	90.2	88.89	2.2	6.9	4.54	1.0	2.7	1.84	35.7	41.0	38.37	34.2	43.3	38.75	1.84
Wheat straw	1	----	----	93.50	----	----	4.98	----	----	1.49	----	----	41.99	----	----	38.08	6.96
Cow-pea vines	6	86.0	90.7	88.95	13.6	19.8	15.68	1.1	4.1	2.87	34.9	46.4	42.17	17.2	23.7	19.8	8.41

Composition of American Feeding Stuffs—*Continued.*

Name.	Analyses.	Total Dry Matter. Min.	Max.	Aver.	Albuminoids or Protein. Min.	Max.	Aver.	Crude Fat. Min.	Max.	Aver.	Nitrogen-free Extract. Min.	Max.	Aver.	Fiber. Min.	Max.	Aver.	Ash.
Roots, Bulbs, Tubers and other Vegetables and Fruits.																	
Beets, red	2	10.5	12.3	11.43	1.5	1.7	1.60	.2	.2	.18	7.2	7.6	7.40	.6	1.7	.12	1.08
Beets, sugar	7	9.2	16.4	13.03	1.7	2.8	2.01	.1	.2	.08	5.7	12.0	9.12	.7	1.1	.88	.94
Mangolds	5	5.6	11.7	8.24	1.0	1.9	1.53	----	.5	.15	2.4	8.4	4.67	.8	1.0	.86	1.03
Ruta bagas	1	----	----	12.92	----	----	1.15	----	----	.09	----	----	9.11	----	----	1.16	1.41
Turnips	1	----	----	11.11	----	----	1.34	----		.09	----	----	8.11	----	----	.86	.71
Carrots	5	8.9	13.5	12.04	.8	2.0	1.22	.2	.7	.46	5.1	10.4	7.86	1 0	2.3	1.45	1.05
Onions	6	6.5	18.4	12.45	.8	2.3	1.41	.2	.4	.26	3.8	14.1	9.53	.6	.8	.69	.56
Potatoes	6	19.4	23.8	21.53	1.1	3.0	2.12	----	.2	.10	15.3	19.9	17.88	.3	.9	.54	.89
Sweet potatoes	3	26.6	34.0	29.72	.5	1.2	.98	.3	.3	.32	23.0	29.7	26.13	.6	2.5	1.36	.93
Cabbage	1	----	----	6.41	----	----	2.01	----	----	.19	----	----	2.00	----	----	1.44	.72
Squash	2	4.8	5.4	5.12	.6	.6	.66	.2	.3	.28	2.9	3.5	3.24	.5	.5	.54	.40
Pumpkin	1	----	----	7.73	----	----	1.11	----	----	.16	----	----	4.34	----	----	1.49	.63
Apples	5	15.9	22.7	18.22	.2	1.2	.69	.3	.6	.41	12.6	20.0	15.31	.9	2.9	1.49	.32

Composition of American Feeding Stuffs—*Continued.*

Name.	Analyses.	Total Dry Matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen-free Extr.			Fiber.			Ash.
		Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	
GRAIN AND OTHER SEEDS.																	
Barley	9	87.4	92.7	*89.08*	8.6	15.7	*12.39*	1.5	3.1	*1.86*	66.7	73.9	*69.88*	1.2	4.1	*2.57*	2.38
Buckwheat	8	85.1	89.1	*87.40*	8.6	11.0	*10.00*	2.2	2.4	*2.25*	62.6	65.4	*64.50*	7.8	9.4	*8.70*	2.00
Oats [raised in Conn.]	7	86.5	90.7	*89.06*	8.0	10.1	*9.32*	4.7	5.8	*5.29*	59.0	63.2	*61.55*	8.9	12.9	*9.95*	2.95
Oats	25	86.5	91.1	*89.06*	8.0	14.4	*11.38*	3.4	5.8	*4.81*	50.8	66.9	*60.05*	1.5	19.4	*9.85*	2.97
Rye	6	86.8	91.3	*88.40*	9.5	12.1	*10.60*	1.4	2.1	*1.70*	70.7	73.9	*72.60*	1.4	2.1	*1.60*	1.90
Wheat, winter	242	83.8	92.9	*89.48*	8.3	16.6	*11.73*	1.3	3.9	*2.11*	68.1	76.6	*72.01*	.4	2.9	*1.77*	1.86
" Spring	13	86.6	91.9	*89.63*	8.1	15.4	*12.51*	1.8	2.5	*2.20*	66.1	78.6	*71.19*	1.3	2.3	*1.82*	1.91
" Unclassified	55	87.6	90.9	*89.31*	9.8	14.7	*11.96*	1.6	2.8	*2.10*	68.5	74.7	*71.50*	1.2	3.1	*1.92*	1.83
" Average of all Analyses	310	83.8	92.9	*89.46*	8.1	16.6	*11.80*	1.3	3.9	*2.11*	66.1	78.7	*71.89*	.4	3.1	*1.80*	1.86
Maize, dent	78	85.9	93.7	*89.90*	7.5	12.1	*10.34*	3.8	6.9	*5.13*	66.2	75.7	*70.59*	1.2	4.8	*2.29*	1.55
" Flint	70	80.4	93.4	*88.93*	7.0	13.7	*10.57*	3.4	7.1	*4.96*	65.0	74.6	*70.31*	.7	2.9	*1.65*	1.44
" Sweet	26	89.1	94.0	*91.18*	9.5	15.3	*11.62*	3.8	11.9	*8.14*	61.8	72.4	*66.70*	1.5	5.2	*2.80*	1.92
" "Western Corn"	3	79.3	83.6	*80.90*	7.8	8.6	*8.30*	3.6	3.9	*3.70*	64.9	68.2	*66.00*	1.7	1.8	*1.75*	1.20
" Average of all varieties	190	79.3	94.0	*89.48*	7.0	15.3	*10.58*	3.4	11.9	*5.46*	61.8	75.7	*69.81*	.7	5.2	*2.08*	1.55
Sorghum Seed	9	83.2	90.7	*87.48*	7.6	11.2	*8.88*	2.1	4.6	*3.65*	66.8	73.6	*71.27*	1.4	3.2	*1.88*	1.80
Cotton Seed, hulls and kernels	1	----	----	*92.28*	---	----	*15.72*	----	----	*18.56*	----	----	*29.09*	----	----	*25.73*	3.16
Cow pea	5	79.2	89.9	*85.21*	19.3	23.0	*20.77*	1.3	1.6	*1.43*	48.1	61.9	*55.75*	3.3	5.0	*4.06*	3.20
Doura, brown	3	87.3	92.4	*89.00*	9.0	11.5	*10.30*	----	----	*4.20*	----	----	*69.90*	----	----	*1.50*	1.60
Soy Bean	3	89.8	93.9	*91.41*	34.6	38.6	*36.22*	16.8	19.0	*17.92*	26.2	30.5	*28.66*	3.6	5.0	*4.24*	4.37

Composition of American Feeding Stuffs—*Continued.*

Name.	Analyses.	Total Dry Matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen-free Extr.			Fiber.			Ash.
		Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	
FLOUR AND MEAL.																	
Barley Meal	3	83.8	86.0	*84.90*	8.8	13.9	*11.80*	.7	2.2	*1.70*	----	----	*70.90*	----	----	*.10*	.50
Buckwheat Flour	3	85.0	87.2	*86.48*	4.2	8.0	*6.48*	.6	1.7	*1.33*	75.8	79.4	*77.34*	.2	.3	*.28*	1.05
Oat Meal	6	91.1	93.8	*92.15*	12.9	16.2	*14.66*	6.1	8.8	*7.06*	66.6	68.9	*67.57*	.6	1.2	*.86*	2.00
Rye Flour	4	86.4	87.7	*86.90*	6.0	7.1	*6.65*	.8	.9	*.84*	77.6	79.1	*78.28*	.4	.5	*.41*	.72
Wheat Flour, from Winter Wheat*	1	----	----	*87.04*	----	----	*8.56*	----	----	*1.19*	----	----	*76.59*	----	----	*.17*	.53
" from Spring Wheat†	6	86.5	89.7	*87.68*	8.6	14.1	*10.68*	.6	2.0	*1.11*	68.3	78.1	*75.00*	----	1.2	*.22*	.64
" Unclassified	21	86.4	88.8	*87.52*	9.7	13.3	*11.25*	.8	1.9	*1.16*	69.5	76.9	*74.33*	.1	1.0	*.25*	.53
" Average of all varieties	25	86.4	89.7	*87.44*	8.6	14.1	*11.28*	.6	2.0	*1.20*	68.3	78.1	*74.13*	.0	1.2	*.27*	.56
Graham Flour	3	86.3	87.9	*86.90*	11.3	12.4	*11.70*	1.5	1.9	*1.70*	69.8	70.0	*69.80*	1.8	2.1	*1.90*	1.80
Maize Meal	49	75.5	92.0	*84.81*	7.1	10.3	*9.20*	2.2	5.1	*3.85*	60.6	74.0	*68.39*	.5	2.8	*1.89*	1.48
Hominy	2	86.4	86.6	*86.50*	8.1	8.4	*8.25*	.4	.5	*.44*	77.1	77.2	*77.12*	.3	.3	*.32*	.38
Sorghum Meal, mostly decorticated	1	----	----	*86.84*	----	----	*8.25*	----	----	*3.85*	----	----	*71.27*	----	----	*1.88*	1.59
Pea Meal	1	----	----	*87.92*	----	----	*21.37*	----	----	*.86*	----	----	*52.02*	----	----	*11.06*	2.61

* The average of 18 analyses, most of them incomplete, is: Total dry matter, 89.63; Ash, .64; Albuminoids, 10.92.

† The average of 16 analyses, most of them incomplete, is: Total dry matter, 88.55; Ash, .60; Albuminoids, 11.63.

Composition of American Feeding Stuffs—*Continued.*

Name.	Analyses.	Total Dry Matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen-free Extr.			Fiber.			Ash.
		Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	
By-Products and Refuse.																	
Apple Pomace	5	17.5	27.4	*22.51*	1.0	1.7	*1.37*	.6	2.0	*1.39*	12.6	17.0	*15.04*	2.3	5.9	*4.19*	.52
Brewers' Grains, wet from Brewery	15	20.6	31.4	*24.99*	4.3	7.7	*5.57*	.8	2.9	*1.68*	10.1	15.7	*12.86*	3.0	5.6	*3.87*	1.01
" " Dried "	3	88.1	93.8	*91.81*	19.2	20.2	*19.89*	4.2	6.5	*5.56*	46.1	56.8	*51.75*	10.2	11.6	*11.01*	3.58
" Kiln-dried	1	....	....	*97.43*	....	....	*20.30*	....	....	*6.40*	....	....	*54.89*	....	....	*11.79*	3.97
" From Silo	3	26.1	33.2	*30.18*	5.8	7.1	*6.64*	1.8	2.5	*2.11*	13.6	16.8	*15.58*	3.9	5.4	*4.64*	1.21
Brewers' Swill	1	....	....	*5.70*	....	....	*1.90*	....	....	*.80*	....	....	*2.00*	....	....	*.70*	.30
Malt Sprouts	3	88.0	92.7	*89.72*	21.0	25.9	*22.95*	1.1	2.9	*1.79*	45.4	50.3	*48.60*	9.3	11.9	*10.72*	5.67
Cotton Seed Meal	24	81.5	94.2	*91.67*	23.3	50.8	*42.06*	10.2	18.0	*13.24*	12.7	38.6	*23.43*	2.7	11.7	*5.69*	7.25
Linseed Cake	4	89.2	91.6	*89.98*	31.8	34.9	*33.77*	4.0	6.1	*5.04*	33.4	39.1	*36.68*	7.9	9.3	*8.52*	5.97
Linseed Meal, Old Process	9	87.4	93.8	*90.80*	27.7	34.0	*31.53*	5.1	11.6	*7.78*	31.3	41.9	*36.34*	7.1	12.9	*9.26*	5.87
" New Process	12	86.6	93.2	*89.25*	27.1	37.1	*32.85*	1.3	4.4	*3.08*	35.2	48.0	*38.29*	7.6	14.0	*9.46*	5.57
" Oil not removed	1	....	....	*91.67*	....	....	*22.97*	....	....	*30.26*	....	....	*25.48*	....	....	*9.60*	3.36
Palm Nut Meal	3	89.1	93.8	*91.71*	13.5	16.0	*14.39*	6.4	18.7	*13.30*	33.8	41.6	*38.88*	18.7	23.9	*21.40*	3.74
Rye Bran	5	86.3	91.8	*88.52*	12.6	16.8	*15.39*	1.8	2.8	*2.47*	59.8	67.6	*63.42*	2.5	4.1	*3.56*	3.68
Wheat Bran	52	84.2	91.8	*87.58*	7.5	16.9	*15.03*	1.5	5.9	*3.74*	45.5	63.1	*54.17*	2.4	17.8	*8.96*	5.68
Wheat Middlings	23	84.0	91.5	*88.04*	10.1	19.2	*14.87*	2.1	5.9	*3.89*	53.0	70.9	*61.55*	1.3	12.7	*4.55*	3.18
Wheat Shorts	8	84.5	89.0	*87.26*	11.1	16.1	*13.83*	2.5	5.3	*4.14*	53.3	67.0	*57.59*	5.8	10.5	*7.45*	4.25
"Hominy Chops," "Hominy Feed," Baltimore Meal," "White Meal"	11	86.5	91.9	*88.86*	7.9	11.2	*9.85*	4.6	11.2	*8.43*	61.0	71.1	*64.49*	2.5	4.8	*3.59*	2.50
Gluten Meal	8	88.3	92.7	*90.85*	25.0	35.0	*29.88*	4.2	8.7	*6.11*	44.7	58.5	*52.62*	.7	3.3	*1.46*	.78
Maize Cob	13	85.6	92.8	*90.67*	1.2	3.7	*2.50*	.1	.9	*.47*	45.3	66.4	*55.99*	28.2	38.2	*30.36*	1.33
"Starch Feed," refuse from starch manuf.	8	27.8	37.7	*34.34*	3.6	7.7	*5.73*	1.3	4.3	*3.02*	18.7	28.9	*22.21*	1.6	4.3	*3.17*	.21
Sugar Feed, refuse from glucose manuf.	2	89.6	93.4	*91.50*	13.1	13.5	*13.30*	5.9	11.2	*8.60*	54.9	61.4	*58.10*	8.4	10.7	*9.50*	2.00
Sorghum Bagasse	3	11.3	16.6	*14.50*	.6	.7	*.65*	....	....	....	....	....	*10.20*	2.8	3.3	*3.10*	.60

amides or amido-acids. These bodies have a different percentage composition from albuminoids, differ from them in their properties and very considerably in their nutritive value. They are closely related to the albuminoids, and may be derived from or assist in producing the latter.

Other nitrogenous substances which are sometimes found in certain feeding stuffs, generally in very small quantity however, are peptones, alkaloids, nitrates and ammonia salts. The last three are without any nutritive effect on animals so far as is known.

Crude Fat includes fat oil, solid fat, wax, chlorophyl (the green coloring matter of plants,) and other coloring matters, in brief everything which can be extracted from the perfectly dry feeding stuff by absolute ether.

Nitrogen-free Extract, sometimes called *Carbhydrates* includes starch, gum, sugar and pectin bodies. They are readily extracted from the feeding stuff by water and dilute acid but their amount is always indirectly determined by subtracting the sum of the albuminoids, fiber, fat and ash from the total dry matter.

Fiber or *Cellulose* is the essential constituent of the walls of vegetable cells and is seen in a nearly pure state in cotton fiber or paper pulp. It is the most insoluble part of the vegetable substance and its quantity is determined by boiling the feeding stuff successively with a weak acid and a weak alkali, and after copious washing with water, extracting the residue with alcohol and ether. This treatment leaves undissolved what is properly called Crude Fiber which is Cellulose in a state of comparative purity.

Ash is what is left when the combustible part of a feeding stuff is burned away by heating to faint redness in a current of air and besides a little charcoal and sand, which are accidental impurities, consists chiefly of lime, magnesia, potash and soda, combined with chlorine and carbonic, sulphuric and phosphoric acids.

The methods of fodder analysis are, in some respects, still very imperfect, as will be inferred by what has been said with regard to the albuminoids. The results, however, have proven themselves of great value in farm practice which is the best gauge of utility and will be used until more satisfactory methods can be devised.

Use of the Tables of Composition of Feeding Stuffs.

These tables are designed to be a help in forming an estimate of the composition of feeding stuffs which for any reason cannot be specially submitted to chemical analysis. It follows that judgment is necessary in their use. All feed and particularly all coarse feed varies considerably in quality. The first thing to decide is whether the feed in question is in fair condition. If coarse fodder, was it raised on poor land or not, was it cut early or late, was it harvested in good order, is it clean and sweet or not? The answers to these questions will decide whether the average composition of that kind of feed can be fairly attributed to the article in hand. If it cannot be, the maximum and minimum figures will indicate how much allowance is to be made in extreme cases for a specially good or unusually poor condition of the feed.

A determination of albuminoids or of albuminoids and crude fiber will greatly assist in the estimate, and it will rarely happen that such determinations cannot be made within a few days if the sample is sent to the Station with notice that results are wanted for immediate use. Concentrated foods, grain, bran, etc., it will be observed, vary much less in composition than coarse fodder. In any case the quality of the feed should be underestimated rather than overestimated.

II. The Digestibility of Feeding Stuffs.

When food is received into the stomach a portion of it is dissolved and otherwise altered by the juices of the mouth, stomach and intestines, is then taken up from the alimentary canal and in the form of chyle passes into the blood and becomes a part of the juices or tissues of the body. This portion is said to be digested and assimilated and from it alone the animal is nourished. The other portions pass through the body and are excreted as dung. The urine removes from the body only certain waste products which are formed from the digested or assimilated food.

The analysis of a feeding stuff, as has been said, divides its constituents into several groups, albuminoids, fat, etc., each group may contain a number of similar substances, some of which or portions of which are soluble in the juices of the digestive organs, i. e. are digestible, while others are not soluble, or are indigestible.

As only the soluble or digestible portion of the feeding stuff is of any nutritive use to the animal, it is essential, in order to feed rationally that it should be known of each feeding stuff what part of its albuminoids, fat, and other ingredients—the total quantity of which is given by the analysis—is actually digested by the animal. This is learned by feeding trials upon a number of animals. In the case of coarse fodders which can make up the entire ration during the period of experiment, the food consumed and the dung excreted are both very carefully weighed and analyzed and from their quantities and composition it is calculated how much albuminoids, nitrogen-free extract, fiber, etc., was eaten by the animal, and how much of these several materials was voided, the difference being what was digested and served as actual nourishment. The digestibility of concentrated fodders is determined in the same way, the process being somewhat complicated and the results probably made a little less accurate because the concentrated foods cannot be fed by themselves but must be administered in connection with a coarse fodder whose digestibility has already been determined.

Many practical trials have been made, chiefly at German experiment stations, to determine accurately the digestibility of the feeding stuffs commonly in use. The larger number of trials were made with cattle and sheep, some also with horses and swine. Some of the results of these trials are given in the following table of the Digestibility of Feeding Stuffs or of Digestion Coefficients. This is made up in large part from the one given in Mentzel and Lengerke's Landw. Kalender, 1885. Use has also been made of the tables in Dr. H. P. Armsby's Manual of Cattle Feeding. The arrangement of the table is simple. Thus the figure 3 after pasture grass in the first column signifies the number of distinct lots of pasture grass which were tested. In the next column 6 means that with the three separate lots of pasture grass six distinct feeding experiments were made with ruminating animals: sheep, cows and oxen. The greater the number of experiments and lots of grass tested, the more accurately will the average digestibility be determined. 77 in the fifth column indicates that of the dry organic substance contained in pasture grass, the ruminants digest on the average 77 per cent. or $\frac{770}{1000}$, while the maximum and minimum figures 78 and 75 mean that one of the three samples of hay tested had but 75 per cent. and another had as high as 78 per cent. of its organic substance digested. By use of the information given in the tables of the Composition and the Digestibility of Feeding Stuffs it is easy for the farmer to ascertain with reasonable accuracy how much real nutriment is at his disposal for stock feeding.

A single example may illustrate. It is required to know how much digestible food is contained in a ton of wheat bran. By reference to the table of Composition of Feeding Stuffs it is seen that 100 parts of wheat bran contain on the average:

Dry matter	87.58
Albuminoids	15.03
Fat	3.74
Nitrogen-free extract	54.17
Fiber	8.96
Ash	5.68

The table of the Digestibility of Feeding Stuffs shows that in wheat bran about

78 per cent. of the albuminoids,
69 per cent. of the fat,
77 per cent. of the nitrogen-free extract,
33 per cent. of the fiber,

are digested by oxen.

Multiplying the total amounts of the different constituents as expressed in per cent. or pounds per hundred by their percentage digestibility or "digestion coefficients" gives the actual amounts of digestible matter in 100 pounds of the bran, and this again multiplied by 20 will give the amounts of *digestible* albuminoids, fat, etc., in 2000 pounds or one ton.

Digestible albuminoids	$15.03 \times .78 = 11.72 \times 20 = 234.4$ lbs.
Digestible fat	$3.74 \times .69 = 2.58 \times 20 = 51.6$ "
Digestible N.-free extract	$54.17 \times .77 = 41.71 \times 20 = 834.2$ "
Digestible fiber	$8.96 \times .33 = 2.95 \times 20 = 39.0$ "

By precisely the same method the actual nutriment of all the feeding stuffs used may be determined with sufficient accuracy.

The next step is to compound from these materials a ration which shall supply the animal with sufficient but not a wasteful excess of the different kinds of nutriment. With regard to the use of these various nutrients in the animal body it may be said that the albuminoids have a different physiological significance from fiber and the nitrogen-free extract, which latter consists of starch, the sugars, the gums and similarly constituted matters.

Albuminoids may easily be made over by the animal into its own substance, i. e., into muscles, tendons and the various working tissues and membranes because these necessary parts of the animal machine are themselves made up of the same kind of materials, or, chemically speaking, have the same composition as the albuminoids.

Fiber and the nitrogen-free extract on the other hand, probably cannot serve at all for building up the muscles and other parts of

DIGESTIBILITY OF FEEDING STUFFS (Digestion Coefficients.)

	Number of samples tested.	Number of experiments.	Total dry organic matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen-free extract.			Fiber.		
			Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.
GREEN FODDER.																	
Pasture grass	3	6	75	78	*77.*	72	79	*75.*	63	69	*66.*	75	84	*78.*	72	80	*75.*
Meadow grass [experiments with horses]	10	13	43	62	*50.*	54	69	*61.*	9	42	*21.*	49	66	*57.*	33	57	*41.*
Meadow rowen	6	30	62	71	*64.*	61	68	*62.*	31	56	*46.*	63	74	*66.*	59	68	*64.*
Pasture clover, very young	1	2	--	--	*75.*	--	--	*78.*	--	--	*64.*	--	--	*78.*	--	--	*67.*
Red clover, just before blossoming	6	15	59	74	*66.*	60	76	*66.*	58	74	*64.*	63	83	*73.*	47	60	*53.*
Lucerne, before flowering and in flower	9	28	55	67	*60.*	67	83	*74.*	29	55	*39.*	61	73	*67.*	34	48	*43.*
Vetches*	--	--	--	--	--	73	80	*76.*	50	66	*60.*	63	67	*65.*	51	58	*54.*
Lupines*	--	--	--	--	--	73	76	*74.*	16	45	*30.*	57	66	*62.*	67	80	*73.*
Maize fodder (very good)	1	1	--	--	*70.*	--	--	*73.*	--	--	*75.*	--	--	*67.*	--	--	*72.*
Sorghum	1	1	--	--	*73.*	--	--	*62.*	--	--	*85.*	--	--	*78.*	--	--	*59.*
Beet leaves [ensilaged]	1	2	--	--	*57.*	--	--	*65.*	--	--	*60.*	--	--	*54.*	--	--	*54.*
Beans, peas, cabbage, turnip leaves, parsnip leaves	--	--	--	--	--	--	--	*71.*	--	--	*60.*	--	--	*100†*	--	--	--
Fodder rye, fodder oats, beet leaves, carrot leaves, buckwheat	--	--	--	--	--	--	--	*58.*	--	--	*46.*	--	--	*100†*	--	--	--
HAY.																	
Meadow hay	38	104	46	71	*62.*	42	72	*62.*	10	63	*52.*	49	76	*64.*	46	71	*57.*
Meadow hay (very good)	14	42	56	71	*65.*	57	70	*64.*	31	63	*50.*	58	76	*68.*	55	71	*62.*
Meadow hay (medium)	24	62	46	69	*60.*	42	72	*57.*	10	63	*48.*	49	73	*62.*	46	66	*58.*

* These coefficients were obtained in experiments with very good hay of these plants but are approximately correct for the green fodder.

† The number 100 indicates that the sum of the digestible extract and fiber is equal to the total amount of nitrogen-free extract.

DIGESTIBILITY OF FEEDING STUFFS (Digestion Coefficients)—*Continued.*

	Number of samples tested.	Number of experiments.	Total dry organic matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen-free extract.			Fiber.		
			Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.
HAY—*continued.*																	
Meadow hay (inferior)	7	18	46	59	*55.*	42	56	*51.*	10	57	*41.*	49	61	*58.*	46	61	*54.*
Meadow hay (very good, experiments on horse)	3	4	49	55	*52.*	63	66	*64.*	14	42	*24.*	52	62	*57.*	36	46	*43.*
Meadow hay (medium, experiments on horse)	5	6	43	51	*48.*	54	62	*58.*	16	33	*23.*	49	61	*55.*	33	40	*37.*
Clover hay [very good]	6	12	58	63	*61.*	55	69	*62.*	44	72	*60.*	67	72	*70.*	39	52	*47.*
Clover hay (medium)*	6	19	54	62	*57.*	43	61	*55.*	35	70	*51.*	58	67	*65.*	39	52	*45.*
Clover hay (experiments on horse)	4	6	49	55	*51.*	51	60	*56.*	28	31	*29.*	61	67	*64.*	35	39	*37.*
Lucerne hay (very good)	9	28	55	67	*60.*	67	83	*74.*	29	55	*39.*	61	73	*66.*	34	48	*43.*
Hay of fodder vetches [before blossom]	1	6	--	--	*65.*	--	--	*76*	--	--	*60.*	--	--	*66.*	--	--	*54.*
Lupine hay, in blossom	1	2		--	--	--	--	*74.*	--	--	*30.*	--	--	*62.*	--	--	*74.*
ROOTS.																	
Potatoes	3	23	83	90	*88.*	64	67	*65.*	--	--	--	89	96	*93.*	--	--	--
Potatoes [experiments with pigs]	5	8	--	--	*93.*	--	--	*73.*	--	--	--	--	--	*98.*	--	--	*55.*
Sugar beets	2	28	84	93	*89.*	56	68	*62.*	--	--	--	95	96	*95.*	--	--	--
Mangolds	2	16	87	88	*88.*	66	86	*76.*	--	--	--	94	96	*95.*	--	--	--
Turnips	1	8	--	--	*78.*	--	--	*57.*	--	--	--	--	--	*89.*	--	--	--
GRAINS.																	
Oats	6	31	62	74	*68.*	68	86	*77.*	75	97	*82.*	67	79	*74.*	0	26	*17.*
Oats (experiment with horse)	1	5	--	--	*72.*	--	--	*86.*	--	--	*78.*	--	--	*76.*	--	--	*24.*
Barley	1	2	--	--	*81.*	--	--	*77.*	--	--	*100.*	--	--	*87.*	--	--	--

* The digestibility of clover hay may serve as a basis for determining that of hay of other legumes, and the digestibility of meadow hay for determining that of hay from the cultivated grasses.

DIGESTIBILITY OF FEEDING STUFFS (Digestion Coefficients)—*Continued.*

	Number of samples tested.	Number of experiments.	Total dry organic matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen-free extract.			Fiber.		
			Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.
GRAINS—*continued.*																	
Barley (experiment with horse)	1	1	--	--	*87.*	--	--	*80.*	--	--	*42.*	--	--	*87.*	--	--	*100.*
Barley (experiments with pig)	4	8	82	85	*83.*	75	80	*78.*	65	77	*68.*	89	91	*90.*	0	27	*12.*
Maize	1	2	--	--	*89.*	--	--	*79.*	--	--	*85.*	--	--	*91.*	--	--	*62.*
Maize (experiment with horse)	1	1	--	--	*91.*	--	--	*78.*	--	--	*63.*	--	--	*94.*	--	--	*100.*
Maize (experiments with pig)	3	4	90	95	*92.*	84	88	*86.*	76	77	*76.*	93	96	*95.*	19	57	*40.*
Field beans	5	18	83	94	*89.*	81	95	*88.*	65	100	*87.*	88	95	*92.*	25	92	*72.*
Field beans (experiments with horse)	1	4	--	--	*87.*	--	--	*86.*	--	--	--	--	--	*93.*	--	--	*69.*
Peas	1	2	--	--	*90.*	--	--	*89.*	--	--	*75.*	--	--	*93.*	--	--	*66.*
Peas (experiment with horse)	1	1	--	--	*80.*	--	--	*83.*	--	--	*67.*	--	--	*89.*	--	--	*8.*
Peas (experiments with pigs)	5	10	88	95	*91.*	85	90	*88.*	36	67	*49.*	95	99	*96.*	55	89	*71.*
BY-PRODUCTS AND REFUSE.																	
Wheat bran (fed dry)	5	12	67	78	*72.*	71	89	*78.*	50	80	*69.*	70	82	*77.*	20	39	*33.*
Rye bran (experiments with pigs)	1	2	--	--	*67.*	--	--	*66.*	--	--	*58.*	--	--	*75.*	--	--	*4.*
Malt sprouts	1	3	--	--	*84.*	--	--	*82.*	--	--	*49.*	--	--	*88.*	--	--	*95.*
Brewers' grains	1	2	--	--	*63.*	--	--	*73.*	--	--	*84.*	--	--	*64.*	--	--	*39.*
Rape meal (oil extracted)	1	1	--	--	*6[illegible].*	--	--	*84*	--	--	--	--	--	*85.*	--	--	--
Rape cake	2	7	56	75	*66.*	76	86	*81.*	69	88	*79.*	74	78	*76.*	0	16	*8.*
Linseed meal (oil extracted)	1	8	--	--	*71.*	--	--	*82.*	--	--	*91.*	--	--	*73.*	--	--	--
Linseed cake	2	10	78	83	*81.*	84	87	*86.*	89	91	*90.*	70	91	*80.*	26	62	*44.*

Digestibility of Feeding Stuffs (Digestion Coefficients)—*Continued.*

	Number of samples tested.	Number of experiments.	Total dry organic matter. Min.	Max.	Av.	Albuminoids or Protein. Min.	Max.	Av.	Crude Fat. Min.	Max.	Av.	Nitrogen-free extract. Min.	Max.	Av.	Fiber. Min.	Max.	Av.
By-Products and Refuse—*continued.*																	
Palm-nut meal (oil extracted)	2	3	89	93	*91.*	89	100	*95.*	89	100	*95.*	92	96	*94.*	72	92	*82.*
Cotton-seed cake (decorticated)	1	2	..	..	*80.*	..	..	*85.*	..	..	*88.*	..	..	*95.*	..	..	..
Cotton-seed cake (not decorticated)	1	4	..	..	*50.*	..	..	*73.*	..	..	*91.*	..	..	*46.*	..	..	*23.*
Cocoanut cake	1	2	..	..	*78.*	..	..	*76.*	..	..	*100.*	..	..	*81.*	..	..	*62.*
Cocoanut cake [experiments with pigs]	1	2	..	..	*80.*	..	..	*74.*	..	..	*83.*	..	..	*89.*	..	..	*60.*
Flesh meal	1	2	..	..	*95.*	..	..	*95.*	..	..	*98.*	..	..	..	..	..	..
Flesh meal [experiments with pigs]	1	8	..	..	*95.*	..	..	*97.*	..	..	*87.*	..	..	..	..	..	..
Blood meal	1	2	..	..	*63.*	..	..	*62.*	..	..	*100.*	..	..	*100.*	..	..	..
Blood meal [experiments with pig]	1	1	..	..	*72.*	..	..	*72.*	..	..	..	..	..	*92.*	..	..	..
Fish guano	1	2	..	..	..	..	..	*90.*	..	..	*76.*	..	..	..	..	..	..
Straw.																	
Wheat straw*	2	3	45	48	*46.*	8	26	*17.*	27	44	*36.*	37	40	*39.*	52	59	*56.*
Wheat straw [experiments with horse]	1	2	..	..	*23.*	..	..	*19.*	..	..	*49.*	..	..	*17.*	..	..	*27.*
Rye straw	2	9	42	51	*46.*	17	25	*21.*	..	..	*32.*	35	38	*37.*	49	70	*60.*
Oat straw	4	8	48	56	*51.*	24	48	*41.*	20	49	*30.*	39	45	*46.*	55	64	*60.*
Barley straw	2	5	51	55	*53.*	17	24	*20.*	41	43	*42.*	51	57	*54.*	55	56	*56.*
Pea straw (very good)	1	2	..	..	*59.*	..	..	*61.*	..	..	*46.*	..	..	*64.*	..	..	*52.*
Bean straw*	1	3	..	..	*50.*	..	..	*51.*	..	..	*55.*	..	..	*63.*	..	..	*36.*
Lupine straw	1	2	..	..	*55.*	..	..	*37.*	..	..	*30.*	..	..	*65.*	..	..	*51.*

* The coefficients of wheat straw may also be applied to stover and those of bean straw to vetch straw.

the growing animal and cannot restore the waste and wear of those parts of mature animals, because they are of a very different nature. They contain no nitrogen, an element which enters into all the animal tissues (albuminoids) to the extent of some sixteen per cent. of their dry matter.

Fiber and the N.-free extract cannot restore the worn out muscles or membranes of the animal any more than coal can be made to renew the used-up packing, bolts, valves, flues and gearing of a steam-engine. Albuminoids are to the ox or the man what brass and iron are to the machine, the materials of construction and repair.

Fat, fiber and N.-free extract are, furthermore, to the animal very much what coal and fuel are to the steam-engine. Their consumption generates the power which runs the mechanism. Their burning (oxidation) in the blood of animals produces the results of life just as the combustion of coal in the fire-place of the steam-engine produces the motion and power of that machine.

There is, however, this difference between the engine and the animal: the former may be stopped for repairs, the latter may run at a lower rate, but if it be stopped it cannot resume work. Hence the repairs of the animal must go on simultaneously with its wastes. Therefore, the material of which it is built must admit of constant replacement, and the dust and shreds of its wear and tear must admit of escape without impeding action. The animal body is as if an engine were fed not only with coal and water, but with iron, brass and all the materials for its repair, and also is as if the engine consumed its own worn out parts, voiding them as ashes or as gas and smoke. Albuminoids or the blood- and tissue-formers are thus consumed in the animal, as well as the fat, fiber and N.-free extract or fuel proper. The fact that albuminoids admit of consumption implies that when the proper fuel is insufficient, they may themselves serve as fuel. Such is the case, in fact. But, nevertheless, the two classes of substances have distinct offices in animal nutrition, and experience has demonstrated, that for each special case of animal nutrition a special ratio of digestible albuminoids to digestible fat, fiber and N.-free extract is the best and most economical, and, within certain limits, is necessary. This proportion we designate as the *nutritive ratio*, and these explanations make its significance evident.

It is believed that the digestible parts of fiber and of N.-free extract (i. e., of starch, sugar, and gums), have about the same nutritive value, i. e. answer essentially the same purposes in the body. The fat, however, has a greater value, formerly assumed to be two and a half times that of fiber and N.-free extract. This assumption is not entirely justified by our present knowledge, yet for the sake of uniformity and to avoid confusion, that factor must be retained till a more satisfactory one is agreed upon.

The rule then to determine the nutritive ratio in any feeding stuff or ration is to add together the amounts of digestible fiber and N.-free extract, and the amount of digestible fat multiplied by $2\frac{1}{2}$ and divide that sum by the amount of digestible albuminoids.

To illustrate: the nutritive ratio of the wheat bran, whose digestible nutrients are given above, is calculated as follows:

Digestible fiber	2.95
" nitrogen-free extract	41.71
" fat ($2.58 \times 2\frac{1}{2}$)	6.45
	51.11

$51.11 \div 11.72$ (digestible protein) $= 4.36$

Thus the nutritive ratio of wheat bran is 1 : 4.36.

III. Feeding Standards.

In the last paragraphs a comparison has been made between the animal and a steam engine. It is evident that the engine must be fed with sufficient fuel of a kind adapted for use in its furnace, and besides this, to run it economically the amount of fuel and the rate of feeding it must be adapted to the work to be performed. If the engine is simply standing in readiness, with steam up, a very little fuel will do, if it is propelling a locomotive and approaching a steep grade with a heavy train the consumption of fuel must be enormously increased. The same holds with the animal machine: the amount of food must be suited to the performance required.

But the locomotive engine does a single kind of work; domestic animals on the contrary do several kinds—they produce beside animal heat, either flesh, milk, wool or muscular energy.

Not only is the total amount of food required for these various kinds of production different but, as experience proves, different proportions of the various digestible food-elements or nutrients are required to yield fat mutton than are needed to produce milk, or to sustain labor, or to keep the resting animal in fair condition;

and again the most suitable milk-producing ration is not the one best adapted for the growth of wool.

A careful observant feeder of cattle by long trial can ascertain with approximate correctness in what quantity and proportion he may most profitably use the feeding stuffs which are at his command.

Table of Feeding Standards.

A. Pounds per day per 1,000 pounds live weight.

Kind of animal.	Total organic matter.	Albuminoids or Protein.	Nitrogen-free extract and fiber.	Fat.	Total nutritive substances.	Nutritive ratio.
Horse at light work	21.0	1.5	9.5	0.40	11.40	1 : 7.0
" average work	22.5	1.8	11.2	0.60	13.60	1 : 7.0
" hard work	25.5	2.8	13.4	0.80	17.00	1 : 5.5
Oxen at rest in stall	17.5	0.7	8.0	0.15	8.85	1 : 12.0
" ordinary work	24.0	1.6	11.3	0.30	13.20	1 : 7.5
" hard work	26.0	2.4	13.2	0.50	16.10	1 : 6.0
Oxen fattening, first period	27.0	2.5	15.0	0.50	18.00	1 : 6.5
" " second "	26.0	3.0	14.8	0.70	18.50	1 : 5.5
" " third "	25.0	2.7	14.8	0.60	18.10	1 : 6.0
Milk Cows	24.0	2.5	12.5	0.40	15.40	1 : 5.4
Sheep, wool-producing (coarser breeds)	20.0	1.2	10.3	0.20	11.70	1 : 9.0
" wool-producing (finer breeds)	22.5	1.5	11.4	0.25	13.15	1 : 8.0
" fattening, first period	26.0	3.0	15.2	0.50	18.70	1 : 5.5
" " second "	25.0	3.5	14.4	0.60	18.50	1 : 4.5
Swine, fattening, first period	36.0	5.9	27.5		32.50	1 : 5.5
" " second "	31.0	4.9	24.0		28.00	1 : 6.0
" " third "	23.5	2.7	17.5		20.20	1 : 6.5
Growing Cattle.						
Age. Months. — Average live weight per head.						
2–3 — 150 pounds	22.0	4.0	13.8	2.0	19.8	1 : 4.7
3–6 — 300 "	23.4	3.2	13.5	1.0	17.7	1 : 5.0
6–12 — 500 "	24.0	2.5	13.5	0.6	16.6	1 : 6.0
12–18 — 700 "	24.0	2.0	13.0	0.4	15.4	1 : 7.0
18–24 — 850 "	24.0	1.6	12.0	0.3	13.9	1 : 8.0
Growing Sheep.						
5–6 — 56 pounds	28.0	3.2	15.6	0.8	19.6	1 : 5.5
6–8 — 67 "	25.0	2.7	13.3	0.6	16.6	1 : 5.5
8–11 — 75 "	23.0	2.1	11.4	0.5	14.0	1 : 6.0
11–15 — 82 "	22.5	1.7	10.9	0.4	13.0	1 : 7.0
15–20 — 85 "	22.0	1.4	10.4	0.3	12.1	1 : 8.0
Growing Pigs.						
2–3 — 50 pounds	42.0	7.7	30.0		37.5	1 : 4.0
3–5 — 100 "	34.0	5.5	25.0		30.0	1 : 5.0
5–6 — 125 "	31.5	4.3	23.7		28.4	1 : 5.5
6–8 — 170 "	27.0	3.4	20.4		23.8	1 : 6.0
8–12 — 250 "	21.0	2.5	16.2		18.7	1 : 6.5

TABLE OF FEEDING STANDARDS—*Continued.*

B. POUNDS PER DAY PER HEAD.

KIND OF ANIMAL.		Total organic matter.	Albuminoids or Protein.	Nitrogen-free extract and fiber.	Fat.	Total nutritive substances.	Nutritive ratio.
GROWING CATTLE.							
Age. Months.	Average live weight per head.						
2–3	150 pounds	3.3	0.6	2.1	0.30	3.00	1 : 4.7
3–6	300 "	7.0	1.0	4.1	0.30	5.40	1 : 5.0
6–12	500 "	12.0	1.3	6.8	0.30	8.40	1 : 6.0
12–18	700 "	16.8	1.4	9.1	0.28	10.78	1 : 7.0
18–24	850 "	20.4	1.4	10.3	0.26	11.96	1 : 8.0
GROWING SHEEP.							
5–6	56 pounds	1.6	0.18	0.87	0.045	1.095	1 : 5.5
6–8	67 "	1.7	0.17	0.85	0.040	1.060	1 : 5.5
8–11	75 "	1.7	0.16	0.85	0.037	1.047	1 : 6.0
11–15	82 "	1.8	0.14	0.89	0.032	1.062	1 : 7.0
15–20	85 "	1.9	0.12	0.88	0.025	1.047	1 : 8.0
GROWING PIGS.							
2–3	50 pounds	2.1	0.38	1.50		1.88	1 : 4.0
3–5	100 "	3.4	0.50	2.50		3.00	1 : 5.0
5–6	125 "	3.9	0.54	2 96		3.50	1 : 5.5
6–8	170 "	4.6	0.58	3.47		4.05	1 : 6.0
8–12	250 "	5.2	0.62	4.05		4.67	1 : 6.5

mand. His results may be adopted by his neighbors with profit provided that their feeding materials are of the same kind and of the same quality, but if their feed is different, if one is using early cut hay, the other late cut hay, if one uses corn meal, the other wheat bran, if one has mangolds at his disposal, the other not, then the valuable experience of the one is of comparatively little use to the other. Some common standard of comparison is necessary in order to make the experience of one readily available for others. The best means of comparison as yet realized, is furnished by the table of Feeding Standards taken in connection with the other tables which have been already explained.

This Table expresses the average result of many carefully conducted experiments with cattle in which the quantity of the food used and the material produced by the animals, whether beef, milk or wool, were all accurately and repeatedly determined. The table involves no guess-work or speculation, but is to be regarded simply as a convenient and concise way of expressing the general results of the best practical experience in feeding cattle. Like all such general statements it must be used intelligently to be of any

value. The special circumstances of the feeder, the ruling prices of the different articles of feed used, the individual peculiarities of his stock, all have to be considered and all may have a modifying effect on the composition or effect of the ration.

These tables and explanations are not substitutes for common sense or experience in feeding, but are helps to them.

A single example may here be given to illustrate the method of using the tables:

There are available for feeding a herd of milk cows, a rather short allowance of Timothy hay, plenty of wheat straw and turnips, while brewers' grains can be got fresh daily at a low price. It is first to be determined about how much digestible matter these feeding stuffs contain. From the Table of Average Composition, their probable percentage amount of albuminoids, fat, etc., can be learned, and from the Table of Digestibility is found what proportion is to be regarded as digestible. The calculation is as follows:—

	Pounds per hundred.		Per cent. digestible.		Pounds per hundred digestible.
TIMOTHY HAY.					
Organic matter*	84.87				
Albuminoids	6.02	×	57†	=	3.43
Fat	2.16	×	48	=	1.04
N.-free Extract	45.82	×	62	=	28.41
Fiber	30.89	×	58	=	17.91
WHEAT STRAW.					
Organic matter	86.54				
Albuminoids	4.98	×	17	=	.84
Fat	1.49	×	36	=	.53
N.-free Extract	41.99	×	39	=	16.37
Fiber	38.08	×	56	=	21.32
TURNIPS.					
Organic matter	10.40				
Albuminoids	1.34	×	57	=	.77
Fat	.09‡				.09
N.-free Extract	8.11	×	89	=	7.22
Fiber	.86‡				.86
BREWERS' GRAINS.					
Organic matter	23.98				
Albuminoids	5.57	×	73	=	4.06
Fat	1.68	×	84	=	1.41
N.-free Extract	12.86	×	64	=	8.23
Fiber	3.87	×	39	=	1.51

* Dry matter less the ash.
† These are the digestion coefficients of medium meadow hay.
‡ Regarded as wholly digestible.

The Table of Feeding Standards gives as the average daily ration for milk cows—*per* 1000 *pounds live weight*:—

Total Organic matter	24.0	pounds.
Digestible Albuminoids	2.5	"
" N.-free Extract*	12.5	"
" Fat	0.4	"
Nutritive ratio	1 : 5.4	"

* Including digestible fiber.

A few preliminary calculations may bring us to something like the following ration :—

	Organic matter, pounds.	Albuminoids, pounds.	Fat, pounds.	N.-free Extract pounds.	Fiber, pounds.
9 pounds hay, containing digestible,	7.6	.31	.09	2.56	1.61
10 " straw, " "	8.7	.08	.05	1.64	2.13
20 " turnips, " "	2.1	.15	.02	1.44	.17
20 " brewers' grains, "	4.8	.81	.28	1.64	.30
Total,	23.2	1.35	.44	7.28	4.21

Comparing this ration with the Standard it has a little less organic matter, over one pound less albuminoids and nitrogen-free extract (7.28+4.21=11.49), and the nutritive ratio is quite wide, viz. 1 : 9.3. Perhaps the ration under some circumstances might be economical. It needs the addition of some concentrated feed rich in albuminoids and N.-free extract, but poor in fat. Looking over the table of average composition of feeding stuffs, new process linseed meal seems to answer that description.

Calculating the amount of digestible food in it as in the cases just given it appears that four pounds of it will bring the digestible albuminoids of the ration up to the Standard.

	Organic matter.	Albuminoids.	Fat.	Extract.	N.-free Fiber.
Already in the ration	23.2	1.35	.44	7.28	4.21
4 pounds new process linseed meal	3.3	1.08	.11	1.12	
Total	26.5	2.43	.55	8.40	4.21
				12.61	
Feeding Standard	24.0	2.50	.40	12.50	

In this ration we have 2.5 pounds more organic matter and $\frac{1}{6}$ pounds more digestible fat than the Standard calls for, while digestible albuminoids and nitrogen-free extract agree quite closely with the Standard. The nutritive ratio is 1 : 5.8.

It will be observed that the ration is calculated for 1000 *pounds live weight* and must be brought to correspond with the weight of the cows.

Analyses of Feeding Stuffs.

Buckwheat Mill Products.

The three following samples were sent by the Quinnebaug store, Danielsonville. They are stated to represent the products of a new milling process there in operation.

CCXII. Buckwheat Hulls.
CCXIII. Buckwheat Bran or Middlings.
CCXV. Buckwheat Flour.

	Buckwheat Hulls. CCXII.	Buckwheat Middlings. CCXIII.	Buckwheat Flour. CCXV.
Water	14.07	16.33	17.63
Ash	2.27	5.50	.83
Albuminoids or Protein	4.87	30.31	8.13
Fiber	38.49	4.02	.52
Nitrogen-free extract	39.20	36.29	71.10
Crude Fat	1.10	7.55	1.79
	100.00	100.00	100.00

The Hulls have very little feeding value, considerably less than wheat or rye straw. The digestibility of their albuminoids is probably less than that of straw. As regards its chemical composition the Flour is of superior quality. The bran or Middlings is remarkable, being a much more concentrated food than wheat bran and more nearly resembling gluten meal or linseed meal in its content of albuminoids or protein and fat. It should be used at first with great caution, but may prove to be an excellent feed if produced in sufficient quantity.

Oat Feed.

CCXXXV. Oat feed. Sampled and sent by Benj. F. Case, Canton Center.

Mr. Case says: "It is said to be the product of an oatmeal mill where they can use none but strictly No. 1 oats that are perfectly sweet, which are thoroughly cleaned and dried before crushing. I consider it one of the economical feed stuffs to make up a ration for horses, milk cows and young calves."

The analysis shows that this material has about $1\frac{1}{3}$ per cent. more of albuminoids, a per cent. more of fat, $3\frac{1}{2}$ per cent. more fiber and 4¾ per cent. less nitrogen-free extract than average oats. If wholly made from clean oats the digestibility should not be less than that of oats. [For ash analysis see pages 117 and 118.]

Barley Feed.

CCXXXI. A by-product in the manufacture of Pearl Barley. Sampled and sent by B. F. Case, Canton Center.

	Oat Feed. CCXVII.	Barley Feed. CCXXXI.
Water	8.19	13.20
Ash	4.24	4.25
Albuminoids or Protein	12.64	11.94
Fiber	12.48	7.98
Nitrogen-free Extract	56.31	59.38
Crude Fat	6.14	3.25
	100.00	100.00

The Buckhorn Fern. [*Osmunda regalis*, L.]

CCXVI. This sample (2 pounds) was sent by L. J. Platts, Esq., Deep River, who says in regard to it, "It is known here as the buckhorn or broad leaf brake. Of all products of swamp land cattle will eat this with the greatest relish when cured as hay, picking out every leaf before eating much of the bog hay. It is probably the only fern they eat much of. Sheep will eat most varieties to some extent. It grows to a considerable extent in most swamps mixed with bog and other grasses." This sample was cut about the middle of August, and consisted entirely of sterile fronds.

As far as chemical analysis can indicate, the fern is equal to good meadow hay in composition, but it should be remembered that chemical analysis alone does not positively determine the feeding value.

	Fern. (Osmunda regalis.)
Water	14.56
* Ash	6.09
Albuminoids or Protein	10.24
Fiber	21.60
Nitrogen-free Extract	45.10
Crude Fat	2.41
	100.00

* For analysis of the ash, see pages 117 and 118.

Wheat Bran.

CCXXXVIII. Sent by Joshua Lyon, Greenwich. Cost $17.00 per ton by the car load. Bought of Young, Tripp & Co., White Plains, N. Y.

Cotton Seed Meal.

CCXXIII. Sent by E. F. Thompson, Warehouse Point.

Gluten Meal.

CCXXIV. Bought by the Station from Betts & Alling, New Haven, for feeding experiments. Cost, $1.25 per 100 pounds.

ANALYSES.

	CCXXXVIII. Wheat Bran.	CCXXIII. Cotton Seed Meal.	CCXXIV. Gluten Meal.
Water	12.48	7.95	12.29
Ash	6.60	6.96	.66
Albuminoids or Protein	15.06	44.00	29.47
Crude Fiber	8.48	4.10	.97
Nitrogen-free Extract	53.20	21.93	50.62
Crude Fat	4.18	15.06	5.99
	100.00	100.00	100.00

HAY.

CCXXX. Oat Hay sent by B. F. Case, Canton Center.

CCXXXIX. Hay from North Haven. Clear Timothy and Red Top, apparently in about equal proportions. Cut in bloom.

CCXXV. Baled hay. Bought by the Station in New Haven as "*Extra Timothy*" at $22.00 per ton. Sample drawn from a lot of 600 pounds which had been cut in two inch lengths. It was a mixture of all kinds of hay containing clover, timothy, red top, blackberry bushes and some coarser bushes, and considerable dirt, which in one case was noticed to be near the middle of the bale while generally the bales were "faced" with clean timothy.

ANALYSES.

	Oat Hay. CCXXX.	Timothy and Red Top. CCXXXIX.	Baled Hay. CCXXV.
Water	13.78	18.90	15.95
Ash	6.31	4.11	3.93
Albuminoids	7.99	4.97	6.20
Fiber	33.62	25.41	26.60
Nitrogen-free extract	36.23	44.22	45.13
Crude Fat	2.07	2.39	2.19
	100.00	100.00	100.00

Analysis of Florida Oranges.

A considerable number of Connecticut citizens are interested in orange growing in Florida and from time to time inquiries have been made as to the requirements of that crop which could not be satisfactorily answered from the data at hand.

The subjoined analysis of a fine sample of orange fruit gathered in its best condition about the first of January and furnished by Mr. T. W. T. Curtis of New Haven from his grove in Florida, has been made in order to ascertain what is carried off the land in the orange crop. The analysis includes the whole fruit as it comes into market.

Water (with some volatile oil) expelled at 212°	85.29
Organic and volatile matter (lost at low red heat)*	14.27
Ash (reckoned free from carbon and carbonic acid)	.44
	100.00

* Containing nitrogen .14.

The ash analysis is as follows: For comparison is given an analysis of the ash of oranges from "St. Michaels Island" (Wolff's Aschen-Analysen, 1871, p. 124.)

The ash contains—

	Florida.	St. Michael's Island.
Potash	56.44	38.72
Soda	1.81	7.64
Lime	18.70	22.99
Magnesia	4.72	6.55
Oxide of iron	.50	.92
Phosphoric acid	13.28	14.99
Sulphuric "	4.15	2.95
Silica	.40	5.24
	100.00	100.00

The oranges in a single box exclusive of the case and packing weighed 64.5 pounds. The yield per acre was 100 boxes or 6450 pounds of fruit. The export per acre in this crop is accordingly as follows:

Nitrogen	9.2	pounds.
Potash	16.0	"
Soda	0.5	"
Lime	5.3	"
Magnesia	1.4	"
Oxide of iron	0.1	"
Phosphoric acid	3.8	"
Sulphuric acid	1.2	"
Silica	0.1	"

The oranges were quite uniform in size and weight. The total number in the box was 112, and their average weight was $9\frac{1}{5}$ ounces.

Analysis of Asparagus.

Nine bunches of asparagus bought in New Haven market weighed 7 pounds 6 ounces. The asparagus contained .37 per cent. of nitrogen. (58.1 per cent. of the nitrogen present was albuminoid-nitrogen and 18 per cent. of it amide-nitrogen.) The composition of the ash is given in the following tables on pages 117 and 118:

A ton of asparagus would take from the land about

6	pounds of	potash.
2.6	"	phosphoric acid.
7.4	"	nitrogen.

Ash Analyses of Feeding Stuffs.

The following analyses have been made at this Station* by Mr.

* The method of ash analysis followed by Mr. Winton is as follows: A known weight of the substance to be analyzed is burned, at as low a heat as possible—in no case as high as a red heat—in a platinum dish over a suitable burner. The burning may require from one to several days' time. During this time it should not be stirred, but near the close of burning the thin layer of char on the surface may be stirred in and the heat continued a little longer. The ash is then thoroughly mixed and pulverized in the dish, weighed and bottled.

Ten grams of the ash are digested on the water bath with dilute hydrochloric acid [one volume of pure concentrated acid with one of water], for one to two hours and the insoluble residue of sand, silica and charcoal is collected on a weighed filter, dried at 100° C. and weighed. The filter paper and charcoal are burned off in a platinum crucible and the sand and silica are weighed together. The difference between this weight and the last represents the charcoal. Sand is separated from silica by boiling repeatedly with a solution of pure sodium hydrate as strong as can be filtered without injuring the paper. When the filtrate no longer contains silica the residue, consisting of sand, and filter is washed with dilute hydrochloric acid and water, ignited and weighed. From the filtrate which contains the soluble portion of the ash, silica is separated and determined in the usual way and added to that already found as above. The solution of the ash, free from silica, is then made up to 1000 c.c. In one portion of 100 c.c. bases are determined as follows:

The solution, nearly neutralized with ammonium hydrate, is heated to about but not above 50° C. 3 c.c. of acetic acid and ammonium acetate in sufficient quantity are added and the solution is vigorously stirred. When the precipitate of iron phosphate has settled it is filtered, washed with water containing a little ammonium acetate, ignited and weighed. In one precipitate thus obtained, phos-

Winton to determine the manurial value of certain foods, at the request of persons who were using them. The figures given denote pounds per 100 pounds of the feed.

The percentage composition of the ash itself is as follows:

phoric acid is determined with ammonium molybdate and in a duplicate iron is estimated with potassium permanganate after solution and reduction with sulphuretted hydrogen. The sum of the iron-oxide and phosphoric acid is generally a little less than the weight of the first precipitate. The difference, if not within the limits of analytical error is due to silica which escaped separation, or to a trace of alumina. Lime is determined in the filtrate from the iron phosphate by precipitation as calcium oxalate which is ignited and weighed as calcium oxide. In the filtrate from the lime, phosphoric acid is usually present in more than sufficient quantity to combine with all the magnesia. This latter is therefore precipitated by adding ammonium hydrate to slight alkaline reaction. After vigorous stirring and standing for half an hour, ammonium hydrate is added in sufficient quantity to make up one-fourth of the final volume. After standing from four to six hours the precipitate is collected and treated as usual for determining magnesia. Most of the free ammonia is evaporated from the filtrate, magnesia mixture is added and the remaining phosphoric acid is determined. The total phosphoric acid will be the sum of that which was in the iron phosphate precipitate, that which was obtained in determining magnesia, and that precipitated last with magnesia mixture. If phosphoric acid is not present in excess over magnesia, it can be determined in the precipitate obtained with barium hydrate in the determination of the alkalies. From a second portion of the original solution, after removing nearly all of the free acid by evaporation, sulphuric acid is separated as barium sulphate. The alkalies are determined in the same solution after removing the other bases by barium hydrate and ammonium carbonate. If much magnesia is present this separation must be repeated after removing the ammonia-salts by ignition. After weighing the alkalies as chlorides, potassium is thrown down as potassium-platinum chloride. Chlorine is determined gravimetrically in the nitric acid solution of a portion of the ash. Carbonic acid is estimated with the apparatus devised by Wells and described in the last American edition of Fresenius' Quant. Analysis, 1882, page 415.

Water, Nitrogen and Ash-Ingredients in 1000 pounds of

	Water.	Nitrogen.	Ash.	Potash.	Soda.	Lime.	Magnesia.	Oxide of Iron	Phosphoric Acid.	Sulphuric Acid.	Chlorine.	Sand and Silica.
Winter Wheat Middlings CXCV	127.3	28.2	36.3	10.02	.64	.33	4.27	....	20.48	.90	....	.49
Wheat Middlings CCXXXVI	133.3	25.4	40.3	12.19	.32	.96	5.84	.17	19.70	.26	....	.84
Winter Wheat Bran CXCVIII	133.5	26.4	57.1	16.23	1.36	.25	5.74	....	32.66	.72	....	.18
Wheat Bran CCXXXII	136.0	24.8	42.2	12.33	.62	.79	6.58	.15	20.78	.34	.07	.54
Rye Bran CCXXXIV	122.3	25.3	32.2	10.20	.13	.86	4.21	.05	15.78	.20	....	.74
Corn Meal CCXXXIII	140.7	13.2	13.2	3.86	.14	.07	1.91	.11	6.22	.21	.01	.64
Oat Feed CCXXXV	97.6	22.5	36.6	6.60	.23	1.10	2.96	.22	11.07	.68	.04	13.74*
Hay CCXI	120.1	9.8	38.3	13.13	.29	5.57	2.61	1.55	2.98	1.23	.30	10.64
Buckhorn Fern [*Osmunda regalis*]	145.6	16.4	58.6	13.68	.69	5.05	4.45	....	1.46	3.32	3.18	27.42
Asparagus	929.7	3.7	5.9	3.02	.07	.26	.23	.06	1.31	.47	.52	.07
Florida Oranges	852.9†	1.4	4.4	2.49	.08	.82	.21	.02	.58	.18	....	.02

* 12.67 of soluble silica.

† Including some volatile oil.

Percentage Composition of Ash.

	Wheat Middlings. CXCV.	Wheat Middlings. CCXXXVI.	Wheat Bran. CXCVIII.	Wheat Bran. CCXXXII.	Rye Bran. CCXXXIV.	Corn Meal. CCXXXIII.	Oat Feed. CCXXXV.	Hay. CCXI.	Buckhorn Fern, [Osmunda regalis.]	Asparagus.	Florida Oranges.
Potash	27.39	30.20	27.98	29.32	31.33	29.29	17.89	34.41	23.31	51.37	56.44
Soda	1.81	.72	3.67	.61	.42	1.06	.64	.77	1.21	1.16	1.81
Lime	.95	2.34	.16	1.88	2.68	.53	3.01	14.54	8.60	4.32	18.70
Magnesia	12.18	14.76	10.04	15.68	13.18	14.53	8.07	6.81	7.68	3.90	4.72
Oxide of Iron	trace.	.44	trace	.34	.16	.86	.62	4.04	trace	1.02	.50
Phosphoric Acid	55.98	48.81	56.42	49.98	49.28	47.14	29.89	7.78	2.64	22.17	13.28
Sulphuric Acid	.27	.65	1.26	.80	.62	1.64	1.85	3.22	5.65	8.04	4.15
Chlorine	----	trace	----	.11	trace	.07	.12	.79	5.42	8.75	----
Sand and Silica	1.42	2.08	.47	1.28	2.33	4.88	37.91	27.80	46.74	1.23	.40
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.16	101.15	101.96	100.00
Deduct Oxygen Equivalent to Chlorine								.16	1.15	1.96	
								100.00	100.00	100.00	

Milk Analyses.*

The following analyses† have been made of the milk of selected cows in the herd of Hon. T. S. Gold, of West Cornwall. When the samples were taken, in June and in October, the cows were on pasture, and had no other feed. During the day they had a range of seventy-five acres, and at night of some five acres. They were driven night and morning about fifty rods to and from pasture. The samples were taken by Mr. Farrington, of the Station, immediately after the milking which was done in his presence, and he also weighed the milk on scales provided by the Station. The time of milking was 6 P. M. and 5 A. M. All the figures given are the average of duplicate determinations which in general agreed very closely. Rejecting the milk of the two Holsteins, Keiser 3d, and Sneeker 4th, the results may be briefly summarized as follows:

	Milk of Individual Cows. June.	Milk of Individual Cows. October.	Mixed milk of the herd as sent to market. June. Night.	June. Morning.	October. Night.	October. Morning.
Average Solids	13.30	13.62	13.23	13.05	13.84	13.31
Maximum "	14.53	14.94				
Minimum "	11.95	12.38				
Average Fat	4.11	4.56	4.15	3.91	4.61	4.01
Maximum "	5.04	5.51				
Minimum "	3.42	3.50				

In a single case the total solids were less than 12.0 per cent. The mixed milk of the herd is of excellent quality.

Ewkahn, a full blood Ayrshire 4 years old, calved on Oct. 4th. On the evening of the 6th and morning of the 7th of Oct. her milk, or more properly, colostrum, had the following composition:

	Evening.	Morning.
Solids	16.32	15.04
Fat	6.03	4.61
Casein [Nitrogen × 6.25]	4.37	4.63

The difference between the first milk drawn and the strippings is seen from the following tests made in June on the milk of Brindle, a grade Ayrshire, 10 years old, who calved in March.

	Evening. First quart milked.	Evening. Last quart milked.	Morning. First Milk. About ½ pint from a single teat.	Morning. Strippings.
Solids	10.82	17.24	9.86	16.38
Fat	1.22	8.48	.61	7.63
Casein [Nitrogen × 6.25]	3.88	3.69	3.69	3.38

* See note on page 139. † See pages 120–123.

T. S. Gold's Herd—Tests made June 11th and 12th, 1886.

Breed.	Names.	Age. Years.	When calved.	Time of milking.‖	Weight of milk.	Solids.	Fat.	Casein. [Nitrogen × 6.25.]
Holstein	Keiser 3d, No. 4696. H. Herd Book	3	March.	N.	13 lbs.–7 oz.	11.40	2.89	3.50
Holstein	Truie,‡ No. 5749. "	3	March.	N.	14–15½	13.32	3.78	4.00
Holstein	Sneeker 4th, No. 4695. "	3	March.	N.	13–0	11.30	3.56	2.88
Holstein	Sneeker 4th, No. 4695. "	3	March.	M.	12–2	10.42	1.48	2.86
Ayrshire†	Bessie	9	April.	N.	16–8	12.55	3.60	
Ayrshire†	Short-legged Ayrshire	4	April.	N.	11–13½	12.71	3.47	3.63
Ayrshire†	Short-legged Ayrshire	4	April.	M.	11–15	13.04	3.64	3.58
Ayrshire†	Belle of Cream Hill	14	Dec.	N.	10–4½	12.92	3.48	4.32
Grade Ayrshire	Black	8–9	----	N.	10–11	12.81	4.01	
" "	Lillie	6	Jan.	N.	10–8	13.56	3.97	
" "	Cherry	10	April.	N.	13–12	12.53	3.85	3.19
" "	Pride of America	8	April.	N.	17–0	13.88	5.04	3.50
" "	----------	3	10 days ago‡	N.	15–12	13.78	4.21	4.29
" "	Louisa	6	Feb.	N.	13–1	12.87	3.82	3.87
" "	Bobtail	6	Sept. 1885.*	N.	8–15½	14.57	4.79	2.76
" "	Rubber teat	10	March.	N.	18–1	13.53	4.48	3.38
" "	Rubber teat	10	March.	M.	17–2	13.53	4.52	3.72

* Due in September, 1886. † Full blood, but not registered. ‡ First calf. ‖ N., night; M., morning.

T. S. Gold's Herd—Tests made June 11th and 12th, 1886.

Breed.	Names.	Age. Years.	When calved.	Time of milking.‖	Weight of milk.	Solids.	Fat.	Casein. [Nitrogen × 6.25.]
Grade Ayrshire	Bug Horn	10	February.	N.	14 lbs.–5 oz.	12.44	3.47	3.25
" "	Excelsior	10	March.	N.	17–5	13.07	4.18	3.61
" "	Excelsior	10	March.	M.	15–1	13.39	4.55	3.38
" "	Curly Head	5	March.	N.	15–14	13.11	4.13	3.91
" "	Mattie	4	Sept. 1885.*	N.	6–13	13.91	4.36	4.28
" "	Dolly Varden	12	May.	N.	18–11½	12.70	4.62	3.88
" "	Dolly Varden	12	May.	M.	12–1	11.95	3.42	3.75
" "	Josie	4	Aug. 1885.	N.	7–8	14.37	4.37	4.69
" "	Beauty	9	February.	N.	8–6	13.63	4.21	3.72
" "	Three teat	7	April, 1885.	N.	6–0	14.52	4.85	3.81
" "	Three teat	7	April, 1885.	M.	5–5	14.49	4.51	4.13
" "	Brindle	10	March.	M.	13–13½	12.64	3.47	3.57
	Sample of the mixed night's milk of the whole herd (40 cows), taken from six 40-quart cans					13.23	4.15	3.68
	Sample of mixed morning's milk of whole herd (40 cows), taken from five 40-quart cans					13.05	3.91	3.81

* Due in September, 1886. ‖ N., night; M., morning.

T. S. Gold's Herd—Tests made October 7th and 8th, 1886.

Breed.	Name.	Age. Years.	When calved.	Time of milking.†	Weight of milk.	Solids.	Fat.	Casein. [Nitrogen × 6.25.]
Holstein	Keiser 3d, No. 4696	3	March.	N.	8 lbs.-4 oz.	11.18	3.28	2.97
"	" 3d, No. 4696	3	"	M.	8-4	10.64	1.37	2.84
"	Truie, No. 5749	3	"	N.	6-7	14.53	5.12	3.56
"	" No. 5749	3	"	M.	8-8	14.03	4.71	3 69
"	Sneeker 4th, No. 4695	3	"	N.	6-6½	11.62	3.57	3.15
"	" 4th, No. 4695	3	"	M.	8-1	10.97	2.88	3.00
Ayrshire*	Bessie	9	April.	N.	8-4	13.88	4 97	3.44
Ayrshire*	Short legged Ayrshire	4	"	N.	6-10	13.60	4.44	3.28
Ayrshire*	Belle of Cream Hill	14	December.	N.	6-12	14.33	4.85	3 75
Grade Ayrshire	Black	8-9	May.	N.	6-4	13.47	4.59	3.47
" "	Cherry	10	April.	N.	9-9	12.48	3.99	3.06
" "	Rubber teat	10	March.	N.	8-11	13.87	5.28	3.37
" "	" "	10	"	M.	10-11	12.86	3.93	3.47
" "	Excelsior	10	"	N.	7-3	14.44	5.08	3.50
" "	"	10	"	M.	10-11	13.18	4.05	3.32
" "	Curly Head	5	"	N.	7-11	14.12	4.51	3.44

* Full blood but not registered.

† N. night; M. morning.

T. S. Gold's Herd—Tests made October 7th and 8th, 1886—*Continued.*

Breed.	Name.	Age. Years.	When calved.	Time of milking.†	Weight of milk.	Solids.	Fat.	Casein. [Nitrogen × 6.25.]
Grade Aryshire	Mattie	4	September.	N.	4lbs.-14oz.‡	13.19	4.18	3.37
" "	Dolly Varden	12	May.	N.	9-11	12.90	4.56	3.25
" "	"	12	"	M.	11-10	12.38	3.75	3.34
" "	Beauty	9	February.	N.	7-1	14.94	5.51	3.72
" "	"	9	"	M.	8-8	13.64	4.15	3 56
" "	Brindle	10	March.	N.	9-0	13.36	4.00	3.53
" "	"	10	"	M.	10-8	12.82	3.50	3.41
Ayrshire*	Ewkahn	4	October 4.	N.	9-1	16.32	6.03	4.37
"	"	4	October 4.	M.	13-0	15.03	4.61	4 63
Grade Ayrshire	Amy	2	3 wks. ago.	N.	8-5	14.08	4.87	3.31
" "	Strawberry	8	May.	N.	9-0	13 63	4 64	3.41
" "	"	8	"	M.	10-8	14.02	4.60	3.53
	Sample of mixed night's milk of whole herd (40 cows)	--	----	--	----	13.84	4.61	
	Sample of mixed morning's milk of whole herd (40 cows)	--	----	--	----	13.31	4.01	

* Full blood but not registered.

† N. night; M. morning.

‡ Nearly dry.

A similar trial in October gave:

	First of Milking.	Strippings.
Solids	11.08	16.27
Fat	1.79	7.55
Casein [Nitrogen × 6.25]	3.53	3.37

It will be noticed that the solids and fat in the milk of one of the Holsteins, Truie, were slightly below the average of the herd in June and considerably above the same average in October, while the solids and fat in the milk of the other Holsteins, Keiser 3d, and Sneeker 4th, who calved about the same time as Truie and whose total milk-yield was not very different, were below the average of the herd both in June and October.

The result merely shows that at these particular times two of the Holsteins were giving milk which, judged by its analysis, was of poor quality. It does not prove that either of these cows is generally a thin milker.

Samples of the milk of Keiser 3d, taken Dec. 27, were of better quality. The total weight of the night's milk was 4 lbs. and 7 oz. The morning milk weighed 8 lbs. and 5 oz. The composition of the milk was as follows:

	Keiser 3d, Morning.	December 27, Night.
Total Solids	11.81*	13.11
Fat	3.19	4.06
Casein, [Nitrogen × 6.25]	3.38	3.56
Sugar	4.03	4.61
Ash	.70	.72
Specific Gravity	1.031	

The feed of the cows at this time was good hay twice a day as much as they would eat or fodder corn [rather poor] and four quarts of mixed feed (new process linseed meal and wheat middlings), and one peck of mangolds.

The variations which may be found at any given time in the quality of milk of single cows of the same breed have been illustrated in previous reports. Thus the average composition of the milk of 10 Ayrshires in the herd of S. M. Wells, Esq., of Wethersfield was:

* It will be noticed that the sum of the fat, casein, sugar and ash obtained by direct determination is less than the total solids, directly determined, in one case by .51, in the other by .16 per cent. If the factor 6.4 is used in reckoning casein from the nitrogen, which is unquestionably more correct, the differences will then be .43 and .07 per cent.

Solids	12.55 per cent.
Fat	3.91 "

But the milk of one of the cows had only 11.27 per cent. of solids, while that of another had 12.77, a difference of 1.5 per cent. The fat varied between 3.17 and 4.30 per cent.

The average composition of the milk of 7 Guernseys in the herd of E. Norton, Esq., of Farmington, was:

Solids	14.93
Fat	5.34

But the solids in the milk of individual cows varied by 4.3 per cent., from 12.81 to 17.15 per cent., and the fat from 4.0 to 6.17 per cent.

Other facts which go to explain the quality of the Holstein milk in this case are stated by Mr. Gold as follows:—

"While the Holsteins are larger they are less combative than the Ayrshires. As the Ayrshires were all raised on the farm they naturally herd together and after two years the three Holsteins rather keep by themselves when they can, and are in the position of underlings or strangers in the herd, which condition is not favorable to the best or highest milk production. My experience formerly in bringing in a few strange cows has led me to expect this difficulty. I am now raising Holstein grades. In them the Ayrshires will find their match and will learn to tolerate and respect black and spotted cattle."

Similar facts have been brought to the notice of the Station before, and it is well established that any kind of worry has a very marked influence on the quality of milk. The improved milk of Keiser 3d, on stall feeding is perhaps partly due to her greater freedom from persecution by the other cows.

Notes on Milk-analysis.*

Determination of Total Solids.—The method employed at this Station is to bring 5 grams of the milk into a small porcelain capsule of 1½ inch diameter, containing a small stirring rod and 15–20 grams of perfectly dry pulverized quartz ("glass sand"). The total weight of the capsule, rod and sand are previously determined. Our capsules and rods are of such weight that in every case we add sand till the total weight is exactly 40 grams.

* The experiments under this head have been carried out by Mr. Farrington of this Station.

After the milk has been weighed in, the capsules are placed over a water bath and the contents are frequently stirred till the sand and milk set and cannot be longer stirred without danger of mechanical loss. After standing from 1–1½ hours on the bath, they are placed for an hour in a drying oven which has a temperature a little below 100° C. They are then cooled and weighed and again dried until the weight is practically constant, i. e. till the loss after an hour's drying is not more than five hundreths of one per cent.

Duplicate analyses show very close agreement and the method has been most carefully compared by Schmœger* with the result obtained by drying in hydrogen, which latter method must be regarded as theoretically more nearly perfect than any other. The results by these two methods agreed within about one tenth per cent., being slightly higher by the sand method.

The English Society of Public Analysts in March of the present year agreed on the following method: "Total Solids. These to be estimated by evaporating in a platinum dish about 5 grams of milk. The residue to be dried to practical constancy at the temperature of a water oven or water bath."

The Association of Public Analysts of New York have adopted essentially the same process (only finishing the drying at 105° C.) and it is commonly referred to as "Waller's method," being a modification of the method originally proposed, we believe, by Wanklyn.

The following trials have been made to compare our present method with the method above described of the English Analysts' Association. The form of dish is not stated and would perhaps have an effect on the results. The platinum dishes used here were flat bottomed, two inches square and five-eighths of an inch deep. Five grams of milk were used in each trial.

TOTAL SOLIDS.

No. of sample.	I.†	II.	III.	IV.	V.	VI.	VII.	VIII.
Station method	23.87 23.86	14.73 14.54	13.30	12.66 12.68	12.47	12.21	12.20 12.23	11.85 11.89 11.86
Analysts' method	23.77	14.69 14.70	13.36	12.73	12.65	12.33	12.25 12.23	

	IX.	X.	XI.	XII.	XIII.
Station method	9.26 9.29	11.99 11.94 11.99 11.98	10.00 9.98	8.35	7.69
Analysts' method	9.29	12.01 12.01	10.02 10.03	8.35	7.71

* Pflüger's Archiv., xxxi, 1883.

† Cream.

The following results were on a sample which had been kept two weeks in the laboratory previous to analysis. It was coagulated and very sour but not putrid. The weighing was made in a small covered beaker and the clotted milk was stirred immediately before each portion was poured out.

TOTAL SOLIDS.

	Station Method.	Analysts' Method.
No. 1	12.21	
No. 2	12.06	
No. 3		12.09
No. 4		12.03
No. 5	11.94	
Average	12.07	12.06

The comparisons show that the results by the two methods agree within the limits of experimental error. The English Analysts' method is the more convenient when it is simply desired to learn the amounts of water and total solids. The sand-method is better when an accurate fat determination is subsequently to be made.

Determination of Fat.

It has been proposed to determine fat indirectly by exhausting with ether or benzine the Total Solids as obtained by the English Analysts' method, and weighing the residue remaining from this treatment.

In the trials of this plan made here a light (petroleum) benzine, furnished by the Maverick Oil Co., of Boston, was used, which left no residue on evaporation. The dish with the Total Solids was half filled with benzine, heated to boiling in the oven and decanted off. This treatment was repeated six times and then the dish and contents were thoroughly dried and weighed.

The method usually employed at this Station is to remove the sand and dry residue from the capsule used in the Total Solids determination, pulverize it finely, bring it into a continuous extractor and wash with hot absolute ether for at least three hours, we prefer four or five hours. The ether extract is received in a weighed flask, the ether is distilled off and the fat dried in the steam oven to a constant weight. Following are the results of comparative determinations made by the two methods.

FAT DETERMINATIONS.

	Station Method.	Indirect Method.	Difference.
Duplicates	4.34	4.08	.26
	4.36	4.12	.24
	4.21	3.59	.66
	4.14	3.89	.25
	3.85	3.20	.65
Duplicates	3.17	3.14	.03
	3.21	3.02	.19
	2.84	2.30	.54
	2.62	2.44	.18

A sample of milk which, by the Station method of extraction above described, in four trials gave 3.01, 3.02, 3.04 and 3.05 per cent. of fat, by successive treatment with benzine yielded the following quantities:

	Per cent. of Fat.	
Digested five times with benzine	2.67	2.67
Digested seven times with benzine	2.74	2.75
Digested nine times with benzine	2.80	2.79
Digested twelve times with benzine	2.86	2.82

That is, about .2 per cent. less fat were obtained after twelve successive treatments with benzine than were obtained by the Station method.

The above figures prove that the method used at this Station yields more accordant results in duplicate work and in general gives a notably greater percentage of fat than this indirect method.

With suitable apparatus* for continuous extraction the method here employed is not less convenient than the other.

A possible error in the determination of fat lies in the use of extracting apparatus whose parts are connected by corks, due to the waxy matters of common cork which are slowly dissolved by ether and other fat-solvents.

To ascertain the extent of the error thus incurred an apparatus made entirely of glass, with ground joints, has been provided. In two portions of milk, fat was determined by extracting the residue dried with sand in this apparatus by means of ether for four hours. Fat was also extracted from two other portions of the same milk in the apparatus commonly employed here fitted

* The apparatus employed is essentially that first described and figured by S. W. Johnson in American Journal of Science, June, 1877. The same arrangement was afterward described by Tollens.

with corks which had been some time in use. The results are as follows:—

Fat extracted in apparatus with glass joints	3.04	3.05
Fat extracted in apparatus with cork joints	3.01	3.02

Other blank trials were made in apparatus provided with old and new corks, and the matter extracted was weighed with extreme care in small flasks, each of which was counterpoised by a similar empty flask so as to avoid error due to unequal condensation of moisture on the glass. The apparatus A had been in use for perhaps a year without change of corks. B had one cork long in use and one new one, C had two new corks which had never been treated with ether. Following are the times of extraction and the weights of matter extracted:

	A	B	C
9 hours.	nothing.	.0011	nothing.
19 "	.0003	.0025	.002
29 "	.0010	.0037	.003
39 "	.0020	.0040	.0033

By extraction for double the time which is necessary for a fat determination in milk, nothing appreciable is taken from the corks and extraction for 39 hours removed in the extreme case 4 milligrams which would make an error of only .08 per cent. in a milk analysis.

We therefore conclude that narrow corks as used in the station apparatus are without effect on the accuracy of the fat-estimations.

The English Society of Public Analysts have adopted the following method of determining fat in milk, sometimes called, from the name of the originator, "Adams' method."

"Pipette 5 c. c. of milk into a beaker 2 inches deep by 1¼ inch in diameter; weigh and place into it one of Mr. Adams' coils, viz: rolled-up strip of white demy blotting paper (sharply cut to 2½ inches wide and 22 inches long), which must have been previously extracted with ether in a Soxhlet apparatus, and the ether driven off. When as much as possible of the milk has been taken up by the paper, the coil is removed and placed dry end downwards upon a slip of glass, and the beaker (which should be kept covered by a bell-jar during the absorption of the milk) is at once re-weighed. Dry the coil in a water oven for a period of one to two hours, and extract the fat by ether in a "Soxhlet" apparatus, twelve syphonings at least being necessary; the flask in which the solution is collected being as small and light as possible. Boil off the ether, and place the flask in a water oven, in a horizontal position, and dry to constancy; allow to cool for about ten minutes, and weigh." (The Analyst, vol. x, p. 217, and vol. xi, p. 66).

It was proposed by Adams,* also to determine total solids by this method using coils which had been previously dried and weighed in closed tubes.

The following experiments have been made to test the method. The coils were of the common white demy blotting paper which is considerably heavier than the English paper. A strip 11 inches long and 2½ inches wide is as heavy and presumably as effective for this purpose as a strip of the English paper of the size recommended by the Analysts' Association. Nine of the coils were first extracted for an hour with ether and then dried for six hours in tubes which could be closed with ground glass stoppers. They were then extracted with ether for four hours and the extract was dried in the water oven for three hours and weighed. The extraction was repeated for the same length of time. By the first four hours extraction the average weight of matter extracted from each coil was .0027 grams. The second extraction removed on the average .0007 grams from each coil. The coils were now charged with milk in the manner directed and dried in the water bath. They were weighed at the end of three hours, and again at the end of six hours. After three hours they were still far from dry. After six hours the average dry matter was 11.52 per cent.; maximum 11.78, minimum 11.30.

In the same milk the sand method gave 11.98 per cent. and the English Analysts' method 12.01 per cent. The experiment was not continued further as it was evident that the results were worthless.

The coils were then extracted with absolute ether for five hours in the apparatus commonly used here, as above described, and the fat extract was dried to constant weight.

For comparison the coils were also dried and thus the fat was indirectly determined by the loss of weight of the coil. In the following table are given the results:

* Analyst, vol. x, p. 50.

ADAMS' METHOD.

No. of sample.	Fat reckoned from loss of weight of coils.	Fat reckoned from weight of fat.	Station method.
X	3.10	3.06	3.05
X	3.07	3.09	3.04
X	3.14	3.08	3.02
X	2.86	3.03	3.01
X	3.07	3.01	
X	3.06	3.01	
X	3.05	3.02	
X	3.13	3.02	
X	lost	3.03	
Average	**3.06**	**3.04**	**3.03**
XI	1.07	1.00	.91
XI	1.02	.99	.90
XII	1.53	1.38	1.41
XIII	.90	.75	.71

It appears that any results depending on the weight of the dried coils are unreliable as might be expected considering the hygroscopic nature of paper and the fact that it is so easily oxidized. The results obtained by weighing the fat extracted from the coil have shown very satisfactory agreement in all cases with the results of the sand extraction.

If the coils after absorption of milk are thoroughly dried as is necessary to prevent extraction of any other bodies than fat, there seems to be no saving of time over the sand method, unless possibly in cases where a determination of fat without total solids is desired. The use of asbestus in a tube to absorb milk for the determination of solids and fat has been proposed by Dr. Babcock of the New York Station. A bibulous asbestus paper made of the finely shredded material might prove to be a perfect substitute for paper and admit of accurate determination of solids, fat and possibly ash in a single portion of the milk.

EXAMINATION OF BUTTER.

The General Assembly at its last session passed an act entitled, An Act to Prevent and Punish Fraud, which places certain restrictions on the sale of imitation butter, appoints a Dairy Commissioner whose duty it is to prosecute for violations of the law and provides in the 5th section that "The Dairy Commissioner may have samples suspected to be imitation butter analyzed at the Connecticut Agricultural Experiment Station or by any State chemist, and a sworn and affirmed certificate of the analyst shall be *prima facie* evidence of the ingredients and constituents of the sample analyzed."

The Commissioner, Hon. J. B. Tatem, having in May represented to the Director that he must depend solely upon the Experiment Station for the chemical work requisite for identifying "imitation butter," it was decided to undertake the analyses needed, in order that there should be no failure in the enforcement of the law, although evidently the Station was under no legal obligation to assume the work, and notwithstanding, the Commissioner represented that there were no funds at his disposal to sustain the expenses which would be incurred.

This undertaking has involved a considerable outlay of time, both in the examinations made for the Commissioner and in the necessary testing of methods. It was also found advisable that the Director or Vice-Director should be present whenever prosecutions were brought in court. In both Massachusetts and New Jersey the clause providing that the certificate of a chemist shall be *prima facie* evidence, has been declared objectionable by the supreme court, and it is held that the analyst himself must appear in person. The interruption occasioned by this attendance at police courts all over the state has been very serious and the loss of time to the Station has hardly been made good by the mileage and the witness fee of fifty cents allowed by the court.

During the six months since the law went into force, 61 samples have been examined by the Station for the Commissioner, and of these 47 were found to be imitation butter within the meaning of the statute. In no case has there been any serious dispute as to the correctness of the Station certificate. The samples were all received either from the hands of the Commissioner or under his official seal and were designated by numbers, so that the Station had no knowledge of the origin of the samples till the cases were called in court. The results of the examinations follow in detail, and they may be prefaced with some notice of the methods of testing and an account of some experiments bearing on the subject.

The examination of the samples referred to has consisted (1) in the determination of the specific gravity of the filtered butter fat at the temperature of boiling water, and (2) the determination of the volatile fatty acids in the filtered fat by Reichert's method.

Preparation of the Butter Fat.

A suitable quantity of butter—not weighed—is brought into a test tube 1 inch in diameter and 8 or 10 inches long together with a tea spoonful or two of table-salt, and placed in a bath at 100° C. When the butter melts, the contents of the tube are well mixed by shaking, then let stand until the melted fat has separated completely from the brine. The salt shrinks the casein-flocks together and facilitates the separation of the water present. The melted fat is then filtered hot. For this operation we use a circular copper vessel closed above, having a single opening for pouring in water and for the escape of steam. This bath has five funnel-shaped holes, into which glass funnels will fit closely. A lamp beneath keeps the water in the bath boiling. For filtration, Schleicher and Schüll's filter paper is used. The filtered fat is received in tubes used for the determination of specific gravity.

Determination of Specific Gravity of Butter Fat at near 100° C.

This is done at the temperature of boiling water by means of Westphal's hydrostatic balance, as first described by Estcourt and by J. Bell in the Chemical News, vols. xxxiv, 254 and xxxviii, 267.

The balance is so adjusted that water at 15.5° shall represent unity. Thus with water at 15° C. the instrument indicated a specific gravity of .999. With distilled water at the temperature of boiling, the instrument indicated a specific gravity of .9625. If the specific gravity of fat at the temperature of boiling water is desired, using the weight of an equal volume of distilled water *at that temperature* as a standard, the reading of the instrument must be multiplied by 1.039.

We have also used an areometer made for us by E. Greiner, 79 Nassau St., N. Y., 6⅜ inches long, which reads from .8550–.8700 and is graduated to show differences of .0005 in sp. gr. The following comparison shows the substantial agreement of the two instruments.

	Specific Gravity at 100° C. by Areometer.	Westphal's Balance.
Canton creamery butter	.8650	.8638
Market butter, No. 5	.8650	.8654
" " No. 6	.8655	.8650
" " No. 7	.8660	.8653
Butterine	.8605	.8607
Oleomargarine	.8580	.8582

But the areometer, in our experience, is not quite so convenient as the Westphal balance, because it requires a somewhat larger volume of fat and a glass vessel for the boiling water.

Determination of the Volatile Fatty Acids.

This is done according to the method proposed by Reichert, (Fres. Zeitschr., xviii, p. 68). 2.5 grams of the clear filtered fat are weighed into a flask of 150 c.c. capacity with one gram of potassium hydrate and 20 c.c. of 80 per cent. alcohol. The mixture is heated on a water bath till the fat is perfectly saponified and all the alcohol has been expelled, 50 c.c. of water are then added and the soap perfectly dissolved, 20 c.c. of dilute sulphuric acid (1 volume of acid in 10 of water) and a few pieces of pumice stone are added and the contents of the flask are distilled. The distillate, after passing a small filter is received in a 50 c.c. tube or flask and the distillation is discontinued when exactly 50 c.c. have come over. This distillate is titrated with $\frac{1}{10}$ normal potassium hydrate solution, using phenol-phthalein as an indicator. The distillate, after titration, was usually tested for sulphuric acid, which might have been carried over by incautious boiling.

We have departed from Reichert's directions in two particulars, having proved by experiment that the change is without influence on the result. He directs to pour back the first few centimeters of the distillate into the distilling flask, apparently to rinse the apparatus but the result is the same whether it is done or not. He also directs to weigh off the *melted* fat. Our practice has been to congeal it in small capsules, weigh capsule and butter and remove 2.5 grams with a platinum spatula or piece of foil which is dropped into the flask with the butter. The only objection to this is that the butter fats might separate somewhat in cooling according to their specific gravities, so that the mass would not be homogeneous. With the spatula however, a core of butter fat is taken out from the surface to the bottom of the dish. To ascertain to what extent separation of butter fats might thus occur, the following experiment was tried.

Into a glass cylinder $1\frac{1}{4}$ inches in diameter $14\frac{1}{2}$ inches long and closed below was poured melted butter fat which at 100° C. had a sp. gr. of .866. The tube was nearly immersed vertically in a water bath and cooled slowly. The initial temperature was 50.4° C. After one hour it was 47°, after two hours 40°, three hours 34.5°, four hours 32.5°, five hours 31°, etc. Twelve hours afterwards there were places in the tube where the oil appeared to be still liquid. The tube was therefore placed in a refrigerator in a mixture of ice and salt, and after the contents appeared to have perfectly solidified, the tube was slightly heated and the core of butter fat pushed out. A section from the interior portion at the top of the tube was numbered 1, one taken half-way down the tube was numbered 2, one from the bottom was marked 3. An oily portion from the interior of the butter core which had not solidified was marked 4. The specific gravity and volatile fatty acids of these samples were found to be as follows:—

	Specific gravity at 100° C. Water at 15.5° C.=1.	Cubic centimeters of $\frac{1}{10}$ normal potassium hydrate solution equivalent to volatile fatty acids. Duplicates.	Average.
No. 1—Top layer	.8645	14.62–14.70	14.66
No. 2—Middle layer	.8650	15.13–15.73	15.43
No. 3—Bottom layer	.8653	14.88–14.99	14.94
No. 4—Oily portion	.8670	17.30–17.31	17.31

The results of this experiment indicate that no serious error is likely to be encountered by allowing the butter fat to cool in a capsule and taking a portion as we have practiced for determining the volatile fatty acids.

Effect of rapidity of distillation.—It is known that all volatile acid is not removed by Reichert's method and it might happen that the amount obtained in 50 c.c. of distillate would vary with rapidity of distillation. To test this point, three equal weights of butter fat from pure butter were saponified as usual and the soap solutions, decomposed by sulphuric acid, were distilled as above described, with the difference that 50 c.c. of distillate were collected from one portion in 26 minutes, from the second, in 35 minutes, and from the third portion in 60 minutes. The number of cubic centimeters of $\frac{1}{10}$ normal potash solution neutralized were

No. 1	15.1
No. 2	14.8
No. 3	14.6

All distillates were free from sulphuric acid. The temperature in the flasks, it may be noted, rises to 103.5°–104° C. The time of distillation is thus shown to have no important influence on results.

Tests on Pure Butter.—The following determinations of specific gravity and volatile fatty acids in the filtered fat of pure dairy butter, we owe to Prof. J. H. Washburn of the Storrs Agricultural School. They serve to show the limits within which pure butter made in this State may vary in these particulars. The figures in the column headed Volatile Fatty Acids give the number of cubic centimeters of $\frac{1}{10}$ normal potassium hydrate solution required to neutralize the volatile fatty acids in 2.5 grams of the filtered butter fat.

Date when butter was made		Specific gravity at 100° C. Water at 15.5° C.=1.	Volatile fatty acids.
July.	Dairy of Augustus Storrs	.8650	12.9
Aug. 2.	" " "	.8643	12.5
June 1.	" " Storrs School*	.8670	16.3
June 14.	" " "	.8658	14.1
July 22.	Mansfield Creamery, Merrow	.8645	14.6
27.	" "	.8650	14.8
Aug. 2.	" "	.8652	14.8
July 27.	Guernsey butter, farm of C. M. Beach, Hartford	.8660	13.8
Aug. 2.	Guernsey butter, farm of C. M. Beach, Hartford	.8650	14.3
9.	Guernsey butter, farm of C. M. Beach, Hartford	.8658	14.5
July 27.	Jersey butter, farm of C. M. Beach, Hartford	.8644	13.2
Aug. 2.	Jersey butter, farm of C. M. Beach, Hartford	.8651	13.4
9.	Jersey butter, farm of C. M. Beach, Hartford	.8658	14.8
May.	Canton Creamery butter	.8660	15.6
20.	Butter made at Experiment Station (grade Alderney)	.8660	15.3

Prof. Washburn has also begun in coöperation with the Station a systematic examination of the butter of certain dairies to be continued through the year, noting food, etc. The results thus far obtained he reports as follows:—"The feed from which Mansfield Creamery butter was made cannot be definitely stated because so many farmers sell their cream to the corporation. The company allows not over one quart of linseed meal daily, and no cotton seed.

Mr. S. O. Barrows of Mansfield, who owns 'Silver Brook Farm,' has a herd of high grade Jerseys. He feeds 4 quarts corn

* Had been salted down. Examined in July.

and cob meal, and what corn stalks and oat straw the cows will eat.

The Storrs School has 3 registered Jerseys, 1 Guernsey and 5 grade Jerseys. They are fed one bushel of corn-stalks and hay (poor quality), about equal parts, cut together and wet with warm water, 1 quart fine bran, and 1 quart corn ground with the cob. They have the above ration night and morning.

Mr. Augustus Storrs has a herd of full blood short horns. He feeds 4 quarts of meal daily, 1 bushel steamed corn fodder and one feed of English hay of the best quality."

Date when butter was made.		Specific gravity at 100° C. Water at 15.5° C.=1.	Volatile fatty acids.
Oct.	Mansfield Creamery	.8644	14.9—15.1
Nov.	" "	.8646	14.5—14.6
Dec.	" "	.8650	14.7—14.8
Oct.	Storrs Agricultural School	.8653	15.8—15.9
Nov.	" " "	.8655	15.1—15.2
Dec.	" " "	.8652	14.2—14.3
Nov.	S. O. Barrows	.8644	13.2—13.4
Dec.	" "	.8644	14.4—14.6
Dec.	Augustus Storrs	.8648	14.0—14.1

The specific gravity observed in single cases has been as low as .8643 and as high as .867. The average of 24 tests is .8652. Allen found .865. The volatile fatty acids have varied between 12.5 and 16.3. The determination of specific gravity and of volatile fatty acids in any sample will, we believe, detect with absolute certainty the presence of any considerable amount of fat other than butter fat. Either determination by itself is ordinarily satisfactory evidence of the nature of a butter sample. We have however preferred to make assurance doubly sure.

Determinations made at this Station for the Dairy Commissioner.

A sample of pure oleomargarine had a specific gravity of .8582 and yielded volatile acids equal to 1.8 c.c. decinormal alkali.

A sample of "butterine, best quality, guaranteed to contain fifty per cent. of pure butter" and which had excellent flavor, had a specific gravity of .8607 and volatile acids, =4.0 c.c.

Here follow the determinations made at this Station on samples sent by the Dairy Commissioner, and which are of value as showing the quality of the articles now in the market and on which a chemist may be required to pass judgment.

It is seen that all samples whose sp. gr. is but .861 or less are proved not to be butter by their pronounced deficiency of volatile acids, 0.8 to 4.4. On the other hand, all the samples with volatile acid=12.5 or more have a sp. gr. of .864 or over.

No.	Specific gravity at near 100° C. Water at 15.5=1.	Volatile fatty acids.
1	.8610	1.0
2A	.8650	15.3
2B	.8655	13.6
3	.8609	4.4
4A	.8598	2.1
4B	.8598	2.0
5	.8650	14.8
6	.8653	15.5
7	.8658	15.9
8	.8601	1.6
9	.8649	16.3
10	.8655	15.7
11	.8601	1.6
12	.8600	1.8
13A	.8593	2.4
13B	.8580	2.5
14	.8590	1.9
15	.8650	15.1
16	.8590	1.6
17A	.8597	2.1
17B	.8609	1.8
18	.8592	1.5
19	.8600	1.5
20	.8585	2.5
21	.8640	13.4
22	.8603	1.4
23	.8600	1.3
24	.8600	2.4
25	.8665	15.0
26A	.8650	14.6
26B	.8580	1.7
27	.8606	1.9
31*	.8608	0.9
32	.8610	1.0
33	.8610	1.0
34	.8589	1.2
35	.8601	1.8
36	.8607	0.8
37	.8591	1.4
38	.8600	1.2
39	.8605	1.9

* Three numbers were not sent to the Station.

No.	Specific gravity. Water at 15.5=1.	Volatile fatty acids.
40	.8600	1.6
41	.8590	1.9
42	.8604	2.3
43	.8600	1.4
44	.8600	2.2
45A	.8595	2.9
45B	.8595	1.9
46	.8655	14.8
47A	.8600	1.9
47B	----	12.9
48	.8595	1.8
49	.8593	1.4
50	.8598	2.0
51	.8606	1.3
52	.8595	2.1
53	.8650	13.4
54	.8585	1.0
55	.8597	3.5
56	.8600	1.3
57	.8593	1.9

It will be seen that there was no room for question as to the character of the sample in any case. With the exception of Nos. 2A, 2B, 5, 6, 7, 9, 10, 15, 21, 25, 26A, 46, 47B and 53, all the samples were declared to be "not made wholly, salt and coloring excepted, from the milk of cows," and hence were "imitation butter" within the meaning of the statute. The Commissioner has brought thirty-nine suits in consequence and secured conviction in every instance, no attempt having been made to invalidate the verdict of the Station tests.

NOTE.—In reference to the milk analyses which are given on pages 119–125, Mr. Gold writes:

"The object of the test was to ascertain the exact composition of the milk from the individual cows of a herd, as also of their mixed milk at times when similar conditions of feed were general throughout the State, in place of special feeding or special selection of cows, to ascertain just what the analyst or milk inspector might expect to find in examining milk. Probably nearly all of the more than 100,000 cows in the State were at those dates feeding very much the same, and this milk, allowing for the difference in breeds and some local conditions, would represent the average quality of milk better than could be secured at any other time. Aside from the three Holsteins, the herd were all Ayrshires or Ayrshire grades, graded on high grade Devons, retaining but small proportion of Devon blood."

MECHANICAL SOIL-ANALYSIS.

Introductory by the Director.

It is a fact that while the chemical study of soils has led to general results of the greatest agricultural importance, very little practical benefit is commonly obtained from the analysis of any special soil beyond the detection of some deleterious ingredient or proving the relative deficiency of one or more needful elements. In most of the cases where this Station has undertaken to make soil-analyses the results have probably disappointed those who supplied the samples. An obvious defect of the ordinary chemical analysis lies in the fact that it can give at the best, a very imperfect or one-sided view of the nature of the soil. Two soils may agree fairly in chemical composition and yet differ extremely in their fertility. Again two soils may be about equally productive and yet have very unlike chemical composition. The physical characters of a soil—the texture, porosity, tenacity, amenability to tillage, retentiveness for water, capacity for heat, etc., equally with the chemical composition, influence its productiveness and value. For a long time these considerations have been appreciated and various attempts have been made to take account of the physical qualities of soils. Of late years much attention has been deservedly bestowed upon their mechanical analysis, i. e. separating them into various grades, according to the dimensions of the particles that compose them. Such mechanical analysis is in most cases essential to any conclusive investigation of a soil, it is especially important in studying the causes of the different value of those soils whose chemical analysis gives nearly the same results.

These reasons have led the Station to undertake a thorough study of the methods that have been recently employed in separating soils into their mechanical elements. The results already arrived at are very promising. Dr. Osborne has developed a new system of Beaker-elutriation which we think is a distinct advance upon the older methods, as respects simplicity of apparatus and procedure, economy of time and accuracy of conclusions. It is hoped that in future Annual Reports results of the useful application of this method to the study of our soils may find place.

THE METHODS OF MECHANICAL SOIL-ANALYSIS.

By Thomas B. Osborne, Ph.D.

The following pages are a record of results so far obtained in investigating the processes that have been recently employed for separating soils mechanically into clay and various grades of sand and silt, with a view to the adoption of a method suitable for use in the study of Connecticut soils. It was at first proposed to make a comparison of three methods, viz: Schœne's, Hilgard's and Knop's as modified by Dr. G. E. Moore. While awaiting the construction of Hilgard's elutriator, and the arrival from Germany of Schœne's apparatus, the third above-named method was first examined. It is described by Dr. Moore, in his paper on "Tobacco Soils," in the final report of the 10th U. S. Census, vol. iii, pp. 872–3.

The Knop apparatus consists of a set of metal sieves with round holes of 3, 1, 0.5 and 0.25 millimeters diameter respectively, and a cylindrical glass jar of 36 millimeters caliber, carrying four lateral narrow tubes at intervals of 10 centimeters which may be opened or closed at pleasure by means of rubber tubes and clamps.

In Knop's process the soil is weighed out, boiled, and after removing with sieves all portions coarser than ¼ of a millimeter in diameter, is placed in the cylinder and water added till its level is 10 centimeters above the upper side tube. The cylinder is then closed with a rubber stopper, shaken violently, set up as nearly vertical as possible and the soil allowed to settle for 5 minutes. The upper side tube is then opened and the water and fine sediment drawn off. At intervals of 5 minutes the other side tubes are opened successively. The cylinder is then refilled, and these operations are repeated. The process is continued until no turbidity is seen in the water drawn off. The sediment remaining in the cylinder is called by Knop "fine sand," that deposited from the washings "dust."

Dr. Moore, in the Census Report, calls attention to the fact that the "fine sand" thus obtained by following Knop's method can be of no definite grade, for the reason that as the particles settle they continually collide and interfere with one another and hence do not subside with velocities strictly depending on their dimensions. The effect of these collisions will vary with the number and size of particles in the liquid, and since both their number and size constantly change as the subsidence is prolonged, the size of the particles collecting in the bottom of the cylinder will necessarily be far from uniform. Dr. Moore obviated this difficulty by repeatedly working over his sediments in Knop's cylinder as long as any further separation took place, and, on microscopic examination of the final sediments, he found that a *very* sharp separation had been obtained. These operations, while effective, are so exceedingly tedious as, in our view, to make the method impracticable for extended use.

On attempting to operate Dr. Moore's process, it shortly became evident that nothing is to be gained by limiting sedimentation arbitrarily to any particular intervals of time or space, and it appeared probable that all desired separations could be most simply and easily effected by systematically repeated decantations from beaker glasses with frequent use of the micrometer to control the results.

Attention was therefore turned to this mode of working, and experience thus far indicates that the simple method, which we may designate "Beaker elutriation," is not inferior to any yet proposed as respects accuracy and convenience.

The principles on which this method rests may be gathered from the following considerations:

When a soil is completely suspended in water by vigorous agitation, particles of all the sizes present are to be found throughout the entire mass of liquid. When subsidence takes place, the larger particles will go down more rapidly than the smaller ones, but some of the small particles that are near the bottom will be deposited sooner than some of the larger ones which have a much greater distance to travel. Thus, independently of the fact that the large particles in their descent are somewhat impeded by the smaller—the smaller being at the same time somewhat hastened by the larger—the sediment that reaches the bottom at any moment is a more or less complex mixture of all the mechanical elements of the soil. The liquid, however, above this sediment at the same moment will have completely deposited all particles exceeding certain dimensions, or hydraulic value, determined mainly by the time of subsidence.

If now the aforesaid first sediment be suspended in pure water, and allowed to subside for the same time as before, the larger part of it will be again deposited, but some will remain in suspension, consisting of a considerable part of the finer matter of the first sediment. By pouring off these suspended particles with the water and agitating the sediment again with clear water as before, another portion of fine particles will be suspended and may be decanted from it. On continuing this process of repeated decantations it will soon be found that the soil has been separated into two grades.

It is evident that in this way a separation can be made, but it is perhaps not so clear that such a separation would be sharp enough for the purposes of a mechanical soil-analysis. If for instance the separation is to be made at .05 millimeters diameter, it is evident that by repeated decantations all below .01 millimeter can be washed out of that above .05 millimeters, but it may not appear so probable that all below .045 millimeters can be removed without removing some above .055 millimeters.

Such a result may be easily attained, however, if the following principle is adhered to:

Make the duration of the subsidences such that the *liquid* decanted the first few times shall contain nothing *larger* than the desired diameter. Then decant into another vessel, timing the subsidence so that the *sediment* shall contain nothing *smaller* than the chosen diameter. This can not be done without decanting much that is larger than the chosen diameter, but the greater part of the particles greater and less than the chosen diameter can be removed and an intermediate product obtained, the diameters of whose particles are not very far from that desired.

The reason for first removing the greater part of the coarse particles lies in the fact that as they rapidly subside they drag down with them much of the fine material, and render it difficult to effect a sharp separation in their presence. If then we bear in mind the general principle that repeated subsidences and decantations properly timed will gradually remove the fine particles from the coarse, and also the fact that the removal of the particles much above and much below the limits of any desired grade, greatly facilitates the separation of that grade, there will be no difficulty in obtaining satisfactory results after a little practice. In developing this method, we proceeded as follows:

The Sample.—Unless care is used in selecting the portion to be analyzed considerable discrepancies are liable to be found between duplicate analyses. We usually prepare several pounds of air-dry "fine earth" by passing the soil through a sieve of 3 millimeters mesh to remove the gravel, etc., mix as thoroughly and uniformly as possible, and weigh off for analysis thirty grams taken in many small portions from different parts of this sample.

Sifting.—The weighed soil is at first stirred up with 300 or 400 cc. of water and then thrown successively upon sieves with circular holes of .1, .5, and .25 mm. diameter respectively. Affusions of water and a camel's hair brush are used to cause all the fine material to pass through the sieves which, towards the last, are agitated under water in a shallow dish so that the soil is immersed. The finest sieve should be well wet with water on its lower surface just before use. The finest particles which render the water turbid are easily washed through. The turbid water is kept separate from the clear water which comes off with the last portions that pass the sieves. The turbid water usually does not amount to more than one liter.

Elutriation.—The separations made by elutriation have as yet been mostly confined to three grades, the diameters of which are from .25 to .05^{mm}; .05 to .01^{mm}; and .01 to 0^{mm}. For present convenience of description, we will call those particles having diameters between .25 and .05^{mm}, sand; those between .05 and .01^{mm}, silt; and those below .01^{mm}, dust (or dust and clay).

After the turbid liquid from the siftings has stood a short time it is decanted from the sediment, and on further standing long enough to form a slight deposit, is again decanted and this slight sediment is examined carefully with the microscope, when if the first subsidence has been long enough, it is found to consist wholly of "silt" and "dust" and is free from "sand." If "sand" be present, the subsidence of the turbid liquid is continued until no more "sand" is to be seen in the sediment. As the "sand" subsides rapidly there is no difficulty in freeing the liquid first decanted, altogether from this grade of particles. The sediment obtained in this way contains all the "sand" and also some "dust" and much "silt." As only "dust" and the finest "silt" render the water turbid, the sediment is stirred up a few times with fresh quantities of water and decanted after standing long enough to let *all* the "sand" settle. When the water decanted is free from turbidity, the last portions of the soil passing through the sieve with the clear water are added to the sediment and the decantations continued so as to remove most of the

"silt." When no more "silt" can be easily removed from the sediment without decanting "sand," the decantations are made into a different vessel and the subsidences so timed as to remove as much as possible of the "silt." By using a little care at least three-quarters of the "sand" is thus obtained free from "silt." The rest of the "sand" is mixed with the greater part of the "silt" which has been decanted into the second vessel. The size of the smallest particles in this vessel is determined with the microscope, to make sure that its contents are free from "dust" as they usually will be if, after settling for a few moments, they leave the water free from turbidity.

We have thus separated the soil into three portions, one containing sand, one sand and silt, and the other silt, dust and clay. The sand and silt are separated from each other by repeating the subsidences and decantations in the manner just described.

In this way there is removed from the sediment, on the one hand, a portion of silt free from sand and dust, and on the other hand a portion of sand free from silt. Thus is obtained a second intermediate portion consisting of sand and silt, but less in amount than the first and containing particles of diameters much more nearly approaching .05^{mm}. By repeating this process a few times, this intermediate portion will be reduced to particles whose diameters are very near .05^{mm} and which may be divided between sand and silt, according to judgment. In our work the amount of this has always been very small. As soon as portions are separated, which the microscope shows to be pure sand or pure silt, they are added to the chief portions of these grades already obtained.

The same process is applied to the separation of silt from dust. When all the silt has been removed from the dust and clay, the turbid water containing the dust and clay is set aside and allowed to settle in a cylindrical vessel for 24 hours. The vessel is filled to a height of 200^{mm}. According to Professor Hilgard, whose directions we have followed substantially in most cases, the separation of the dust from clay during a subsidence of 24 hours, will give results of sufficient accuracy, although the clay then remaining suspended will not be entirely free from measurable fine particles up to .001 or .002^{mm} diameter.

Small beakers and small quantities of distilled water are used at first for the decantations, as thus the duration of subsidence is less and more decantations can be made in a given time than when larger quantities of water are employed. Beakers of about 100cc capacity are convenient for the coarser grades, but it is necessary to use larger vessels for the fine sediments from which turbid water accumulates that cannot be thrown away, as may be done with the clear water, from which the coarse sediments settle out completely in a short time.

It is best to keep the amount of water as small as possible in working out the dust since loss is incurred in using too large quantities.

Measurement of the Particles.—The measurement of the particles requires a little practice on account of the confusion occasioned by the organic matters and mica. One soon learns, however, to distinguish between these and the *quartz grains whose average diameter is properly taken as the standard.* In order to determine the size of *particles in suspension* we have found it convenient to apply to the surface of the liquid a small glass tube, in such a way as to take up a single drop, which is transferred to the glass slide. This drop will contain the smallest particles in the liquid. To obtain a sample of the coarsest particles the liquid is allowed to stand long enough to form a very slight sediment, and a portion of this sediment is collected with the glass tube. To determine the diameter of the *particles in a sediment,* it is stirred up vigorously with a little water and the pipette at once applied to the surface of the water. The drop thus taken contains the small particles. On decanting off the greater part of the sediment, the large particles remain at the bottom of the beaker and may be easily examined.

Time.—The time required to make the separations above described, is about two hours for each, so that an analysis including the siftings, is made in five or six hours, exclusive of the time necessary for collecting the dust and separating the clay, for which a subsidence of twenty-four hours has been allowed.

Weighing.—The sediments have been prepared for weighing by allowing them to subside completely, decanting off the clear water as far as possible, rinsing them into a weighed platinum dish, and igniting. Care must be taken in cooling the ignited sediments as they are exceedingly hygroscopic.

Beaker-Elutriation of Sandy Soils.—The working of this method is illustrated by the subjoined results of repeated analyses obtained on sandy drift-soil from the garden of the Experiment Station. These are the first analyses made while acquiring experience of the method. In order that the several elutriations may be strictly compared and that the variations arising from the sifting process and clay-separation may be eliminated, the results given below have been calculated in the following manner: The average amount removed by the sieves was carefully determined in several trials, and the difference between this average and the amount removed by the sieves in each analysis was noted. When more than the average amount remained on the sieve, the noted difference was added to the coarsest grade separated by elutriation, when less remained on the sieve, the difference was subtracted from this grade. It rarely happened that less remained and then only a few hundredths of a per cent. for the chief source of error in sifting arises from the difficulty with which the last portions pass through the sieve. These last portions consist of particles having diameters nearly the same as, or in some directions even greater than the holes of the sieve, and hence the differences due to their imperfect removal properly fall on the coarsest grade subjected to elutriation. All errors due to incomplete separation of the clay fall on the finest grade, and therefore this grade, together with the clay, is here calculated by difference.

SURFACE SOIL, GARDEN OF EXPERIMENT STATION, NOT BOILED.

Two Elutriation-products.

	No. 5.	No. 8.	No. 13.	No. 14.	No. 15
Removed by sieves	48.82	48.82	48.82	48.82	48.82
.25 .01mm	36.84	36.35	35.70	36.53	35.98
.01 0mm (by difference)	7.51	8.00	8.65	7.82	8.37
Loss on ignition of the soil	6.83	6.83	6.83	6.83	6.83
	100.00	100.00	100.00	100.00	100.00

The maximum differences above amount to 1.1 per cent. of the soil. In the subjoined analyses we have three elutriation-products on unboiled soil with greatest difference of 2.2 per cent.

	No. 13.	No. 14.	No. 15.
Removed by sieves	48.82	48.82	48.82
.25 .05	21.06	23.28	22.77
.05 .01	14.64	13.25	13.21
.01 0 (by difference)	8.65	7.82	8.37
Loss on ignition of the soil	6.83	6.83	6.83
	100.00	100.00	100.00

The Effect of Boiling.—As it is now generally considered indispensable to boil a soil for some time before subjecting it to mechanical analysis, a number of analyses were made after boiling the samples for 23 hours with water substantially as recommended by Hilgard. The results obtained are as follows:

SURFACE SOIL, GARDEN OF EXPERIMENT STATION. Boiled for 23 hours. Two elutriation-products. Greatest difference 2.2 per cent. of soil.

		No. 6.	No. 7.	No. 9.	No. 16.	No. 17.	No. 18.
Removed by the sieves		47.77	47.77	47.77	47.77	47.77	47.77
.25	.01	33.34	32.85	32.84	31.47	32.25	31.15
.01	0 (by difference)	12.06	12.55	12.56	13.93	13.15	14.25
Loss on ignition of the soil		6.83	6.83	6.83	6.83	6.83	6.83
		100.00	100.00	100.00	100.00	100.00	100.00

Three elutriation-products. Greatest difference 2.3 per cent.

		No. 9.	No. 16.	No. 17.	No. 18.
Removed by the sieves		47.77	47.77	47.77	47.77
.25	.05	20.40	21.34	20.59	20.66
.05	.01	12.44	10.13	11.66	10.49
.01	0 (by difference)	12.56	13.93	13.15	14.25
Loss on ignition of the soil		6.83	6.83	6.83	6.83
		100.00	100.00	100.00	100.00

In the foregoing analyses "clay" has not been considered independently of "dust," in the product of .01 to 0^{mm} diameter.

Comparison of results on soil boiled, soil not boiled and soil simply pestled.—The effect of boiling on the surface soil of the Experiment Station garden is most clearly seen from the subjoined comparison of the averages of the foregoing more detailed analyses of that soil.

No. 29 is an analysis made on a sample of this soil not boiled in which the sediments were, at the last, worked under a soft rubber pestle by gentle pressing down (but not grinding around), so long as such treatment appeared to detach any fine particles.

The figures for clay in the following statement are reckoned by difference or loss after the other ingredients had been obtained by direct weighings.

SURFACE SOIL FROM EXPERIMENT STATION GARDEN.

		Av. of 4 analyses. Boiled.	No. 29. Pestled.	Av. of 3 analyses. Not Boiled.
Removed by sieves		47.77	48.82	48.82
.25	.05	20.75	22.44	22.37
.05	.01	11.18	12.55	13.70
.01	0	10.72	7.36	7.20
Clay (by difference)		2.75	2.00	1.08
Loss on ignition		6.83	6.83	6.83
		100.00	100.00	100.00

The effect of boiling sandy soils is further illustrated in the following instances:—

SUB-SOIL FROM EXPERIMENT STATION GARDEN.

		No. 19. Not Boiled.	No. 20. Boiled.	No. 21. Boiled.
Removed by sieves		41.60	39.33	39.33
.25	.05	35.93	32.35	32.95
.05	.01	12.13	10.32	10.37
.01	0 (by difference)	5.24	8.29	7.64
Clay (direct)		1.02	5.63	5.63
Loss on ignition		4.08	4.08	4.08
		100.00	100.00	100.00

SANDY LOAM FROM DURHAM, CONN.

	No. 12. Not boiled.	No. 10. Boiled 23 hours.
Removed by sieves	16.19	14.07
.25–.05	29.52	25.10
.05–.01	23.17	23.12
.01– 0	9.65	15.42
Clay (by difference)	1.67	2 49
Loss on ignition	19.80	19.80
	100.00	100.00

The analyses of these sandy soils show a very decided increase in the quantity of particles smaller than .01 mm. diameter at the expense of those coarser, as a result of boiling. The surfaces of the coarser particles which have been boiled are seen to be polished and of a lighter color than those not boiled. The surfaces of the unboiled grains are coated with a film of fine material cemented to them probably by clay. When these coarse particles which have not been boiled are violently stirred with water for a short time no fine particles are detached from them, and a careful examination under the microscope fails to reveal in any of the sediments more than an occasional grain exceeding the .05 mm. limit by so much as .01 mm., or the .01 limit by .005 mm. It would therefore appear that these small particles thus set free by long boiling are really a part of the larger ones, and should be treated as such in a mechanical analysis of these soils.

In case of the pestled soil No. 29, there is a gain on clay and a loss on the .05–.01 mm. sediment of about one per cent. as compared with the unboiled soil, but as the intermediate grade is quite the same in both, the difference is not due so much to scouring of the sediments as to their unlike separation. In fact, the pestling was seen to release very little fine matter from the sediment as first elutriated.

In the analyses that follow the soils were simply pestled.

No. 36, Sandy Loam, Drift Soil, Deer River, New York. A fairly good soil when treated with stable manure.

No. 38, "Blowing Sand," Alluvial Soil, valley of Connecticut River, East Windsor, Conn. Twenty-five years ago considerable tracts of this soil, which had been "skinned" by constant cropping with rye until the yield was reduced to 8 to 10 bushels per acre once in two or three years, were lying waste and in exposed situations drifted with the winds, but having bottom-water at the depth of a few feet were readily reclaimed by means of clover-seed and sheep.

No. 39, "Clay Soil," East Windsor. An alluvial silt so fine as to pass for clay.

	Sandy Loam. No. 36.	Blowing Sand. No. 38.	"Clay Soil." No. 39.
2. mm–1. mm	1.57	1.18	----
1. – .5	3.15	3.44	----
.5 – .25	27.30	12.86	1.22
.25 – .05	40.77	68.62	6.81
.05 – .01	8.38	4.46	69.11
.01 – 0	8.07	6.30	17.83
Clay	2.00*	0.25*	2.97*
Loss on ignition	7.66	3.06	2.60
	98.90	99.92	100.54

* Direct.

Comparison of Beaker Elutriation with Hilgard's Churn Elutriation.

The churn elutriator employed, while differing somewhat in the details of its construction from that originally described by Prof. Hilgard, (Am. Jour. Sci., Oct. and Nov. 1873), closely follows that description in all essential points, and has very nearly the same interior dimensions. The body of the instrument was cast from nickel bronze so as to resist the wear of sediments. The axle bearing the grated wings passes through a stuffing box packed with greased cotton like those employed in steam engines. The other end is covered by a cap which screws water-tight over the end of the axle. By these means leakage is entirely prevented. Just above the axle the spherical body is divided horizontally

into two parts which fit together accurately, the upper part screwing into the lower. This gives opportunity of cleaning the instrument. The interior is carefully turned to a hollow sphere of the dimensions indicated by Hilgard. The glass cylinder is fastened by a collar which screws into the body. The grated wings were cast from nickel bronze and patterned from a drawing kindly furnished by Prof. Hilgard. The instrument has two strong legs with broad feet, cast as part of the body, and the latter were carefully planed so that the instrument stands vertically when secured upon a level table. A glass reservoir is attached as described by Hilgard, and this communicates with a constant-level water tank. The rate of water supply is regulated by a cock, as Hilgard recommends. Motion is communicated to the grated wings by means of a pulley at the end of the axle which is belt-geared to a water motor. The instrument thus constructed* has proved entirely satisfactory, having been in operation for many weeks without serious leak or wear.

Results on Sandy Soils.—The following tables give analyses of coarse soils by the two methods of beaker and churn elutriation, the samples being alike prepared by boiling for 23 hours:

Soil from Experiment Station Garden.

Surface soil—boiled 23 hours.

	Churn Elutriation. VII.	Churn Elutriation. VIII.	Beaker Elutriation. Average of four analyses.
Removed by sieves	47.77	47.77	47.77
.25–.05	22.06	21.95	20.75
.05–.01	11.20	11.62	11.18
.01–0	9.82	9.14	10.72
Clay (difference)	2.32	2.69	2.75
Loss on ignition	6.83	6.83	6.83
	100.00	100.00	100.00

Subsoil—boiled 23 hours.

	Churn Elutriation. X.	Churn Elutriation. XI.	Beaker Elutriation. 20.	Beaker Elutriation. 21.
Removed by sieve	39.33	39.33	39.33	39.33
.25–.05	33.61	30.83	32.35	32.95
.05–.01	10.91	12.25	10.32	10.37
.01–0	7.05	8.11	8.29†	7.64†
Clay	5.02†	5.40†	5.63	5.63
Loss on ignition	4.08	4.08	4.08	4.08
	100.00	100.00	100.00	100.00

*By Mr. J. M. Beers, machinist, New Haven. † By difference.

These analyses agree quite as well as could be expected for two such different methods.

According to Hilgard the results of duplicate churn elutriations usually agree within 5 per cent. of the amount of the sediment. Greater practice in working the churn elutriator will doubtless enable us to obtain more concordant percentages than those here given, which are first attempts.

The comparison we think sufficiently demonstrates that the method by beaker elutriation may properly assume equal rank, in respect to accuracy of separation, with that of Hilgard.

Several attempts were made to use the churn elutriator on these coarse soils without previously boiling, but, like Hilgard, we did not succeed in obtaining uniform results—evidently because the rapid and long continued churning of the soil has the same scouring effect on the sand grains that has been shown to be a result of protracted boiling, and there is consequently a continual abrasion and delivery of fine material throughout the entire elutriating process.

It is difficult to remove all the fine material even on a boiled sample of soil with the churn elutriator, but after some hours the amount passing off with the water is so trifling that the error due to this cause may be neglected. Microscopic examination of the sediments shows a very good separation indeed.

It is important to have water very free from any suspended matter in order to maintain a uniform current. It was found necessary to use distilled water for the low velocities, as the pipe water of the laboratory, although apparently clear, soon clogged the stop-cock.

Elutriation of Clayey Soils.—In applying beaker elutriation to tenacious fine-textured soils the matter of preliminary treatment had to be considered from the outset since Hilgard found that his churn elutriator gave no concordant or satisfactory results on clays without long boiling and subsequent "kneading" of the finer sediments. The first clay-soil examined is the one occurring at North Haven, Conn., which is extensively used in brick manufacture. The air-dry soil analyzed is reddish-brown in color, the lumps have but moderate coherence, being mostly crushed with ease between the fingers. It effervesces moderately with acids, and is fusible at high temperatures. A sample of this soil was boiled 23 hours and subjected to sifting and to beaker elutriation. On examining the sediments microscopically it was

found that they contained many aggregations of extremely small particles which broke into "dust" under the pressure of the thin glass slide-cover. The sediments were then gently crushed or pestled in the beakers with help of a soft perforated rubber stopper (with a glass rod for handle), grinding together of the particles being as much as possible avoided. This pestling was continued with addition of clear water as long as it occasioned turbidity.

Other samples of the unboiled soil were subjected to the same treatment. Comparison of the analyses which follow shows that practically identical results are thus obtained *on this particular soil*, whether it be boiled or not, and indicates that the sediments are reduced to their elements by gentle pestling alone.

As above stated, simple boiling for 23 hours failed to break up the clay of this soil to any adequate extent.

The subjoined percentages were obtained in elutriation of different portions of the North Haven clay. The loss on ignition was ascertained in a special trial. In No. 27 all the determinations except loss on ignition, were made directly on one sample. In XII clay is reckoned by difference.

BRICK CLAY, NORTH HAVEN, CONN.

	Not Boiled.			Boiled 23 hours.		
	Beaker Elutriation.					Churn Elutriation.
	Thoroughly Pestled.				Slightly Pestled.	Not Pestled.
	No. 24.	No. 25.	No. 27.	No. 28.	No. 26.	XII.
Removed by sifting	3.41	3.27	3.49	3.49	3.41	3.36
.25–.05mm	1.61	1.50	1.29	1.42	1.41	1.21
.05–.01	26.24	27.21	27.02	26.36	30.46	28.27
.01–0			52.21			56.29
Clay			10.15			4.92
Loss by ignition			5.95			5.95
			100.11			100.00

We notice that the figures for the first two grades agree substantially throughout. The sediments .05–.01mm in all the thoroughly pestled samples, boiled or unboiled, accord to within 1 per cent. The churn-elutriated sediment is 1½ per cent. higher, the slightly pestled sediment is 4.7 per cent. higher than the average of the thoroughly pestled sediments of the same grade.

In No. 27 the two grades .01–0mm and clay were carefully worked over until their separation was carried to the furthest practicable limit or until the clay contained but a trifling proportion of measurable particles. Professor Hilgard insists that in some soils at least 30 hours lively boiling and repeated *kneading* of the finer sediments is indispensable for their reasonably complete separation. The comparison between No. 27 and XII is therefore not one of beaker- vs. churn-elutriation, so much as one of pestling vs. 23 hours boiling and subsequent churning.*

With exception of the clay, the sediments consist essentially of water-worn quartz grains, in all respects except size, similar to those of the soil from the Experiment Station garden. The clay is in fact an alluvial deposit in the former bed of the Quinnipiac river, derived from the same drift which constitutes the soil of the Experiment Station garden.

In case of No. 27, the sediments .05–.01 and .01–0 were each further divided into two grades. The more detailed analysis is as follows:—

BRICK CLAY, NORTH HAVEN, CONN.

	Detailed analysis. Thoroughly pestled.
Removed by sifting	3.49
.25–.05	1.29
.05–.02	7.21
.02–.01	19.81
.01–.005	22.02
.005–.0	30.19
Clay	10.15
Loss on ignition	5.95
	100.11

The soil next examined was a clay loam from Deer River, N. Y., of very different characters, containing a considerable proportion of water-worn fragments of soft and superficially disintegrated slaty rocks. On this account it serves well for studying the processes that may be used in the treatment preparatory to mechanical analysis.

* I have not attempted to employ kneading or pestling in connection with churn-elutriation. It is evident that the pestling of 15 to 30 grams of soil at once, *preliminary* to elutriation, is objectionable, because the operator has no ready criterion for deciding, either when the process has gone far enough to break up aggregated particles of soil, or when it has reached the point of pulverizing fragments of soft rock. To knead and work over in the churn-elutriator, the sediments that have once passed it, would be effectual but very tedious. In beaker elutriation pestling is much more easily applied to finish the sediments that have been already obtained approximately pure, and the turbidity produced in the small portions of clear water used, indicates the effect of the pestling and shows how far to carry it.

CLAY LOAM, DEER RIVER, LEWIS CO., NEW YORK.*

	Beaker Elutriation. Not boiled but thoroughly pestled. No. 30.	No. 31.	30 grms. boiled 23 hours with 350 c. c. water in ½ liter flask. No. 32.	No. 34.	Churn Elu'n. 15 grms. boil'd 23 hours with 600 c. c. water in 1 liter flask. XIII.
Removed by sifting	20[illegible]2	19.91	14.69	13.89	17.94
.25–.05	17.96	18.41	18.12	18.83	19.32
.05–.01	25.26	26.94	21.42	19.40	24.66
.01–0.	23.05	22.00	28.14	33.13	24.25
Clay	3.55	4.75†	9.39	6.76†	5.84†
Loss on ignition	7.99	7.99	7.99	7.99	7.99
	98.73	100.00	99.75	100.00	100.00

The above analyses plainly demonstrate that for this soil pestling is a much safer treatment than boiling. Pestling gives 20.42 per cent. of material larger than $.25^{mm}$ as the average of two determinations that differ 1 per cent. Boiling for 23 hours abrades these fragments of shale and slate to the extent of 2.5 per cent. when 15 grams of the soil are boiled in 600^{cc} of water, while, when 30 grams are boiled in but 350^{cc} of water, the scouring amounts in two trials, to 5.7 and 6.5 per cent. respectively.

The first sediment, $.25–.05^{mm}$, is remarkably alike in amount in all the elutriations, the extremes differing but by 1.4 per cent. This fact indicates that in boiling it yielded as much to the finer grades as it gained from those coarser, or else that it consisted of

* *Note by the Director.*—This very superior soil was selected for mechanical analysis because the Director was formerly for years quite familiar with its qualities under tillage and cropping as well as with the geological elements from which it is formed. When the sample was taken, some 25 years ago, this land was and for more than 30 years had been capable of yielding 30 to 40 bushels of wheat per acre without manure. It had excellent texture, admitted of easy tillage when not too moist, was naturally well drained by the admixed and underlying gravel, and yet was retentive of moisture and suffered little under drouth. It retains to this day a high repute. The soil lies at the confluence of the Deer River with Black River and is an alluvium formed partly from the granitic drift that covers the adjacent higher land and partly from the disintegration of the soft rocks of the Lower Silurian that overlie each other in a long stretch of terraces and hills to the westward. Through these rocks Deer River and other tributaries of Black River have cut deep channels, and the soil contains a considerable proportion of water-worn gravel stones up to 2 inches or more in diameter, but commonly less than ½ inch in thickness, with well-rounded edges, derived from the Trenton Limestone, the Utica Slate, and the Lorraine Shales of the New York geologists. The soil as analyzed had been freed by sifting from material coarser than 2^{mm} diameter and contained 5.4 p. c. from 2 to 1^{mm}, 6.3 p. c. from .1 to $.5^{mm}$, and 9.2 p. c. from .5 to $.25^{mm}$.

† Clay and loss, by difference. All other determinations are direct.

quartz sand which suffered no considerable change. It does in fact largely consist of colorless transparent quartz grains, but these are intermixed with others of a brown color, some translucent on the edges and others quite opaque, and all the sediments except "clay" are quite alike in appearance under the microscope, both from the unboiled and boiled soils. To the unassisted eye the boiled sediments seen in mass, are whiter or lighter in color than those unboiled, evidently the result of scouring of the sand grains. In the part removed by sifting many fragments of slate or shale are to be seen, but none are detectable in the finer grades. It would appear therefore that when the weathered slate and shale get reduced to near 1^{mm} in thickness they lose all coherence and fall to sand, dust or clay. The brown, partly transparent, partly opaque particles, are probably bits of fine-grained argillaceous sand rock from the Lorraine Shales. The fragments of this rock apparently break up by the attrition of boiling, into the sand-grains of various dimensions from which the rock was originally formed.

In the $.05-.01^{mm}$ sediment the scouring effect of ebullition is again manifest and is evidently greater, as the friction of the grains of soil upon each other is increased by diminishing the volume of water with which they are boiled.

The matter detached by boiling from the foregoing grades is found in the two following, which in the extreme cases are 5.6 and 10.6 per cent. above the corresponding ones obtained from the unboiled but pestled earth.

The "clay" in analyses 30 and 32 as given above, was separated from silt ($.01-0^{mm}$) by 24 hours settling of the latter.

The following analysis was made on the fine earth of a fertile soil, from South Onondaga, New York, which originally contained a considerable proportion of slaty gravel and was derived in part from the limestones, slates and shales of the Upper Silurian and Lower Devonian. It is seen to be very similar in structure as it is in geological character to the clay loam from Deer River.

WHEAT SOIL, SOUTH ONONDAGA, NEW YORK.

	Beaker elutriation. Thoroughly pestled. No. 37.
Above 1^{mm}	6.96
.1-.5	5.45
.5-.25	5.17
.25-.05	9.07
.05-.01	26.35
.01-0	29.43
Clay, by difference	8.10
Loss on ignition	9.47
	100.00

The last analyses to mention in this paper have been made on an extremely fertile Prairie Soil.

PRAIRIE SOIL FROM MERCER CO., ILL.

	Thoroughly pestled. No. 33.	No. 34.	Boiled 23 hours. XIV.
Siftings	.62	.92	.57
.25-.05	2.42	2.89	5.69
.05-.01	43.58	42.86	46.95
.01-0.	31.58	31.44	26.74
Clay	5.81	7.40*	5.56*
Loss on ignition	14.49	14.49	14.49
	98.50	100.00	100.00

* Clay and loss, by difference.

Here again, in a soil consisting almost entirely of matter finer than .05 mm., long boiling and churning are quite insufficient to prepare properly for elutriation. The cementing material in this prairie soil is evidently, to a large extent organic matter. The churn-elutriated sediments were all black. The first two sediments in the other analyses were nearly white after pestling, the organic matter in company with the finest mineral substance being thus transferred to the last two grades.

The trials made thus far appear to justify the following conclusions:

1. On sands and silts of pure quartz or similar resistant material Hilgard's method and Beaker elutriation give practically identical results.

2. With coarse sands and silts upon whose grains finer matter has been cemented by silicates, etc., and with soils containing soft slaty detritus, the churn elutriator with preliminary boiling may give results too low for the coarse and too high for the finer grades. In these cases beaker elutriation with pestling yields more correct figures.

3. Some loamy soils containing no large amount of clay or of extremely fine silt, as well as prairie soils rich in humus, cannot be suitably disintegrated by 24 hours' boiling, but are readily reduced by pestling.

4. Beaker elutriation preceded by sifting, gives results in 5 or 6 hours with use of 2 to 3 gallons of pure water, which in churn elutriation require several days and consume 7 to 10 gallons of pure water.

5. Hilgard "found that practically $0{\cdot}25^{mm}$ is about the lowest velocity" (of water-current per second) "available within reason-

able limits of time" in his elutriator. Such a current carries over particles up to ·015^{mm} diameter and hence the silts of less dimensions cannot be conveniently separated by churn elutriation. In beaker elutriation there is no difficulty in making good separations at ·01^{mm} and at ·005^{mm}.

6. Beaker elutriation requires no tedious boiling or preliminary treatment and with careful pestling of the sediments gives, we believe, as nearly as possible, a good separation of adhering particles and at every stage of the process carries with it, in the constant use of the microscope, the means of testing the accuracy of its work and of observing every visible peculiarity of the soil. It is not claimed that pestling may not easily go too far, but in any case a good judgment may be formed of its effects and of the extent to which it is desirable to carry it.

7. In beaker elutriation the flocculation of particles occasions little inconvenience and does not impair the accuracy of the results.

Further investigations are required on the fine matter of stiff clays and of soils rich in humus. Such it is contemplated to undertake immediately.

Before concluding this paper I must acknowledge my constant indebtedness to Prof. Hilgard and to Dr. Moore for the assistance derived from their publications and for the descriptions, sketches and apparatus supplied by them to this Station, which have been available for my work.

Time has not as yet permitted any extended study of Schöne's method as practiced by Orth, Fesca and Wahnschaff, and we can only say, from a few trials in its use, that it is certainly open to very serious objections, as Hilgard has pointed out.

NOTES ON ANALYTICAL METHODS.

By Dr. T. B. Osborne.

Filtration of Crude Fiber.

The filtrations in the process of determining crude fiber are commonly quite difficult and tedious, the acid liquids especially, either running turbid through a coarse filter or clogging a fine one. In most cases these troubles may be avoided by using the filter pump and a paper filter supported on a platinum cone and by breaking the filter down the fold or crease, on one side. This is done by folding the paper so as to form a cone of an angle slightly less acute than the funnel, placing it in the latter, moistening and then applying the suction when the paper will usually tear apart, leaving a narrow rift from the vertex upward, across which stretches a loose network of fibers. If the sample has not been too finely ground it may be filtered clear by shaking or stirring up thoroughly and throwing quickly on to the paper so that the coarser particles will hold the finer and prevent the latter from passing the rift or clogging the paper. The break allows the solution to run off rapidly so that in most cases but three or four minutes are necessary to conclude the filtration.

This method has given good results in crude fiber determinations with hay and bran-feed and with sheep-dung, which were very difficult to manage by the usual methods.

Filtration and Weighing of Silver Chloride.

Solutions containing organic matter are often very difficult to filter from silver chloride, this precipitate at first running through and afterwards clogging the paper so as to make the filtration slow. The removal of the precipitate from the paper and the conversion of the reduced silver obtained after burning into chloride again, are operations taking considerable care and time. In many cases it is better to allow the precipitate to settle and to decant the greater part of the liquid through a Gooch asbestus filter. The precipitate is then dissolved in a very slight excess of ammonia water, the concentrated solution being thereupon made slightly acid with nitric acid, the precipitate will separate in a flocky form, which after carefully washing by decantation may be thrown on to the filter and sucked dry with the pump without danger of running through. If the precipitate be fused it is somewhat difficult to remove from the crucible, but it may be dried at 100°, at which temperature a constant weight is obtained in from a half to one hour.

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