STATE OF CONNECTICUT.

ANNUAL REPORT

OF

The Connecticut Agricultural

EXPERIMENT STATION

For 1880.

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1881.

OFFICERS

OF

The Connecticut Agricultural Experiment Station,

1880.

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H. P. ARMSBY, PH.D.

H. L. WELLS, PH.B., to July, 1880.

C. A. HUTCHINSON, B.S., since Sept., 1880.

His Exc. Hobart B. Bigelow, of New Haven, is President of the Board of Control for 1881. The other officers for 1881 are as above.

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, waters, milks, and other agricultural materials and products, to identify grasses, weeds, and useful or injurious insects, and to give information on the various subjects of Agricultural Science, for the use and advantage of the Citizens of Connecticut.

The Station makes analyses of Fertilizers and Seed-Tests 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 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.

Samples of Commercial Fertilizers, Seeds, etc., will be examined in the order of their coming; but when many samples of one brand or kind are sent in, the Station will make a selection for analysis.

The results of each analysis or examination will be promptly communicated to the party sending the sample. Results that are of general interest will be sent simultaneously to all the newspapers of the State for publication.

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 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 to

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

P. O. Box, 945.

Laboratory and Office, in East Wing of Sheffield Hall, Grove St., head of College St.

CONTENTS.

REPORT OF THE BOARD OF CONTROL.

To the General Assembly of the State of Connecticut:

GENTLEMEN:—The Board of Control of THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION herewith submits to your Honorable Body the Annual Reports of the Director and Treasurer made to this Board at its Annual Meeting held in Hartford, January 18th, 1881.

With the presentation of these Reports we beg leave to state that the work of the Station during the year has gone on without interruption, under the direction of Professor S. W. Johnson, assisted the whole year by Dr. E. H. Jenkins and Dr. H. P. Armsby, and a part of the year by Mr. H. L. Wells and Mr. C. A. Hutchinson. Dr. R. H. Chittenden has also assisted in some special investigations pertaining to animal poisoning.

The Board has held one meeting and its Executive Committee seven meetings during the year.

The last Report of the Experiment Station, by an arrangement with the Board of Agriculture and with the approval of the Comptroller, was bound with the printed Report of that Board and the two were distributed together from the office of the Secretary of the Board of Agriculture at Hartford. That arrangement has been so satisfactory that it is continued this year.

By order of the Board of Control.

HOBART B. BIGELOW,
President.

WILLIAM H. BREWER,
Secretary.

REPORT OF THE TREASURER.

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

Receipts.

Balance from account of 1879,	$527.71	
Laboratory Receipts,	371.45	
From State Treasurer,	5,000.00	
		$5,899.16

Payments.

Salaries,	$3,967.50	
Travelling expenses of the Board,	57.29	
Printing, Stationery and Postage,	287.75	
Gas,	91.96	
General Laboratory Expenses,	1,108.55	
Furniture, Repairs and Fixtures,	214.96	
Miscellaneous,	38.59	
Cash on hand,	132.56	
		$5,899.16

There is due the Station for Laboratory work, one hundred fifty-eight (158) dollars, which added to the cash on hand, amounts to two hundred and ninety (290) dollars. The bills outstanding against the Station will fully equal that amount.

The Station is in possession of office furniture, apparatus, laboratory stock, seed, plant and other collections, tools, appliances, etc., estimated to be worth thirteen hundred (1300) dollars. That is, it would take that sum or more to replace them or their equivalent.

WM. H. BREWER,
Treasurer.

New Haven, Jan. 17th, 1881.

T. S. Gold,
W. O. Atwater, } *Auditing Committee.*

REPORT OF THE DIRECTOR.

The pages that follow contain the Fourth Annual Report on the work of this Station, and give an account of its operations for the year 1880.

The Objects and Uses of the Station, and the Privileges which it offers to the citizens of Connecticut, are concisely set forth in the Announcement which is to be found on page 3.

The most important subjects which have engaged attention at the Station during the year 1880, are briefly stated in the paragraphs that immediately follow. Reference to the Table of Contents will direct to their details and show what other topics are considered in this Report.

The analysis and valuation of *Commercial Fertilizers* continues to be the most engrossing employment of the Station. During the eleven months ending Dec. 1, 1880, one hundred and forty-one (141) samples of such fertilizers have been analyzed. Twenty (20) analyses have been made of *Swamp Mucks, Soils and Rocks.* Of *Fodder and Feeding Stuffs*, seventeen (17) samples have been examined.

Seven (7) *River and Well Waters* have been tested as to their sanitary condition.

Five (5) specimens of *Market Butter* were analyzed for the purpose of ascertaining whether this article is subject to adulteration.

Four (4) *Vinegars* were tested as to strength and for adulterations.

Nine (9) samples of *Bread* have been examined for alum.

Five (5) poison-tests have been made, viz: on a sample of London purple, on corn stover that had been sprinkled when young with Paris Green, and on the stomachs, kidneys or urine of animals that died of poison or under suspicion of it.

In addition to the above specified two hundred and eight (208) analyses, a large amount of work has been done in further study of methods of determining phosphoric acid in quantitative analysis.

Sixty-five (65) *Seed* tests have also been made for the Trade.

Station Bulletins—Fourteen in number—have been printed and sent to each of the eighty-two newspapers published in the State, and also to the Secretaries of the thirty-one Agricultural Societies and twenty-six Farmers' Clubs of Connecticut. The Bulletins have also been supplied by way of exchange to many of the Agricultural Periodicals published in the New England and Middle States, and are regularly re-printed in several of the most widely circulated of these journals. Those who wish to see all of these Bulletins, and at the earliest moment, can find them in the CONNECTICUT FARMER, published weekly at Hartford, to the editor of which I must express my obligations for their first printing and for supplying copies of them for the use of the Station, at a small cost.

After conducting the work of this Station for three and one-half years, I feel it a duty to lay before the General Assembly and the citizens of the State some statements regarding its present efficiency as contrasted with the work which I conceive it ought to accomplish and might easily perform with a moderate increase of its resources.

The Present Resources of the Station.—In its present organization the locality of the Connecticut Agricultural Experiment Station consists of two apartments sixteen by thirty feet, besides an entrance hall, and a small closet, all loaned for its use. One of these larger rooms is its chemical laboratory, the other its office and writing room. Its property consists of the most essential chemical apparatus needed for analytical work and the simplest office furniture and requisites. It has no land and no place where any experiments on soils, plants or animals, under agricultural conditions, can be set up or carried out. The Station owns no books except its own manuscript records, a few copies of its printed Reports and a few volumes of agricultural journals and transactions received in way of exchange.

That the Station thus lives in borrowed lodgings, without grounds or opportunities for agricultural experiments, is not the plan or desire of the Board of Control, but has been necessitated by the limited means at its disposal.

The Wants of the Station.—In its present shape the Station is quite strictly confined to those investigations which can be made in the chemical laboratory, but is debarred from any systematic or serviceable experimental study of the very numerous and most important questions which relate to the wants of soils, crops, or domestic animals, a study which would require ground and the simpler appliances that are employed in practical agriculture.

The analysis of Commercial Fertilizers, which so largely occupies the working force of the Station, accomplishes a single though highly useful purpose, viz: to enable the farmer to know the composition and approximate commercial value of the costly manures that are so largely consumed in our State.

But what is equally important is to know the agricultural value of these fertilizers or their elements, and their economical adaptation to various soils, crops or circumstances. Numerous inquiries are constantly addressed to the Station relating to these topics, to which in many cases no satisfactory answer can be given. In most instances, however, suitably conducted practical experiments would make it possible to answer these inquiries more or less perfectly, and to make valuable additions to our store of knowledge. There are two methods of making such experiments. They may be carried out on a farming scale for a series of years, as has been done at a few places in Europe, notably by Mr. Lawes of England; but thus conducted, their expense is so great and so long a time must usually pass before the useful results appear, that this method is not open to the Experiment Station unless it were transferred to a farm, and provided with five or six times its present amount of funds. Another plan is to make experiments on a small scale in pots or boxes. This method has indeed some drawbacks, but very many advantages. It requires but little ground. By use of a greenhouse, in this sunny climate, experiments may be carried on nearly throughout the year, their number may be cheaply multiplied and results got in a comparatively short time. Furthermore, the influence of disturbing causes, excess or lack of rain or warmth, the ravages of birds and insects, may be more perfectly avoided. By this method a large number of experiments have been made and are constantly making in the European Stations and in this country. Prof. Storer at the Bussey Institution, Dr. McMurtrie at the Department of Agriculture, Washington, and the writer have obtained useful results by its means.

On subsequent pages is given an account of some efforts to ascertain how the nitrogen of swamp muck becomes available to plants, which illustrate the value of this plan of experiment.

To carry on such experiments as a part of Station work would require that the Station should have control of a plot of ground of one or several acres in extent, with unobstructed exposure to sun, and so enclosed as effectually to exclude all intrusion from man and beast.

Furthermore, there would be needed a suitable glass plant-house, with heating arrangements, water, etc., and a skillful gardener would have to be added to the working force of the Station.

The seedsmen of our State are beginning to call upon the Station to test the vitality and purity of their seeds, and to do this at the proper time (in winter) and to the extent which is soon likely to be demanded, a special seed laboratory will be absolutely necessary.

This experimental ground, furthermore, should be the site of the Station Laboratory, because the experiments to be conducted there would require more or less chemical work to be done in preparing for them and in elaborating their results, and would demand the constant oversight of the Director and his assistants throughout all their duration.

The Station should also have lodgings for its gardener and for other responsible assistants within its enclosure, to ensure the undisturbed progress of its investigations.

The Station grounds with these buildings cannot be placed beyond the reach of illuminating gas and water-service pipes, without extreme inconvenience to its garden and laboratories. The Station should therefore be permanently located in some city suburb where it will also be readily accessible to the Post, Express and Telegraph Offices. The chemical laboratory of the Station ought to consist of a room somewhat larger than that now occupied, and should have adjoining a capacious store-room and a smaller furnace room. In connection with its office should be suitable accommodation for a considerable library. It would be extremely desirable also to have space for preserving and displaying specimens of objects having agricultural interest, which fall in the line of its investigations, viz: samples of the seeds of useful and injurious plants and a collection of such plants as might be useful for purposes of comparison and identification. The Station has already in its possession a small but valuable collection of seeds, and a pretty complete herbarium of the grasses and sedges of New England. Samples of rocks, soils, crude and native fertilizing materials and agricultural products of various kinds could readily be kept as an instructive exhibition, if but the place were provided.

A plain brick building with the capacity of a large dwelling house would give the Station good accommodation in all these respects.

To carry on the Station thus equipped in a manner commensurate with the interests involved would require some increase of its funds, for several purposes.

1. To enlarge its laboratory outfit, which is barely sufficient for the analytical work it has had to do, but ought to be considerably extended for profitable working.

2. To establish a working reference library. The Station must be vitally defective unless those who labor in it can have ready and constant access to all the special books, journals and Reports which record the results of investigations in the Experiment Stations of other States and Countries.

3. The Station will need a larger fund for current expenses so soon as it begins to experiment in the field, garden and plant-house.

COMMERCIAL 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, all results obtained in its Laboratory, for the public benefit, and in no case will enter into any privacy that can work against the public good.

During 1880, one hundred and forty-one (141) samples of fertilizers have been analyzed. Of these, 33 were examined for private parties, and the remainder, 108, for the general use of the citizens of the State.

The samples analyzed for the public benefit have been sent in from various quarters of the State, in most instances by actual purchasers and consumers, but in some instances, by dealers or agents.

* The matter of this and of several subsequent pages explanatory of the sampling and valuation of fertilizers, is copied with a few appropriate alterations from the Report for 1879.

All the analyses of the first class are made on samples understood to have been taken in accordance with the printed Instructions which the Station supplies to all applicants. Here follows a copy of these instructions.

INSTRUCTIONS FOR SAMPLING COMMERCIAL FERTILIZERS.

The *Commercial Value* of a high priced Fertilizer can be estimated, if the amounts *per cent.* of its principal fertilizing elements are known. Chemical analysis of a small sample, so taken as to fairly represent a large lot, will show the composition of the lot. The subjoined instructions, if faithfully followed, will insure a fair sample. Especial care should be observed that the sample neither gains nor loses *moisture* during the sampling or sending, as may easily happen in extremes of weather, or from even a short exposure to sun and wind, or from keeping in a poorly closed vessel.

1. Provide a tea cup, 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. Weigh separately at least three (3) average packages (barrels or bags) of the fertilizer, and enter these *actual weights* in the "Form for description of Sample."

3. Open the packages that have been weighed, and mix well together the contents of each, down to one-half its depth, emptying out upon a clean floor if needful, and crushing any soft, moist lumps in order to facilitate mixture, but leaving hard, dry lumps unbroken, so that the sample shall exhibit the texture and mechanical condition of the fertilizer.

4. Take out five (5) equal cupfuls from different parts of the mixed portions of each package. Pour them (15 in all) one over another upon a paper, intermix again thoroughly but quickly to avoid loss or gain of moisture, fill a can or box from this mixture, close tightly, *label plainly*, and send, charges prepaid, to

The Conn. Agricultural Experiment Station, New Haven, Conn.

The foregoing instructions may be over-nice in some cases, but they are not intended to take the place of good sense on the part of those who are interested in learning the true composition of a fertilizer. Any method of operating that will yield a *fair sample* is good enough.

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 a good number of places will give a fair sample with great ease. With dry, coarse articles, such as ground bone, there is likely 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. Otherwise the analysis will certainly misrepresent the article whose value it is intended to fix.

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

It is also important that samples for analysis should be taken at the time when the fertilizer is purchased, and if they cannot be at once dispatched to the Station, they should be so preserved as to suffer no change. Moist fish, blood or cotton seed will soon decompose and lose ammonia, if bottled and kept in a warm place. Superphosphates containing much 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.

These changes in the composition of a sample not suitably preserved, must invalidate any conclusions from its analysis, and work serious injustice either to the manufacturer or to the consumer.

It doubtless often happens that a purchaser on laying in a stock of fertilizers, decides that he will not then trouble the Station to analyze the goods he has obtained, but will set aside samples which he can send for examination in case the crops report adversely as to their quality. It is always better to send all samples at once to the Station where they can be directly analyzed or so prepared that they shall keep without chemical change.

With the Instructions for Sampling, the Station furnishes a blank Form for Description of Samples, a copy of which is here given.

Form for Description of Sample.

Station No.................. Rec'd at Station,................................18

Each sample of Fertilizers sent for gratuitous analysis must be accompanied by one of these Forms, with the blanks *below* filled out fully and legibly.

The filled out Form, if wrapped up with the sample, will serve as a label.

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

Brand of Fertilizer,...

Name and address of Manufacturer,...

....

Name and address of Dealer from whose stock this sample is taken,...

Date of taking this sample,...

Selling price per ton or hundred, bag or barrel,.................................

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

Actual weight of packages opened,...

Here write a copy of any analysis or guaranteed composition that is fixed to the packages.

....

Signature and P. O. address of person taking and sending the sample.

....

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 estimating, with help of the analysis, the commercial value of its fertilizing elements, and 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 manufacturers or dealers as well as mislead consumers. It is especially important that the *Brand* of a fertilizer and its *Selling price* should 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.

When a sample of fertilizer has been analyzed, the results are entered on a printed form, which is filed in the Station Record of Analyses, facing the "Description of Sample" that was received with the fertilizer to which it pertains, and there remains for future reference.

A copy of the analysis is also immediately reported to the party that furnished the sample, the report being entered on one page of another printed form and facing a second 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 of Fertilizer-Analysis and Valuation.

Nitrogen is commercially the most valuable fertilizing element. It occurs in various forms or states. *Organic nitrogen* is the nitrogen of animal and vegetable matters generally, existing in the albumin and fibrin of meat and blood, in the uric acid of bird dung, in the urea and hippuric acid of urine, and in a number of other substances. Some forms of organic nitrogen, as that of blood and meat, are highly active as fertilizers; others, as that of hair and leather, are comparatively slow in their effect on vegetation unless these matters are reduced to a fine powder or 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 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. It is not only readily taken up by plants, but is distributed through the soil by rains. Once well incorporated with soil it shortly becomes reverted phosphoric acid.

Reverted (reduced or precipitated) Phosphoric acid, strictly means phosphoric acid that was once freely soluble in water, but from chemical change has become insoluble in that liquid. It is freely taken up by a strong solution of ammonium citrate, which is therefore used in analysis to determine its quantity. "Reverted phosphoric acid" implies phosphates that are readily assimilated by crops, but generally have less value than soluble phosphoric acid, because they do not distribute freely by rain.

Insoluble Phosphoric acid implies various phosphates not freely soluble in water or ammonium citrate. In some cases the phosphoric acid is too insoluble to be rapidly available as plant food. This is true of South Carolina rock phosphate, of Navassa phosphate, and especially of Canada apatite. The phosphate of coarse raw bones is at first nearly insoluble in this sense, because of the animal matter of the bone 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 is most costly in the form of sulphate, and cheapest in the shape of muriate or chloride.

The Valuation of a Fertilizer signifies estimating its worth in money, or its trade-value; a value which 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 other fertilizers, for which $30 to $80 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 easily estimated from the market prices of the standard articles which furnish them to commerce.

The average Trade-values or cost in market per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash, as found in the Connecticut and New York markets, and employed by the Station during 1879 and 1880, have been as follows:

TRADE-VALUES FOR 1879 and 1880.—*See page 21.*

	Cents per pound.
Nitrogen in nitrates,	26
" in ammonia salts,	22½
" in Peruvian Guano, fine steamed bone, dried and fine ground blood, meat and fish,	20
" in fine ground bone, horn and wool dust,	18
" in fine medium bone,	17¼
" in medium bone,	16½
" in coarse medium bone,	15¾
" in coarse bone, horn shavings, hair and fish scrap,	15
Phosphoric acid soluble in water,	12½
" " "reverted" and in Peruvian Guano,	9
" " insoluble, in fine bone and fish guano,	7
" " " in fine medium bone,	6½
" " " in medium bone,	6
" " " in coarse medium bone,	5½
" " " in coarse bone, bone ash and bone black,	5
" " " in fine ground rock phosphate,	3½
Potash in high grade sulphate,	7½
" in low grade sulphate and kainite,	6
" in muriate or potassium chloride,	4½

These "trade-values" of the elements of fertilizers are not fixed, but vary with the state of the market, and are from time to time subject to revision. They are not exact to the cent or its fraction, because the same article sells cheaper at commercial or manufacturing centers than in country towns, cheaper in large lots than in small, cheaper for cash than on time. These values are high enough to do no injustice to the dealer, and properly interpreted, are accurate enough to serve the object of the consumer.

To Estimate the Value of a Fertilizer we multiply the per cent. of Nitrogen, etc., by the trade-value per pound, and that product by 20, we thus get the values per ton of the several ingredients, and adding them together we obtain the total estimated value 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 one one-hundredth of that product, multiplying it by the estimated value per pound of nitrogen in that grade, and taking this final product as the results 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 estimated value of the sample of bone. For further particulars, see page 28.

The uses of the "Valuation" are, 1st, 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 no higher than the estimated value, the purchaser may be quite sure that the price is reasonable. If the selling price is but $2 to $3 per ton more than the estimated value it may still be a fair price, but if the cost per ton is $5 or more over the estimated value, it would be well to look further. 2d, Comparisons of the estimated values and selling prices, of a number of fertilizers, will generally indicate fairly which is the best for the money. But the "estimated value" 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.

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.

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 estimated from different data. The greatest good of the greatest number is best served, in an Annual Report, by a middle course, especially since, in such a document, the fluctuations in trade-value that may occur within the year, cannot be accurately followed, and the comparisons of estimated values are mostly in retrospect.

For the year 1881 it is proposed to employ the following revised Trade-Values:

TRADE-VALUES FOR 1881.—*See page 49.*

	Cents per pound.
Nitrogen in nitrates,	26
" in ammonia salts,	22½
" in Peruvian Guano, fine steamed bone, dried and fine ground blood, meat and fish, superphosphates and special manures,	20
" in coarse or moist blood, meat or tankage, in cotton seed, linseed and Castor Pomace,	16
" in fine ground bone, horn and wool dust,	15
" in fine medium bone,	14
" in medium bone,	13
" in coarse medium bone,	12
" in coarse bone, horn shavings, hair and fish scrap,	11
Phosphoric acid soluble in water,	12½
" " "reverted" and in Peruvian Guano,	9
" " insoluble, in fine bone and fish guano,	6
" " " in fine medium bone,	5½
" " " in medium bone,	5
" " " in coarse medium bone,	4½
" " " in coarse bone, bone ash and bone black,	4
" " " in fine ground rock phosphate,	3½
Potash in high grade sulphate,	7
" in low grade sulphate and kainite,	5½
" in muriate or potassium chloride,	3½

The reasons for these changes are to be found in subsequent pages.

ANALYSES AND VALUATION OF COMMERCIAL FERTILIZERS.

The Commercial fertilizers analyzed in the Station Laboratory during the year 1880, are as follows, viz:

38 superphosphates and guanos.
2 Pollard's Privy Guano.

15 ground bone.
17 dried blood, etc.
16 dried fish scrap.
1 horn shavings.
5 castor pomace and cotton seed meal.
4 sulphate of ammonia.
1 nitrate of soda.
8 potash salts.
1 leached wood ashes.
1 unleached wood ashes.
3 plaster.
3 salt kiln-refuse and salt washings.
1 stable manure.
1 vegetable ivory.
24 "special manures" or "formulas" for particular crops.

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Here follow the details of those analyses which have any general interest, together with such remarks as may be useful in explanation.

Superphosphates, Guanos, &c.

Of thirty-eight samples of this class of fertilizers sixteen were analyzed for private parties.

The twenty-one fertilizers whose analyses follow, whatever may be their trade names, are all superphosphates in the commonly received sense of that word, i. e., they contain soluble or reverted phosphoric acid, as a distinctive ingredient. With one exception, **436,** they contain nitrogen, and in fifteen of them potash is present in a greater or less amount. Their nitrogen is in all cases mostly the nitrogen of fish, blood or other animal matters—so-called organic nitrogen. Their soluble and reverted phosphoric acids are mostly the result of acting on some native phosphate, or on bone with sulphuric acid. Their potash is in all cases due to admixture of some grade of potash salts. While, with the exception of **436,** they are of two kinds in respect to the number and nature of their active ingredients, they are practically of one and the same kind as far as the state and mode of action of these ingredients are concerned, and are alike in being compounded and manufactured of similar raw materials, as well as in the circumstance that they are offered and used for the purpose of applying to crops and soils in general. For these reasons they are classed and tabulated together, so that the consumer may be able easily to make comparisons as to their composition, cost, and estimated value. To facilitate the comparison of cost and valuation, they are arranged in the order in which value exceeds cost or the reverse. In regard to the last two columns of the Table p. 25, it must be remembered that the cost per ton depends somewhat upon the place where they are purchased; the difference, for example, between New York and New Haven prices for articles manufactured or imported at the former place being $1.50 more or less per ton. Prices also usually vary for the same article, according to the quantity sold. Thus one and the same superphosphate was sold at New Haven for $38 per ton and at Bristol at $2.00 per hundred pounds, equal to $40 per ton. On comparing the composition, valuation and cost of the same articles as obtained from different sources at different times, as, for example, **374** with **410, 378** with **386, 399** with **412, 380** with **456, 430** with **424** and **460,** it is seen that the extreme fluctuation of cost in any of these cases is $2.00 per ton, while the valuation varies from about $0.50 to $3.50 per ton. The differences in the percent of valuable fertilizing ingredients in the same brand are in some instances not inconsiderable, as will be seen by glancing through the columns of the Table on page 26, where in one case, soluble phosphoric acid varies from 2.4 to 4.9 per cent, and in another, potash ranges from 1.9 to 4.6 per cent. In general, however, the samples are fairly accordant in composition, as nearly so, doubtless, as it is possible to make them, for the manufacturer can only get a uniform product when he is able to obtain raw materials of uniform quality.

The differences to which attention has been drawn are, in fact, necessarily more or less incidental to the business of compounding fertilizers out of various raw or waste matters which are themselves variable in their composition.

In round numbers, the average cost of these fertilizers, $39, exceeds the average valuation, $36, by $3. In them, therefore, the average cost of nitrogen, etc., is somewhat greater than the trade-values that have been employed by the Station for these fertilizing elements.

The sample **436,** an imported high-grade superphosphate, without nitrogen, supplies, per ton, 312 pounds of soluble phosphoric acid for $31.55, or at the rate of ten cents per pound.

Superphosphates, Guanos, &c.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Sent by
436	Superphosphate of Lime, C. B. 15%	Imported.	H. J. Baker & Bros., New York.	J. J. Webb, Hamden.
404	Superphosphate.	Lombard & Matthewson, Warrenville.	Lombard & Matthewson.	J. D. Gaylord, Ashford.
374	"	Quinnipiac Fertilizer Co., New London.	R. B. Bradley & Co., New Haven.	R. B. Bradley.
378	Mapes Complete Manure.	Mapes Formula & Peruvian Guano Co., Newark, N. J.	A. N. Clark, Milford, Ct.	J. W. Nettleton, Milford.
459	Bridgeport Ground Bone (dissolved.)	Manhattan Fertilizer Co., New York and Bridgeport.	F. C. Stickney, Bridgeport, Ct.	F. C. Stickney.
399	Pine Island Guano.	Quinnipiac Fertilizer Co.	R. B. Bradley & Co.	R. B. Bradley.
455	Superphosphate.	E. Frank Coe, New York.	Buck & Durkee, Williamantic.	Buck & Durkee.
373	Fish and Potash.	Quinnipiac Fertilizer Co.	R. B. Bradley & Co.	R. B. Bradley.
411	" "	" " "	S. A. Weldon & Son, Bristol.	S. R. Gridley, Bristol.
386	Mapes Complete Manure.	Mapes Formula & Peruvian Guano Co., Newark, N. J.	Mapes Formula Co., Hartford.	L. S. Wells, New Britain.
384	Ammoniated Bone Superphosphate.	Geo. W. Miles Co., Milford.	Geo. W. Miles Co.	J. W. Nettleton, Milford.
412	Pine Island Guano.	Quinnipiac Fertilizer Co.	S. A. Weldon & Son.	S. R. Gridley, Bristol.
410	Superphosphate.	" " "	S. A. Weldon & Son.	S. R. Gridley, Bristol.
381	"	Lister Bros., Newark, N. J.	A. N. Clark, Milford.	J. W. Nettleton, Milford.
437	Soluble Pacific Guano.	Pacific Guano Co., Boston, Mass.	J. M. Belden, New Britain.	G. M. Barbour, New Britain.
380	Superphosphate.	Russell Coe. Linden, N. J.	E. B. Clark, Milford.	J. W. Nettleton, Milford.
415	"	Bradley, Boston, Mass.	Wilcox & Judd, Bristol.	S. R. Gridley, Bristol.
456	"	Russell Coe, Linden, N. J.	Buck & Durkee, Willimantic.	Buck & Durkee.
430	Manhattan Blood Guano.	Manhattan Fertilizer Co.	R. J. Homes, Plainville.	J. W. Hemingway, Plainville.
424	" " "	" " "	G. H. Staples, Westport.	S. B. Wakeman, Saugatuck.
460	" " "	" " "	F. C. Stickney, Bridgeport.	F. C. Stickney.

Superphosphates, Guanos, &c.—*Analyses and Valuation.*

Station No.	Name.	Nitrogen.	Soluble Phos. Acid.	Reverted Phos. Acid.	Insoluble Phos. Acid.	Potash.	Estimated value per ton	Cost per ton.	Valuation exceeds cost.
436	C. B. 15 per cent. Superphos.,		15.60	.24	.17		$39.67	$31.55*	$8.12
404	Lombard & M. Superphosph.,	3.61	5.10	8.15	2.97		44.83	40.00	4.83
374	Quinn. Fert. Co. Superphos.,	3.31	1.23	7.60	5.57	2.77	40.28	38.00	2.28
378	Mapes Complete Manure, --	3.13	4.86	5.04	2.48	3.30	40.64	40.00	0.64
									Cost exceeds valuation.
459	Bridgeport Dis. Bone, -----	.89	5.18	3.41	5.24		29.99	30.00	.01
399	Pine Island Guano, -------	5.70	.86	4.03	2.42	4.37	39.52	40.00	.48
455	E. Frank Coe's Superphos., -	2.61	9.14	.55	2.06		37.15	38.00	.85
373	Fish and Potash, ---------	4.25	1.44	3.07	.87	4.65	32.93	34.00	1.07
411	Fish and Potash, --------	4.52	1.27	3.78	1.88	1.92	32.42	34.00	1.58
386	Mapes Complete Manure, --	2.44	2.37	7.34	4.50	3.15	38.32	40.00	1.68
384	G. W. Miles Co. Superphos.,	1.90	6.05	1.65	6.25	1.76	36.03	38.00	1.97
412	Pine Island Guano, -------	4.79	.92	5.57	2.47	4.60	39.09	42.00	2.91
410	Quinn. Fert. Co. Superphos.,	3.22	1.26	6.88	4.68	2.05	36.81	*40.00	3.19
381	Lister Bros. Superphosphate,	2.22	6.84	1.75	2.44		32.55	36.00	3.45
437	Soluble Pacific Guano, ----	3.28	6.93	1.14	2.72	3.98	40.09	46.00	5.91
380	Russell Coe's Superphosph.,	1.13	4.06	2.02	7.30	1.35	29.75	36.00	6.25
415	Bradley's Superphosphate, -	3.06	7.48	.87	1.25	1.46	35.57	**43.00	7.43
456	Russell Coe's Superphosph.,	.84	2.93	2.45	9.60		28.53	38.00	9.47
430	Manhattan Blood Guano, --	2.37	5.57	1.52	6.08	.76	35.33	45.00	9.67
424	Manhattan Blood Guano, --	2.56	5.99	1.10	4.19	.56	33.55	46.00	12.45
460	Manhattan Blood Guano, --	2.47	6.09	.75	2.99	1.29	31.80	45.00	13.20
	Average of 21 samples, --------						$35.95	$39.07	$3.12

* $2.00 per hundred pounds. ** $2.15 per hundred.

Comparison of different samples of the same brand of Superphosphate, &c.

		Nitrogen.	Soluble Phos. Acid.	Revert. Phos. Acid.	Insol. Phos. Acid.	Potash.	Estim. Value.	Cost.
Quinnipiac Fertilizer Co's Superphosphate,	**374**	3.31	1.23	7.60	5.57	2.77	$40.28	$38.00
	410	3.22	1.26	6.88	4.68	2.05	36.81	(40.00)
Mapes Complete Manure,	**378**	3.13	4.86	5.04	2.48	3.30	40.64	40.00
	386	2.44	2.37	7.34	4.50	3.15	38.32	40.00
Pine Island Guano,	**399**	5.70	.86	4.03	2.42	4.37	39.52	40.00
	412	4.79	.92	5.57	2.47	4.60	39.09	42.00
R. Coe's Superphosphate,	**380**	1.13	4.06	2.02	7.30	1.35	29.75	36.00
	456	.84	2.93	2.45	9.60		28.53	38.00
Manhattan Blood Guano,	**430**	2.37	5.57	1.52	6.08	.76	35.33	45.00
	424	2.56	5.99	1.10	4.19	.56	33.55	46.00
	460	2.47	6.09	.75	2.99	1.29	31.80	45.00
Fish and Potash,	**373**	4.25	1.44	3.07	.87	4.65	32.93	34.00
	411	4.52	1.27	3.78	1.88	1.92	32.42	34.00

Pollard's Privy Guano.

The readers of the first Bulletins of this Station will remember that in August, 1877, analyses were published of two so-called "Improved Fertilizers," purporting to be made by Pollard Bros., then of New Haven.

These fertilizers, a "Composition for Grass" and a "Composition for Vegetables," were sold to some extent in the vicinity of New Haven for $32 per ton. They consisted essentially of dried harbor mud, with a little bone dust added, and were commercially worth about $1 per ton.

In January, 1880, the newspapers announced the discovery by H. M. Pollard, of Providence R. I., of a new and valuable fertilizer made from night soil, and soon after a sample of "Concentrated Privy Guano" was brought to the Station by a party who gave his name and address as F. C. Cook, 119 Ellsworth Avenue, New Haven, and who represented the sample to have been sent him by the manufacturers, Pollard & Cook, of Providence. In February the same person brought another sample, which he stated was taken by himself in New Haven from a lot of ten tons which he had purchased for his own use.

These samples were duly analyzed—the first completely, the second partially, and the reports of the analyses were made out in the usual form, signed by me, and mailed to F. C. Cook. On April 3, the analyses were published in Bulletin 38, as follows:

347, 354, Concentrated Privy Guano, manufactured by Pollard & Cook, Providence.

No. **347** sampled by the manufacturers and brought to the Station January 16, by F. C. Cook, 119 Ellsworth Avenue, New Haven.

No. **354** sampled by F. C. Cook, in February, from lot of ten tons purchased by him. Cost, $65 per ton.

COMPOSITION.

	347	**354**
Moisture	5.10	
Organic Matter, (Nitrogen—0.50)	7.93	
Ammonia (" 4.06)	4.92	
Nitric Acid (" 10.03)	38.70	
Phosphoric Acid, soluble	7.76	
Sulphuric Acid	4.71	
Chlorine	.22	
Soda	2.06	
Potash	24.90	
Lime	3.70	
Magnesia	trace	
	100.00	
Total Nitrogen	14.59	14.29

VALUATION OF **347**.

	lbs. per ton.	Val. per lb.	Ton Value.
Nitrogen of Nitrates	200.6	26 cts.	$ 52.15
Nitrogen of Ammonia	81.2	22½ "	18.27
Organic Nitrogen	10.0	20 "	2.00
Soluble Phosphoric Acid	155.2	12½ "	19.40
Potash	498.0	7½ "	37.35
Total Estimated Value			$129.17
Cost			65.00

The analyses were accompanied with the following remarks:

This Privy Guano has an unmistakable privy odor, but unlike night soil, it is almost entirely soluble in water, and unlike both night soil and urine, it consists mainly of nitrates and phosphates of potash, ammonia and soda. It is not manufactured from night soil, although it is flavored with this last-named substance. Its commercial value is almost double its cost, a fact that would be very welcome to the consumers of fertilizers if it could remain a fact. But a "Privy Guano" of this composition cannot long be afforded for much less than $130 per ton, and the extraordinary value of the two samples that thus early have found their way to the Station, should put purchasers on their guard against a sudden and great decline in its composition and value.

Any parties who have laid in a supply would do well to have samples analyzed before waiting for a crop.

In Bulletin 44, issued June 12, 1880, was reported:

The last advices about the Pollard Fertilizers come from Philadelphia, where, according to the letters of an inquiring correspondent, one Dr. H. M. Pollard, representing himself to have been at one time State Chemist to Rhode Island, and afterwards to Massachusetts, has been disposing of the right to make a patent fertilizer, the composition of which is attested by an analysis over the signature of the Director of this Station, giving its value at $127.59 per ton. My correspondent writes that he obtained this information from a party who had agreed to buy the patent right for a certain section of Pennsylvania, for a considerable sum of money, to whom Pollard represented that the fertilizer could be made for $13.56 per ton, and that the right to manufacture it had been sold for Easton, Pa., for $500, and had been negotiated for Allentown and Reading, Pa., and for Baltimore, Md.

It would thus appear that H. M. Pollard "discovered" the Concentrated Privy Guano, and obtained its analysis from this Station for the purposes of a swindling expedition on which he is now engaged.

Finally, in September, inquiry was made at the Station as to the cost of analyzing a sample of guano, or supposed guano, which it was stated had been supplied by H. M. Pollard to parties who had bought the "right" to manufacture for this State. It was further stated that the swindle had been discovered, and that H. M. Pollard had been under arrest for some reason therewith connected.

Bone Manures.

Method of Valuation.

The method adopted for the valuation of bone manures has been already outlined on page 20. I give here further details.

Experience has led me to distinguish, for the purposes of valuation, five grades of ground bone, the proportions of which are found by a mechanical analysis, *i. e.* by passing a weighed sample

of the bone through a system of four sieves. These five grades have the dimensions, and have had, hitherto, the trade-values below specified, viz:

Grade.	Dimensions.	1879 & 1880. Estimated value per pound. Nitrogen.	Phos. Acid.
Fine,	smaller than one $\frac{1}{50}$ inch,	18 cts.	7 cts.
Fine medium,	between $\frac{1}{50}$ and $\frac{1}{25}$ inch,	$17\frac{1}{4}$ "	$6\frac{1}{2}$ "
Medium,	" $\frac{1}{25}$ and $\frac{1}{12}$ inch,	$16\frac{1}{2}$ "	6 "
Coarse medium,	" $\frac{1}{12}$ and $\frac{1}{6}$ inch,	$15\frac{3}{4}$ "	$5\frac{1}{2}$ "
Coarse,	larger than $\frac{1}{6}$ inch,	15 "	5 "

The chemical and mechanical analysis of a sample of ground bone being before us, 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 estimated 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 estimated value of the sample of bone.

As an example of the valuation of a bone manure by this method, the following may serve. **92,*** raw bone, from Stepney Bone Mills, Monroe, contained phosphoric acid 20.56 *per cent.* or 411.2 pounds per ton, and nitrogen 3.63 *per cent.* or 72.6 pounds per ton. By the mechanical analysis it showed:

26	per cent.	fine.
23	"	fine medium.
27	"	medium.
24	"	coarse-medium.
0	"	coarse.

The calculations are as follows:

$72.6 \times 26 \div 100 \times 18 = \$3.40$
$72.6 \times 23 \div 100 \times 17\frac{1}{4} = 2.88$
$72.6 \times 27 \div 100 \times 16\frac{1}{2} = 3.23$
$72.6 \times 24 \div 100 \times 15\frac{3}{4} = 2.84$

Estimated value of nitrogen = $12.25

$411.2 \times 26 \div 100 \times 7 = \$7.48$
$411.2 \times 23 \div 100 \times 6\frac{1}{2} = 6.15$
$411.2 \times 27 \div 100 \times 6 = 6.66$
$411.2 \times 24 \div 100 \times 5\frac{1}{2} = 5.43$

Estimated value of phosphoric acid = $25.72

Total estimated value = $37.97

* Reported in 1878.

This result agreed within $2.00 of the cost ($40.00).

When the sample of bone contains foreign matters introduced as preservatives, dryers or adulterants, such as salt, salt-cake, niter-cake, ground oyster-shells, spent lime, plaster, or soil, these must be taken account of in the mechanical analysis, especially since they would be likely on sifting to pass chiefly or entirely into the finer grades. Lister's Bone usually contains a considerable, sometimes a large percentage of salt-cake; of sample **101***, 54 per cent. passed the finest sieve, but the sample yielded to water 14 per cent. of salt-cake, which mostly passed the finest sieve. In such cases, the several grades as obtained by sifting, must be separately examined and the amounts of foreign matter which they contain must be suitably taken into the account.

In some instances a further source of error in valuation may arise from the fact that the proportions of nitrogen and phosphoric acid are not the same in the finer and coarser portions of a sample, which contains no adulterants, properly speaking, but partly consists of meat, tendon, etc., as is especially the case in certain kinds of "tankings."

There is, however, a limit beyond which it is useless to attempt to refine the processes of valuation. When they become too complicated or costly they defeat the object which they should serve. It is sufficient when the errors of valuation are no greater than those which arise from unavoidable variations in different portions of the same lot of fertilizer, or in different lots of the same brand. A difference of two or three dollars between cost and estimated value cannot ordinarily demonstrate that either is out of the way.

Analyses of Bone Manures.

(See Tables on pp. 32 and 33.)

Fifteen samples of this class have been analyzed, of which fourteen are here reported. As in former years, the valuation of bone manures in most cases exceeds the cost, when the figures adopted in previous reports for the values of nitrogen and phosphoric acid are applied.

Of the fourteen samples, four are to be disregarded in a discussion of cost and valuation. **440,** ivory dust, is exceptional on account of its extreme fineness, dryness and freedom from the sand and dirt which adhere to ordinary bone. It is also exceptional in respect to the small quantity to be had and because its texture is so dense that it probably acts more slowly than ordinary bone of the same fineness. In it, at $30 per ton, the cost of nitrogen per pound is but ten cents and that of phosphoric acid but four cents, while in making the valuation in the table, nitrogen is reckoned at eighteen cents and phosphoric acid at seven cents.

* Reported in 1878.

427 is a clean quality of bone, sold as cattle food and included here for sake of comparison with **383** and **388**, which are equally fine and rich in phosphates, though not so clean, and with **441**, which agrees almost perfectly with it in composition, is equally clean and pure, but slightly inferior in fineness, and scarcely to be distinguished from it in appearance, while the cost is much less.

Again, **382** is exceptional in composition, as it contains but half the phosphoric acid of the best bone, being mixed with a considerable quantity of salt-cake (sulphate of soda). Excluding, therefore, **440, 427, 382** and **443** which is not in market, the average cost of the remaining ten samples is $33.00 and the average valuation is $41.74 per ton. Readers of my report for 1879, will remember that the average cost of eight samples of bone manures there noticed was $32.75 and the average valuation $40.50. In that Report I showed that the cost of bone manures in 1879 would have justified reducing the estimated values of nitrogen and phosphoric acid in this class of fertilizers twenty per cent. below the values employed then and now for superphosphates. It is seen that the analyses of 1880 confirm this result, so that the following comparison between the Station valuation and the cost of the active fertilizing elements of bone manures, holds this year as it did last.

Grade.	Dimensions.	Hitherto estimated value per pound.		Cost per pound in 1879 and 1880.	
		Nitrogen.	Phos. acid	Nitrogen.	Phos. acid
Fine,	Smaller than $\frac{1}{50}$ inch,	18 cts.	7 cts.	15 cts.	6 cts.
Fine-medium,	Between $\frac{1}{50}$ and $\frac{1}{25}$ inch,	17¼ "	6½ "	14 "	5½ "
Medium,	" $\frac{1}{25}$ and $\frac{1}{12}$ inch,	16½ "	6 "	13 "	5 "
Coarse-medium,	" $\frac{1}{12}$ and $\frac{1}{6}$ inch,	15¾ "	5½ "	12 "	4½ "
Coarse,	Larger than $\frac{1}{6}$ inch,	15 "	5 "	11 "	4 "

It is therefore proper to abandon the estimated values* hitherto adopted for the ingredients of bone and to substitute for them the real trade-values or cost per pound of those ingredients as established by the analyses of 1879 and 1880. This substitution will in fact be carried out in 1881. See p. 21.

* In my first Report I was obliged to adopt the values then currently employed, some of which were sufficiently exact, but others were less so, because of the insufficiency of the data at hand at that time for establishing them.

Bone Manures.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Sent by
440	Ivory Saw Dust.	F. S. Johnson, Plainville.	Manufacturers.	J. W. Hemingway, Plainville.
441	Bone Saw Dust.	Holyoke Mf'g. Co., Holyoke, Mass.	R. T. Prentiss, Holyoke, Mass.	" "
422	Strictly Pure Ground Bone.	H. J. Baker & Bro., N. Y.	S. B. Wakeman, Saugatuck.	Dealer.
395	" " " "	" " "	Manufacturers.	J. H. Jennings, Green's Farms.
383	Peter Cooper's Ground Bone.	Peter Cooper, N. Y.	E. B. Clark, Milford.	J. W. Nettleton, Milford.
406	Bone.	Edmund Smith, South Canterbury.	Manufacturers.	B. Corbin, Fair Haven.
405	Bone.	Lombard & Matthewson, Warrenv'e.	"	J. D. Gaylord, Ashford.
434	Strictly Pure Ground Bone.	H. J. Baker & Bro., N. Y.	"	J. J. Webb, Hamden.
502	Ground Bone.	Peck Bros., Northfield.	"	S. R. Gridley, Bristol.
388	Bone Meal.	Mapes Form. & Peruvian Guano Co.		L. S. Wells, New Britain.
442	Ground Bone.	Atwood Bros., Watertown.	"	M. S. Baldwin, Naugatuck.
382	Ground Bone.	Lister Bros., Newark, New Jersey.	A. N. Clark, Milford.	Dealer.
427	Bowker's Bone Meal for Cattle.	Bowker Fertilizer Co., N. Y. (?)	Hubbell & Wakeman, Saugatuck.	W. H. Crouch, Saugatuck.
443	Ground Bone, screened from **442**.	Atwood Bros., Watertown.	Manufacturers.	M. S. Baldwin, Naugatuck.

Bone Manures.—*Analyses and Valuation.*

Station No.	Name or Brand, &c.	Nitrogen.	Phos. Acid.	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.	Station Valuation.	Cost.	Valuation exceeds cost.	Worth reckoned from average cost of 10 samples.‖
440	Ivory Saw Dust; Johnson's.	5.42	24.38	94	6				$53.64	$30.00	$23.64	$45.30
441	Bone Saw Dust; Holyoke.	3.64	26.16	87	11	2			49.24	35.50	13.74	41.82
422	Strictly pure ground Bone; Baker's.	4.39	22.17	44	26	30			45.21	32.00	13.21	37.11
395	" " " " "	4.08	22.72	35	30	35			43.62	32.00*	11.62	36.42
383	Peter Cooper's Ground Bone.	1.12	27.38	100					42.36	32.00	10.36	36.22
406	Bone, E. Smith.	4.08	20.99	24	23	21	21	11	39.39	30.00	9.39	32.41
405	" Lombard & Matthewson.	4.05	21.06	18	21	40	21		40.15	32.00	8.15	32.64
434	Strictly pure ground Bone; Baker's.	3.94	19.56	40	29	28	3	1	39.13	31.50	7.63	33.01
502	Ground Bone; Peck Bro's.	4.06	21.79	4	15	30	38	13	38.40	33.00	5.40	31.07
388	Bone Meal; Mapes'.	3.00	25.12	100					45.97	42.00	3.97	39.14
442	Ground Bone; Atwood Bro's.	3.76	20.02	2	11	20	23	44	33.96	30.00	3.96	29.85
	Average of 10 samples.‖								41.74	33.00	8.74	34.97
											Cost exceeds Valuation.	
382	Ground Bone; Lister Bro's.	3.61	13.04	36	20	18	16	10	28.63	30.00	1.37	20.56
427	Bowker's Bone Meal for Cattle.	3.69	26.29	100					50.09	60.00(?)†	9.91†	31.55
443	Ground Bone (screened from **442**).	4.29	21.95	27	26	23	14	10	40.80‡			34.51

* In N. Y., $30.00. † From selected bone ground for Cattle food, sold at $3.00 per hundred. ‡ Not in market. ‖ Exclusive of **440**, **382**, **427** and **443**.

The figures in the last column of the foregoing table are estimated values, reckoned with aid of these revised trade-values, and their fair general agreement with the cost figures, is evidence of their correctness.

The analysis of sample **443** which was screened from bone of the quality of **442**, would seem to show that the softer parts of bone are richer, both in nitrogen and phosphoric acid. This may have been the result of the more perfect drying of the finer part, but the difference of $7.00 in valuation is chiefly due to the difference in the results of the mechanical and not of the chemical analysis.

Dried Blood and Tankage.

Of 17 samples analyzed, 13 were examined for private parties. The other 4 gave results as follows:—

No.	Made by	Sampled by
391 Dried Blood, &c.	Sperry & Barnes, New Haven.	R. E. Pinney, Suffield.
392 " " "	Strong, Barnes, Hart & Co.	" "
439 " " "	" " " "	J. J. Webb, Hamden.
468 " " "	S. E. Merwin & Co., N. Haven.	J. D. Sage & Sons, Long Hill.

Analyses.

	391	392	439	468
Nitrogen,	6.20	8.80	8.25	7.38
Phosphoric acid,	6.02	3.55	6.41	8.27
Estimated value per ton,*	$33.23	$36.65	$41.97	$40.27
Cost per ton,	26.00	?	30.00	35.00
Valuation exceeds cost,	7.23	?	11.97	5.27
Worth reckoned from average cost,**	27.06		34.09	33.54

* Nitrogen reckoned at 20 cts. and phosphoric acid at 7 cts.
** " " " 16 cts. " " " " 6 cts.

Here the average valuation is $38.47, and the average cost $30.31. The difference, $8.16, is twenty-one per cent. of the valuation. Thus it is seen that the trade values of nitrogen and of phosphoric acid in dried blood hitherto used, viz.: twenty cents and seven cents, admit of the same reduction as in bone manures. The phosphoric acid of dried blood and tankage comes mostly from bone, and should therefore, when finely pulverized, properly rank with that of fine bone at six cents per lb. The nitrogen is somewhat more active than that of simple bone, owing to greater subdivision of the substance, and may therefore be reckoned at sixteen cents. The last figures in the table above, are the values

thus calculated from the average cost of the samples, and they show that six cents and sixteen cents are high enough valuations for the phosphoric acid and nitrogen, respectively, of this class of goods.

The other analyses of dried blood and so-called azotin, made in 1880, are given below to show the proportions of moisture and nitrogen in these materials as employed by manufacturers in compounding fertilizers. Phosphoric acid was not determined.

Dried Blood and Azotin.

Station No.		Water.	Nitrogen.	Ammonia equiv. to Nitrogen.
343	Dried Blood,	29.88	9.17	11.13
349	" "	24.78	10.10	12.26
350	" "	10.11	10.73	13.03
355	" "	24.78	9.85	11.96
361	" "	20.42	10.53	12.79
368	" "	19.02	9.32	11.32
444	" "	15.10	7.33	8.90
344	Azotin,	8.32	11.95	14.51
353	"	6.65	11.96	14.52
360	"	10.21	10.08	12.24
367	"	8.84	11.90	14.45
369	"	11.27	10.07	12.24
371	"	10.78	10.40	12.39

Fish Scrap or Fish Guano.

Of the sixteen samples examined, but two have been sent in by consumers, viz., **372** and **433**, both made by the Quinnipiac Fertilizer Company of New London. The former was sampled by R. B. Bradley, from stock of R. B. Bradley & Co., New Haven. Cost, $40; valuation,* $44.31. The latter was sampled by E. F. Blake from stock of J. M. Belden, New Britain. Cost, $38; valuation,* $42.75.

The cost of nitrogen and phosphoric acid in these samples is about eighteen cents and six cents, respectively.

The analyses of all the samples (phosphoric acid not determined except in two cases) are given below, with the average composition as found in former years.

* Nitrogen reckoned at twenty cents and phosphoric acid at seven cents.

ANALYSES OF FISH SCRAP.

Station No.	Designation.	Water.	Nitrogen.	Ammonia equiv. to Nitrogen.	Nitrogen in water-free fish.	Phos. Acid.
372	Dry Fish Guano,	10.16	8.54	10.37	9.50	7.25
408	Fish,	20.85	7.63	9.27	9.51	
429	Dry Fish Guano,	16.26	8.04	9.76	9.60	
433	Dry Ground Fish,		8.14	9.88		7.28
445	Dry Fish Guano,	19.24	8.02	9.74	9.93	
461	Fish Guano,	17.39	8.26	10.03	9.99	
463	" Scrap,	16.55	8.40	10.20	10.06	
466	Dry Fish,	18.78	8.35	10.14	10.28	
478	" "	15.65	7.84	9.52	9.29	
479	Fish Guano,	23.61	7.57	9.19	9.91	
480	" "	20.11	7.86	9.54	9.84	
495	" "	17.87	8.08	9.80	9.83	
498	" "	19.00	7.77	9.43	9.59	
499	" "	21.86	7.30	8.87	9.34	
501	" "	16.11	8.10	9.84	9.65	
504	" "	16.43	7.86	9.54	9.40	
	Average for 1880,	17.99	8.11	9.85	9.89	
	" " 1879,	19.13	7.70	9.34	9.46	
	" " 1878,	14.90	7.65	9.24	7.91	
	" " 1877,	13.66	8.24	10.01	9.36	
	" " 1875 and 1876,	11.78	7.80	9.47	8.84	

BUFFALO HORN SHAVINGS.

432. Sent by J. W. Hemingway from factory of F. S. Johnson, Plainville.

ANALYSIS.

	432
Nitrogen	14.50
Phosphoric Acid	.15
Cost per ton	$30.00
Cost of Nitrogen	10⅛ cts. per lb.

The sample is quite identical in composition with that from the same source reported last year, and the cost of nitrogen in it nearly the same as in coarse bone, i. e., eleven cents.

CASTOR POMACE AND COTTON SEED MEAL.

No.	Name.	Manufacturer.	Dealer.	Sent by
390	Castor Pomace,	Collins Co., St. Louis.	F. Ellsworth, Hartford.	L. S. Wells, New Britain.
398	" "	H. J. Baker & Bro., New York.	Manufacturers,	M. S. Baldwin, Naugatuck.
418	" "	Same.	F. Ellsworth, Hartford.	L. S. Wells, New Britain.
394	Cotton Seed Meal,	------	Smith, Northam & Robinson, Hartford.	R. E. Pinney, Suffield.
402	" " "	------	C. H. Carrington, Naugatuck.	M. S. Baldwin, Naugatuck.

ANALYSES AND VALUATIONS.

Station No.	Nitrogen.	Phos. Acid.	Potash.	Estimated value per ton.	Cost.	Valuation exceeds cost.	Worth reckoned from average cost.
Castor Pomace,							
390	5.73	1.79	1.29	$27.30	$20.00	$7.30	$21.52
398	5.06	1.86	1.02	$24.50	$19.00*	$5.50	$19.24
418	4.64	1.34	.53	$21.45	$20.00	$1.45	$16.88
Average,	5.14	1.66	.95	$24.42	$19.66	$4.75	$19.21
Cotton Seed Meal,							
394	7.20	3.33	2.11	$36 69	$25 00†	$11.69	$28.72
402	6.89	3.49	2.07	$35.69	$30.00	$5.69	$27.89
Average,	7.04	3.41	2.09	$36.19	$27.50	$8 69	$28.30

* In New York. † In 10 ton lots.

The average estimated value exceeds average cost by nearly nineteen and one-half per cent. in case of castor pomace, and by twenty-four per cent. in case of cotton seed meal. The trade values used for reckoning the above valuations were twenty cents for nitrogen, nine cents for phosphoric acid, and four and one-half cents for potash. The same reduction of trade values that we have seen to be justified by the bone manures and by dried blood applies therefore to these fertilizers. Calculating on the basis of nitrogen sixteen cents, phosphoric acid six cents, and potash three and one-half cents we obtain as the average value of castor pomace $19.20, and of cotton seed meal $28.30, which agree fairly with the average market prices, and with the single exception of **418** the valuation thus obtained is above the actual cost of the samples.

The composition and actual value of these samples of cotton seed meal is not essentially different from that of the damaged cotton seed analyzed last year. The cost is more by several dollars per ton.

SULPHATE OF AMMONIA.

The four analyses of this fertilizer were made for manufacturers. The results show the quality of the commercial article. The cost was not made known.

	346	362	370	375
Nitrogen	20.36	20.03	19.84	19.82
Equivalent to Ammonia	24.72	24.31	24.19	24.07
Equivalent to Sulphate of Ammonia	95.98	94.42	93.91	93.49

Sulphate of ammonia is cheaply manufactured as a bye product from the illuminating-gas works, and furnishes more nitrogen in a given weight than any other fertilizer employed in agriculture. Its nitrogen being in the state of ammonia, and the salt itself being freely soluble in water, convenient to handle, and permanent under transport, it is eagerly bought by compounders of fertilizers. It is now manufactured in the large towns of Connecticut, so that consumers have the opportunity to bid for the purchase of it at first hand.

Nitrate of Soda.

482. From stock of Sisson & Butler, Hartford. Sampled and sent by T. N. Bishop, Plainville.

Nitrogen	15.91
Equivalent to Nitrate of Soda	96.30
Moisture	1.61
Undetermined matters	2.09
	100.00
Calculated value per 100 lbs.	$4.13
Cost	4.50

The cost of nitrogen in this sample is 28¼ cents per lb.

Potash Salts.

Muriates.

No.	Importer.	Dealer.	Sent by
387	Mapes Formula and Peruvian Guano Company, New York.	Importers.	L. S. Wells, New Britain.
438	H. J. Baker & Bro., New York.	Importers.	J. J. Webb, Hamden.
509	?	A. Lathrop.	H. H. Austin, Suffield.

Sulphates.

No.	Importer.	Dealer.	Sent by
389	Mapes Formula and Peruvian Guano Company, New York.	Mapes' Ct. Valley Branch, Hartford.	L. S. Wells, New Britain.
397	H. J. Baker & Bro., New York.	Importers.	M. S. Baldwin, Naugatuck.
428	H. J. Baker & Bro., New York.	Importers.	P. M. Augur, Middlefield.
457	C. V. Mapes & Co., New York.	Mapes' Branch, Hartford.	R. E. Pinney, Suffield.
508	?	A. Lathrop, Suffield.	H. H. Austin, Suffield.

Potash Salts.—Analyses.

	Muriates.			Sulphates.				
	387	**438**	**509**	**389**	**397**	**428**	**457**	**508**
Potash (potassium oxide),	50.37	52.18	53.83	35.68	49.17	47.37	46.87	27.38
Equivalent to pure muriate,	79.80	82.50	85.25					
" " sulphate,				66.00	91.00	87.50	86.70	50.74
Chlorine,				7.56	none	none	0.40	1.20
Potash guaranteed or implied in brand,	43.23	44.85		37.83	48.64		44.05	27–29
Cost per ton,	$40.00	$40.00	$32.00	$65.00	$72.00*	$65.00	$66.66**(?	$35.00
Estimated value per ton,†	$45.33	$46.96	$48.45	$53.52	$73.76	$71.06	$70.31	$41.07
Cost per 100 lbs. of potash,	$3.97	$3.83	$2.97	$9.10	$7.32	$6.86	$7.11	$6.39
Sent in month of	April	May	Nov.	April	April	May	June	Nov.

* In New York. ** "Cost 3⅓ in Hartford."
† Potash reckoned in muriate at 4½ cts., in sulphate at 7½ cts. per lb.

The fluctuations in the cost of potash are like those noticeable in former years. The samples bought in April and May yield potash as muriate for about four cents, and as sulphate for seven to nine cents; those sent in November furnish potash for three cents and six and one-half cents per lb. It would appear from these data, together with those of last year, that for the purposes of valuation at present three and one-half cents is a fair trade value for potash in muriate and seven cents in sulphate.

Wood Ashes.

400. Ashes from stock of W. W Cooper, Suffield. Sent by R. E. Pinney, Suffield.

401. Canada Leached Ashes from stock of James A. Bill. Sent by Otis Snow, Rockville.

Sample **400** is apparently unleached ashes, and the analysis closely resembles, in most particulars, one made at this station last year on hickory ashes. The sample has evidently been exposed to wet, and may have lost a portion of alkali. Reckoning in it the potash at seven and one-half cents, lime at one-quarter of a cent (cost at kiln in New Haven), magnesia at two cents, phosphoric acid at seven cents, and sulphuric acid at one-half cent per pound, the estimated value of 100 pounds is $0.57½, while the cost is $0.83. Allowing lime to be worth at Suffield one-half cent per pound, to cover transportation, would raise the valuation to $0.66. On the other hand, considering the potash worth no more than in muriate (four and one-half cents) would reduce the value fourteen cents per hundred pounds. The ashes are thus really worth about fifty to sixty-five cents per 100 pounds, the former price for ordinary crops, the latter for tobacco where muriate of potash is objectionable. The valuation of fertilizers like this sample is less exact than in case of superphosphates, etc., because those ingredients, like lime, which make up a large part of its weight, have very variable commercial values, according to locality and state of market.

	400	**401**
Potash	4.66	1.26
Soda	1.20	.54
Lime	34.02	24.37
Magnesia	2.41	2.43
Iron Oxide and Alumina	1.41	2.13
Phosphoric Acid	1.19	1.26
Sulphuric Acid	.95	.10
Carbonic Acid	19.25	14.99
Silica and Sand	11.11	15.71
Charcoal	6.86	3.11
Moisture expelled at 212°	13.42	32.02
Combined water and loss	3.52	2.08
	100.00	100.00
Carbonate of Lime, equivalent to Lime	60.7	43.6
Weight per bushel	42 lbs.	56 lbs.

The weight per bushel was not stated, but 56 lbs. appears to be the average.

Cost per bushel	35 cts.	21 cts.
Cost per 100 lbs.	83 cts.	37½ cts.

401 has essentially the composition usually found in leached wood ashes. It contains, indeed, more sand and silica than the average, but also more potash, while lime and phosphoric acid are up to the average.

In previous Reports I have endeavored to ascertain by calculation what mixture of other materials can furnish a substitute for the Leached Ashes that are imported from Canada and so highly valued for their effect on the land and crops. In the hope that my conclusions may be of service to some who have not seen those Reports, and that some of our farmers may take the trouble to make some experiments in this direction and publish the results, I reprint a paragraph from the Report for 1879, which was writ-

ten with reference to three analyses of Leached Ashes made that year.

"These ashes, applied at the rate of a ton (36 bushels) per acre, furnish, besides a large dose of carbonate of lime (1,100 lbs.), serviceable quantities of potash (20 lbs.), of magnesia (60 lbs.), and of phosphoric acid (30 lbs.); but the chief effects of the application come from the carbonate of lime. With the help of the analyses of oyster-shell lime, we can calculate closely the composition and cost of a mixture which would be equal in all respects, or even superior to these leached ashes. The essential fertilizing matters of 100 lbs. of leached ashes would be contained in

Slacked Oyster-Shell Lime	54 lbs.	costing*	9 cts.
Muriate of Potash	2 "	"	5 "
Ground Bone	8 "	"	12 "
Total			26 cts.

* At kiln.

One hundred pounds of leached ashes cost, in 1879, on the average, twenty-five cents. Our mixture, however, would contain, in its bone, about four cents' worth of nitrogen which is absent from leached ashes, so that the value of the materials of this mixture is not less than that of the ashes. The mixture would contain hydrate of lime which would make it in most cases a better application to the soil, but might perhaps do damage to the plant unless carefully distributed."

The less cost of the leached ashes analyzed last year (25 cents per bushel on the average) was owing in part at least to the fact that two of the samples were delivered on tide water (for 12½ and 14 cents per bushel). The third sample cost at Canterbury 16½ cents per bushel.

The comparison as to cost between the above mixture and leached ashes at any given locality may easily be made by applying local prices to the reckoning.

Land Plaster.

No.	Manufacturer.	Dealer.	Sent by
414	E. B. Alvord, Jamesville, N. Y.	S. A. Weldon & Son, Bristol.	S. R. Gridley, Bristol.
419	George Abbott, Branchville.	Manufacturer.	D. H. Van Hoosear, East Wilton.
431	?	E. N. Pierce, Plainville.	T. N. Bishop, Plainville.

Analyses.

	Pure Gypsum.	414	431	419
Sand and insoluble matters	——	7.48	7.81	3.83
Carbonate of Lime etc. (by diff.),	——	17.08	17.03	2.34
Sulphuric Acid	46.51	35.09	34.96	43.64
Lime	32.56	24.56	24.47	30.56
Combined water	20.93	15.97	15.73	19.63
Hydrated Sulphate of Lime:	100.00	75.44	75.16	93.83
	100.00	100.00	100.00	100.00
Cost per ton		$7.50	$7.00	$ 6.00
One hundred lbs. of pure Gypsum cost		0.50	0.46½	0.32
		at Bristol.	at Plainville.	at Branchville.

419 is doubtless Nova Scotia plaster, and contains 94 per cent., or about the average amount of gypsum (hydrated sulphate of lime or hydrated calcium sulphate) found in that article. **414** and **431** are the plaster of Jamesville, N. Y., containing 75 per cent. of gypsum and 17 per cent. of carbonate of lime.

Products of Salt Manufacture.

357. Refuse Salt Washings.
358. Kiln Refuse.
359. No. 2 Fine Salt.

The above were sampled by the Secretary of the Onondaga Salt Association at Syracuse, N. Y., and were sent to the Station, March 1, by S. A. Smith, Esq., of Cheshire.

Analyses.

	357	358	359
Chloride of Sodium (salt)	67.92	97.20	98.30
Chloride of Potassium (muriate of Potash)		.54	.54
Sulphates and Carbonates of Lime and Magnesia	29.58	2.09	.97
Moisture	2.50	.17	.19
	100.00	100.00	100.00

Cost, delivered on cars in Cheshire, in lots of ten and twenty tons, $4.67 and $6.67 per ton, and $1.32 per barrel, respectively.

The samples having been sent in paper boxes contained less moisture when received than when put up. The following analyses, published by the Salt Association, show what proportions of of moisture are contained in the fresh article. These figures are probably an average, the refuse being naturally somewhat variable in composition.

	Refuse Salt Washings.	Kiln Refuse.
Chloride of Sodium	50	70
Sulphate of Lime	18	15
Carbonate of Lime and Magnesia	8	5
Insoluble Matter	4	2
Moisture	17	6
Organic Matter	3	2
	100	100

Mr. Smith was desirous of knowing how much potash the sample contained. The amount is too small to be worth considering. The commercial value of these articles is evidently the price put upon them by the manufacturers, there being no competition in this class of goods in our market. The fertilizing value for any given soil or crop is only to be determined by actual trial. On some soils, salt (like gypsum on many soils) produces a good effect, not commonly by directly nourishing crops, for agricultural plants require no soda and very little chlorine, but by its solvent action whereby it disengages plant food from the minerals of the soil, or in some other indirect manner.

Stable Manure.

385. New York Stable Manure, sold by H. A. Peck & Co., First Avenue, cor. 38th Street, New York, sampled and sent March 30, by John H. Jennings, Green's Farms, from a cargo purchased by him.

	385	Horse Manure, New York, 1874.	Wolff's average, moderately rotted Stable Manure.
Moisture	69.295	75.76	75.00
Organic Matter*	19.772	19.17	19.20
Potash	.633	.51	.63
Soda	.145	.09	.19
Lime	.742	.30	.70
Magnesia	.288	.19	.18
Oxide of Iron and Alumina	.554	.19	—
Phosphoric Acid	.670	.41	.26
Chlorine	.110	.07	.19
Sulphuric Acid	.156	.09	.16
Sand and Insoluble matter	7.426	3.20	1.68
Carbonic Acid	.209		—
Undetermined matters	——	——	1.81
	100.000	100.00	100.00
* With Nitrogen as Ammonia	.118	.26	?
" Nitrogen, total	.693	.53	.50

385 Has nearly the same composition as the sample of New York Stable Manure analyzed in 1874 for the Board of Agriculture; the results published in the Report of the Board for 1873–4, page 350, and here reproduced for the sake of comparison, and also fairly agrees in most respects with Wolff's average of moderately rotted Stable Manure as found in German farming.

385, however, contains about nine per cent. less of moisture and insoluble substances and the proportions of some of the fertilizing matters are correspondingly greater. The cost of this article was six cents per "bushel" of about forty quarts, or one and one-third cubic feet. Mr. Jennings states that several hundred small cargoes of fifty to seventy-five tons each are bought at Green's Farms each year. The cargoes are unloaded on the shore where wanted.

The cost of the horse manure in 1874 at New Haven by rail was $4.00 per ton of forty-nine cubic feet, equal to eight cents per cubic foot, or ten and two-third cents per "bushel" of forty quarts.

Vegetable Ivory Sawdust and Turnings.

403 From the manufactory of E. Smith, Union City, sent by M. S. Baldwin, Secretary Naugatuck Farmers' Club.

This article was sent to the Station with the request to report upon its agricultural value as a fertilizer and cattle food. A similar sample, **69,** from Cheshire, was examined in 1878 in respect to its value as a fertilizer.

The analyses are as follows:

	69	403
Moisture		18.78
Organic Matter		80.14
Ash		1.08
		100.00
Nitrogen in Organic Matters	0.48	0.54

As plant food this vegetable ivory has about the same value as straw or dead leaves. It would probably have the same, or a slightly greater value as an ingredient of compost. It is stated to heat and ferment when wet in bulk. Its value in compost, however, requires further observation, since it does not consist mainly of cellulose or woody tissue, but contains sixty-eight per cent. of a carbhydrate soluble in alkalies. See its further analysis under Feeding Stuffs.

Special Fertilizers.

The use of this class of fertilizers would seem to be on the increase. In 1878, twelve samples, in 1879, twelve samples, and this year twenty-four samples have been sent in for analysis. In the first Table of Analyses, p. 47, these fertilizers are arranged in the order in which their cost exceed valuation and the reverse. It is seen from that Table that in the case of fifteen of the samples the cost exceeds the valuation from $1.00 to nearly $25.00, while the valuation of the other nine exceeds the cost from $0.70 to nearly $6.00. It will be noticed that nitrates are the exclusive source of nitrogen in one sample, **469,** and furnish a part of the nitrogen in another, **473.** In a single sample, **423,** all the nitrogen is present as ammonia salts. In three samples, **413, 363,** and **476,** the nitrogen exists entirely in the form of organic matter; in all other cases, the nitrogen is present partly in organic matter and partly as ammonia salts. In seventeen samples the potash exists as muriate, or at least is associated with enough chlorine to form potassium chloride.* In two instances, **425** and **473,** the potash is quite pure sulphate, the samples containing less than one-half per cent. of chlorine. In five samples both sulphate and muriate are present.

In a separate Table, page 48, the composition of these fertilizers as guaranteed, and as found by the Station analyses is given in parallel columns. The results of the analyses are there abbreviated to one place of decimals. In case of phosphoric acid, the guarantee sometimes applies to soluble, sometimes to total, in most cases to "available," which is understood to signify soluble and reverted taken together. In each instance the phosphoric acid in the column "found" corresponds in state or form to that signified in the column "guaranteed." In case of **363** and **476** the guaranteed composition has not been made known to the Station.

Examination of the figures shows that out of the sixty-six comparisons the percentage found falls behind that guaranteed in but five instances, and in but two of these does the deficiency amount to one-half per cent.

The Table on pages 50 and 51 is a comparison of all the analyses of special fertilizers that have been made at the Station, together with a few published by Dr. Goessmann in Massachusetts, and by Prof. Cook, of the New Jersey Experiment Station. In this table

* i. e., 35.5 of chlorine to 47 of potash.

SPECIAL FERTILIZERS.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Sent by
413	Bowker's Kitchen Garden Fertili'r,	Bowker Fertilizer Co.	S. A. Weldon & Son, Bristol.	S. R. Gridley, Bristol.
417	Stockbridge Root Fertilizer,	" " "	Hubbell & Wakeman, Saugatuck.	James Nash, Saugatuck.
363	" Onion "	" " "	Hubbell & Wakeman.	Dealers.
409	" Root "	" " "	S. A. Weldon & Son.	S. R. Gridley.
476	Matfield Corn "	Matfield " "	C. E. Lord, Chester.	Dealer.
474	Forrester's Grass "	H. J. Baker & Bro.	S. B. Wakeman, Saugatuck.	"
471	" Wheat "	" " "	" " "	"
377	Mapes' Grass and Grain Fertilizer,	Mapes F. & P. G. Co.	A. N. Clark, Milford.	J. M. Nettleton, Milford.
470	Forrester's Fruit Tree "	H. J. Baker & Bro.	S. B. Wakeman.	Dealer.
376	Mapes' Potato "	Mapes F. & P. G. Co.	A. N. Clark, Milford.	J. M. Nettleton, Milford.
435	Stockbridge Tobacco "	Bowker Fertilizer Co.	J. M. Belden, New Britain.	G. M. Barbour, New Britain.
379	Mapes' Corn "	Mapes F. & P. G. Co.	A. N. Clark, Milford.	J. M. Nettleton, Milford.
500	Forrester's Rye "	G. B. Forrester.	S. B. Wakeman.	M. S. Baldwin, Naugatuck.
423	" Cabbage "	H. J. Baker & Bro.	" "	Dealer.
475	" Rye "	" " "	" "	"
407	Stockbridge Corn, "	Bowker Fertilizer Co.	S. A. Weldon & Sons.	S. R. Gridley.
469	Forrester's Lawn Dressing,	H. J. Baker & Bro.	S. B. Wakeman.	Dealer.
425	" Turnip Fertilizer,	" " "	" "	"
426	" Oat "	" " "	" "	"
421	" Corn "	" " "	" "	"
472	" Strawberry "	" " "	" "	"
473	" Tobacco "	" " "	" "	"
420	" Potato "	" " "	" "	"
416	" Onion "	" " "	" "	"

SPECIAL FERTILIZERS.—*Analyses.*

Station No.	Name.	Nitrogen as Ammonia.	Nitrogen as Nitrates.	Organic Nitrogen.	Total Nitrogen.	Soluble Phos. acid.	Reverted Phos. acid.	Insoluble Phos. acid.	Potash.	Chlorine.	Estimated value per ton.	Cost per ton.	Cost exceeds valuation.
413	Bowker K. Garden,	....	....	2.98	2.98	5.12	0.74	0.35	9.82	8.62	$35.38	$60.00*	$24.62
417	Stockbridge Root,	1.40	....	2.40	3.80	4.67	0.53	0.66	7.97	7.03	36.70	50.00	13.30
363	Stockbridge Onion,	....	....	3.10	3.10	4.83	0.51	0.45	7.94	2.63	37.94	50.00	12.06
409	Stockbridge Root,	1.40	....	2.70	4.10	4.70	1.16	0.68	8.08	7.02	39.16	50.00*	10.84
476	Matfield Corn,	....	....	6.06	6.06	1.16	0.88	1.55	5.26	4.98	35.62	45.00	9.38
474	Forrester Grass,	3.07	....	2.37	5.44	2.12	trace	0.95	7.45	7.38	36.63	45.00†	8.37
471	Forrester Wheat,	3.78	....	0.70	4.48	4.57	0.03	1.53	5.63	4.84	39.08	45.00†	5.92
377	Mapes Grass & Grain,	3.03	....	1.71	4.74	2.30	5.19	1.30	6.61	5.20	45.32	51.00	5.68
470	Forrester Fruit Tree,	3.03	....	0.58	3.61	1.39	2.25	0.73	15.05	11.02	38.05	42.50†	4.45
376	Mapes Potato,	0.96	....	2.96	3.92	3.18	5.45	1.77	7.70	5.12	45.64	49.00	3.36
435	Stockbridge Tobacco,	4.62	....	1.49	6.11	5.72	0.37	0.20	5.62	5.16	47.04	50.00*	2.96
379	Mapes Corn,	1.31	....	2.36	3.67	4.08	6.12	1.66	7.21	6.48	45.38	48.00	2.62
500	Forrester Rye,	5.00	....	0.33	5.33	4.73	0.02	1.17	9.45	8.75	45.83	47.50	1.67
423	Forrester Cabbage,	5.62	....	....	5.62	5.74	0.52	0.56	8.16	7.90	48.69	50.00‡	1.31
475	Forrester Rye,	4.53	....	0.82	5.35	4.32	trace	1.21	11.34	10.36	46.37	47.50†	1.13
													Valuation exceeds cost.
407	Stockbridge Corn,	1.58	....	3.13	4.71	5.16	0.84	0.42	6.75	5.93	$40.70	$40.00*	$0.70
469	Forrester Lawn,	....	4.39	....	4.39	4.93	0.80	1.12	12.56	11.21	49.47	47.50†	1.97
425	Forrester Turnip,	6.90	....	1.43	8.33	2.86	0.32	1.09	9.13	0.36	54.01	52.00‡	2.01
426	Forrester Oat,	4.78	....	1.84	6.62	3.40	1.56	0.98	9.18	5.80	49.80	47.50‡	2.30
422	Forrester Corn,	4.67	....	0.19	4.86	5.59	0.47	1.01	14.56	13.52	51.10	47.50‡	3.60
417	Forrester Strawb'ry,	2.43	....	0.50	2.93	4.19	4.69	2.75	8.74	2.08	46.19	42.50†	3.69
473	Forrester Tobacco,	2.05	2.31	1.11	5.47	3.87	trace	0.98	9.69	0.50	51.27	47.50†	3.77
420	Forrester Potato,	4.36	....	0.40	4.76	0.81	4.63	2.09	11.33	3.82	51.50	47.50‡	4.00
416	Forrester Onion,	5.34	....	2.06	7.40	2.56	2.07	1.00	7.25	2.21	54.68	49.00	5.68

* The cost per ton is calculated from the price per bag of 100 or 200 pounds. No prices per ton are given in the circulars of the manufacturers.

† In New York. ‡ In New York. Local price $1.50 higher.

SPECIAL FERTILIZERS.

Station No.	Nitrogen.		Phosphoric Acid.		Potash.	
	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed	Found.
Bowker—						
413	2.9–3.7	3.0	5–6*	5.1	6–7	9.8
Stockbridge—						
363						
407	4.1–4.9	4.7	5–6*	5.2	5.5–6.5	6.8
409	3.3–4.1	4.1	6–7	5.9	7–8.5	8.1
417	3.3–4.1	3.8	6–7	5.2	7–8.5	8.0
435	5–6	6.1	4–5*	5.7	5–6	5.6
Matfield—						
476		6.1		2.0		5.3
Mapes—						
376	3.7–4.1	3.9	8–10†	10.4	6–8	7.7
377	4.1–5.8	4.7	9–8†	8.8	5–7	6.6
379	3.7–4.1	3.7	10–12†	11.9	6–7	7.2
Forrester—						
416	5.8	7.4	3.5	4.6	7	7.3
420	3.5	4.8	5.5	5.4	10	11.3
421	5.1	4.8	5.5	6.1	9	14.6
423	4.3	5.6	5	6.3	7	8.2
425	6.8	8.3	3	3.2	8.3	9.1
426	5.4	6.6	4	5.0	8	9.2
469	2.7	4.4	5	5.7	5	12.6
470	1.6	3.6	3	3.6	10	15.1
471	5.1	4.5	4	4.6	4	5.6
472	2.5	2.9	5	8.9	6	8.7
473	4.1	4.4	1	3.9	8.3	9.7
474	4.9	5.4	2	2.1	6	7.5
475	4.9	5.4	4	4.3	8	11.3
500	4.9	5.3	4	4.8	8	9.5

* Soluble. † Total.

the fertilizers are arranged according to the crops for which they are intended, and by the name with which they are commonly designated. The table serves to show (1) the variations which the same brand has been subject to from year to year, and (2) the often wide variations between different brands made for the same crop. Since the manufacturers give abundant testimonials from practical farmers, showing that each of these fertilizers is well-adapted for its purpose, we can hardly avoid concluding that it makes very little difference to the corn crop, for example, whether a corn fertilizer contains 6.2 or 3.7 per cent. of nitrogen, 11.4 or 2 per cent of available phosphoric acid, 14.6 or 4.6 per cent. of potash!

When we consider that soils differ very widely from each other in native producing power, and may be made to differ as widely by the treatment they receive under what we term "cultivation," there can be no doubt that any one of these special fertilizers may be used as profitably on any other crop as on that after which it is named.

COST OF ACTIVE INGREDIENTS OF FERTILIZERS DURING 1880.

Organic Nitrogen has cost in the manipulated fertilizers, viz: superphosphates and special manures, on the average, more than the amount allowed in the valuations, *i. e.* twenty cents per pound. In dry fish scrap the cost has been eighteen cents. In the samples of low-grade dried blood and tankings analyzed by the Station, nitrogen has cost sixteen cents and in castor pomace and cotton seed meal it has also cost sixteen cents. The nitrogen of fine bone has been bought for fifteen cents. The ruling market price of nitrogen in the highest grades of dried blood, has been during the spring, until mid-summer, about fifteen cents. In the autumn, as usual, the price advanced because of active demand among the manufacturers of superphosphates, etc., and reached eighteen cents per pound.

It is plain that there is a considerable and permanent difference between the trade-value or cost to the farmer, of organic nitrogen in the superphosphates and other manipulated fertilizers and that of the raw materials ordinarily accessible to the retail purchaser. To adapt our system of valuation more perfectly to this state of things, I shall continue to rate organic nitrogen in superphosphates and special manures and in fine steamed bone, finely ground and dry meat, blood and fish, and in Peruvian guano, at twenty cents. In view of the market prices that have ruled for two years, I shall rate together the nitrogen of coarse or moist meat, blood, tankage, castor pomace and cotton seed meal at sixteen cents. The trade-values of nitrogen in the various grades of bone will also be reduced to conform to their actual cost. See statement and Table on page 31.

Nitrogen in the form of Ammonia-Salts and Nitrates.—Ammonia salts do not appear in our retail market except as ingredients of some manipulated fertilizers, and the Station valuation for their nitrogen will remain as formerly. Nitrates in the single sample of nitrate of soda analyzed, has furnished nitrogen

Comparison of Special Manures.

According to their Brands and the Crops for which they are offered.

(See paragraph at bottom of pp. 45 and 48.)

Station No.	Name.	Year.	Nitrogen.	Phos. acid sol. and rev.	Potash.	Crop.
137	Stockbridge.	1878	5.9	5.4	6.6	Corn.
195	"	'78	6.2	3.8	7.0	
407	"	'80	4.7	6.0	6.8	
N. J.	"	'80	4.8	7.2	6.2	
476	Matfield.	'80	6.1	2.0	5.3	
379	Mapes.	'80	3.7	10.2	7.2	
N. J.	"	'80	4.0	11.4	4.6	
N. J.	"	'80	3.9	6.5	7.7	
300	Forrester.	'79	5.5	5.3	13.1	
421	"	'80	4.8	6.0	14.6	
	highest	per cent.	6.2	11.4	14.6	
	lowest	"	3.7	2.0	4.6	
146	Stockbridge.	'78	3.5	6.4	10.2	Potato.
260	"	'79	3.8	7.0	8.8	
409	"	'80	4.1	5.9	8.1	
417	"	'80	3.8	5.2	8.0	
Mass.	"	'79	4.4	3.8	7.6	
116	Forrester.	'78	5.7	7.6	11.4	
282	"	'79	4.6	5.5	9.1	
304	"	'79	4.8	5.3	10.3	
420	"	'80	4.8	5.4	11.3	
128	Mapes.	'78	3.7	4.5	14.8	
376	"	'80	3.9	8.6	7.7	
	highest	per cent.	5.7	8.6	14.8	
	lowest	"	3.5	3.8	7.6	
258	Stockbridge.	'79	3.9	6.4	8.3	Onion.
363	"	'80	3.1	5.3	7.9	
259	Mapes.	'79	5.7	6.2	7.5	
301	Forrester.	'79	7.4	4.5	7.4	
416	"	'80	7.4	4.6	7.3	
	highest	per cent.	7.4	6.4	8.3	
	lowest	"	3.1	4.6	7.3	

Station No.	Name.	Year.	Nitrogen.	Phos. acid sol. and rev.	Potash.	Crop.
274	Stockbridge.	'79	5.7	1.4	7.4	Tobacco.
435	"	'80	6.1	6.1	5.6	
Mass.	"	'79	6.7	1.9	9.4	
473	Forrester.	'80	5.5	3.9	9.7	
	highest	per cent.	6.7	6.1	9.7	
	lowest	"	5.5	1.9	5.6	
175	Stockbridge	'78	4.4	7.8	6.5	Strawberry.
284	Forrester.	'79	3.0	10.3	5.9	
472	"	'80	2.9	8.9	8.7	
	highest	per cent.	4.4	10.3	8.7	
	lowest	"	2.9	7.8	5.9	
471	Forrester.	'80	4.5	4.6	5.6	Wheat.
475	"	'80	5.4	4.3	11.3	Rye.
500	"	'80	5.3	4.8	9.5	Rye.
426	"	'80	6.6	5.0	9.2	Oat.
Mass.	Stockbridge.	'79	5.4	4.6	6.2	Oat.
	highest	per cent.	6.6	5.0	11.3	
	lowest	"	4.5	4.3	5.6	
144	Mapes.	'78	4.3	6.0	3.7	Grass & grain top dr.
377	"	'80	4.7	7.5	6.6	" " "
197	Stockbridge.	'78	8.7	2.1	10.4	Grass top dr.
280	"	'79	6.1	4.1	7.5	" "
201	Forrester.	'78	5.7	4.1	12.1	Grass.
474	"	'80	5.4	2.1	7.5	"
469	"	'80	4.4	5.7	12.6	Lawn Dressing.
181	Bowker.	'78	8.0	5.2	6.4	" "
	highest	per cent.	8.7	7.5	12.6	
	lowest	"	4.3	2.1	3.7	
193	Stockbridge	'78	4.6	5.6	7.2	Kitchen Garden.
196	"	'78	5.1	4.1	7.7	Squashes.
413	Bowker.	'80	3.0	5.9	9.8	Kitchen Garden.
281	Forrester.	'79	6.3	6.1	7.4	Cabbage.
423	"	'80	5.6	6.3	8.2	"
	highest	per cent.	6.3	6.3	9.8	
	lowest	"	3.0	4.1	7.2	

at twenty-eight cents, but since probably the price will fluctuate, no change in its trade-value appears to be called for.

Soluble Phosphoric acid has been procurable in 1880 as in 1879, at a cost of ten cents per pound in the imported superphosphate **436**, see p. 23. In our home-made manipulated fertilizers it still costs twelve and one-half cents, and that may therefore remain as the Station valuation.

Reverted Phosphoric acid in the various manipulated fertilizers has cost no less than formerly, and the former price, nine cents, is retained.

Insoluble Phosphoric acid in dry fish and in the different grades of bone, has cost one cent per pound less than last year's valuation. See Table, p. 31.

Potash, in nearly pure, high grade sulphate, is reckoned at seven cents, and in muriate, at three and one-half cents per pound. p. 39. In low grade sulphates containing magnesium chloride, and in kainite, it would probably be fair to reckon potash at five and one-half cents. For comparison of the trade-values employed in 1880 with those it is proposed to use in 1881, see pp. 19 and 21.

Swamp Muck and Peat.

Fifteen samples of this material have been subjected to analysis.

446 Swamp Muck No. 1. Upper stratum.
447 Swamp Muck No. 1. Lower stratum.
448 Swamp Muck No. 2.
} From farm of Messrs. John and Andrew Jackson, Wilton. Sent by D. H. Van Hoosear, Secretary Farmers' Club, East Wilton.

449 Cured Muck.
450 Fresh Muck.
} Sent by S. B. Wakeman, Saugatuck.

451 Muck. Sent by G. W. Stanley, New Britain.

452 Fibrous Muck, from above 453.
453 Bottom Muck, from below 452.
} Sent by Henry Hine, Oxford.

454 Mucky soil of drained meadow, from Augustus Storrs, Mansfield.

465 Swamp Muck, from Ed. C. Birge, Southport.

467 A, Swamp Muck. Upper layer.
467 B, Swamp Muck. Lower layer.
} From Lewis Davis, Milford.

492 Muck, from W. E. Simonds. Canterbury.

510
511
} Muck from H. A. Slater, North Manchester.

Samples **446, 447** and **448** are from a swamp of ten acres, owned by Messrs. John and Andrew Jackson of Wilton. **446** and **447** are from the head of the swale, the former from the surface, the latter from a lower stratum. **448** was taken from the same swale one-half mile distant and at a lower level. Muck from both localities has been used for many years as an absorbent, and also has been applied in spring direct to crops after having been dug in fall and exposed to air and frost during winter. **446** and **447** have given very good results. **448** has been less valuable.

The analyses show large differences of composition, in the fresh samples. We observe, first, that **446** is a very pure muck and quite fully saturated with (eighty per cent.) of water. **448** is drier and contains forty-five per cent. of soil and mineral matter, while **447** stands intermediate. If the three were applied in corresponding states of dryness, we can see that in the first two we should have much more organic matters, with more nitrogen, and likewise more lime than in the last. This appears from the figures in the table, showing the composition of the dry, water-free mucks, p. 54.

The *per cent.* of nitrogen, and that of lime in the dry samples may be taken as fair measures of their relative value. **446** ranks accordingly among the best, while **448** is nearly the poorest of the samples here reported.

The inferiority of **448** is evidently largely due to the fact that nearly three-fourths of it is sand or soil. Reference to the last line of figures in the table shows that the organic matter which it contains is as rich in nitrogen as that of **446.** We see, in fact, that in both these and in seven of the other samples the organic matters contain about two and one-half per cent. of nitrogen.

449 and **450,** from S. B. Wakeman, of Saugatuck, are, it is understood, two samples from the same bed, the former dug a year ago or more and exposed during the winter, the latter a freshly excavated sample. The cured muck, **449,** is used as an absorbent and for composting. The questions asked by Mr. Wakeman are:—

1. "Is the cured muck worth carting 100 rods to use as absorbent and in compost?" and,

2. "Has the muck any value in its fresh state?"

The differences in composition which appear in the undried samples are almost entirely due to their unlike proportions of water, viz: 38 and 85½ per cent. Dry, they agree in containing about 90 per cent. of organic matter with 2.2 per cent. of nitrogen, and about 10 per cent. of ash with 2 per cent. of lime.

To Mr. Wakeman's questions the following answers were given:

1. **449** is well worth carting 100 rods to use as an absorbent. It contains as analyzed, with thirty-eight per cent. water, nearly twice as much nitrogen as good stable manure, and of this there

Analyses of Swamp Muck.

The fresh or undried samples contain per cent.:

	446	447	448	449	450	451	452	453	454	465	467A	467B	492	510	511
Water,	80.68	62.25	42.19	38.04	88.51	32.08	77.23	70.90	67.26	73.81	87.13	81.36	79.73	50.47	42.34
Organic (vegetable) and volatile matter,	15.93	26.33	12.80	55.72	10.40	53.82	21.83	7.55	19.75	23.39	11.55	6.94	16.74	18.96	41.49
Ash, including sand and soil,	3.39	11.42	45.01	6.24	1.09	14.10	0.94	21.55	12.99	2.80	1.32	11.70	3.53	30.57	16.17
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
THE ASH CONTAINS,															
Silica and substances insoluble in acid,	2.19	7.66	36.08	3.34	0.42	9.83	0.42	----	7.87	1.63	0.48	10.78	2.63	27.36	13.36
Oxide of iron, alumina and phos. acid,	0.35	0.88	6.32	0.70	0.13	----	0.31	1.61	4.55	0.34	0.20	0.57	0.27	1.73	1.70
Lime,	0.44	1.78	0.69	1.32	0.23	1.28	0.09	0.06	0.11	0.38	0.35	0.09	0.42	0.78	0.10
Other matters not separately determ'd,	0.41	1.10	1.92	0.88	0.31	2.99	0.12	----	0.46	0.45	0.29	0.26	0.21	0.70	1.01
Nitrogen (in organic matter),	0.41	0.33	0.33	1.36	0.25	0.91	0.24	0.26	0.41	0.60	0.31	0.18	0.44	0.56	0.74
Poisonous iron-salts: soluble in water,	none	none	none	none	none	none	none	trace	much	none	none	none	none	none	none

The dry (water free) mucks contain per cent.:

	446	447	448	449	450	451	452	453	454	465	467A	467B	492	510	511
Organic and volatile matters,	82.44	69.48	22.14	89.93	90.51	79.24	95.87	25.95	60.32	89.31	89.74	37.23	82.58	38.28	71.95
Ash,	17.56	30.52	77.86	10.07	9.49	20.76	4.13	74.05	39.68	10.69	10.26	62.77	17.41	61.72	28.05
Lime,	2.27	4.71	1.19	2.13	2.00	1.88	0.39	0.26	0.33	1.45	2.72	0.48	2.07	1.57	0.17
Nitrogen,	2.12	0.87	0.57	2.19	2.18	1.34	1.05	0.89	1.25	2.29	2.40	0.96	2.17	1.13	1.28

The organic matter of the mucks contains per cent.:

	446	447	448	449	450	451	452	453	454	465	467A	467B	492	510	511
Nitrogen,	2.57	1.25	2.58	2.44	2.40	1.69	1.10	3.44	2.08	2.57	2.68	2.59	2.63	2.95	1.78

can be no reasonable doubt that a good portion would become available to crops, especially after composting with dung and urine. It also contains four times as much lime as stable manure.

2. As to the value of **450,** the fresh dug muck, it would doubtless be serviceable if well pulverized and distributed upon sandy, droughty soil. It contains nothing injurious to vegetation.

The chief advantages of "curing" muck by exposure to air and frost are, 1, pulverization, 2, removal of a share of the useless water, and 3, removal of the soluble poisonous salts of iron. The sample **450,** like all but two of those here reported, is free from injurious iron-salts, and except for the cost of carting its extra water and the convenience of application, it might, most probably, be applied as well fresh as cured.

451, from G. W. Stanley, of New Britain, was a well cured or dried sample, but still retained thirty-two per cent. of water. The composition in the dry state shows it to be rather above medium quality, with 1.9 per cent. lime and 1.3 per cent. nitrogen. Its content of sand and soil (fifteen per cent. or more of the dry muck) depresses the nitrogen, but the organic matter itself contains a less proportion of this element than that of any other sample except **452.**

452 and **453,** from Henry Hine, of Oxford, represent respectively the upper and lower layers of the same bed. **452** was coarse and fibrous from undecayed vegetation. The organic matter of **453** was more fully decomposed but was admixed with clay and fine soil, to the extent of seventy-four per cent. These are the poorest mucks here reported, averaging when water-free but one-third per cent. of lime and one per cent. of nitrogen. The bottom sample contains some soluble and poisonous iron-salts which would disappear by thorough weathering, or more speedily and certainly by composting with ashes, potash or lime. Such muck would probably not pay to apply fresh, except on light, leachy land, and there would be of advantage mainly as an amendment of too great porosity and droughtiness and not as a fertilizer.

454, from the farm of Augustus Storrs, Mansfield, is an interesting sample, as it represents a piece of meadow land that has been drained and cultivated for three or four years, but, as Mr. Storrs reports, all attempts to get crops of buckwheat, corn or turnips have totally failed—even weeds do not grow upon it. The surface of the ground when it dries becomes white as if salt or plaster had been sown upon it.

The barrenness of this soil is due to iron-salts soluble in water, mainly proto-sulphate of iron, the same thing as copperas or green-vitriol, which is present in considerable proportion and which poisons and destroys all vegetation. The remedy is a copious application of leached ashes or lime. Unless there is permanent bottom water also poisoned by iron-salts, the lime will shortly cure the difficulty. The sample is more of a muck than a soil, containing sixty per cent. of vegetable and volatile matters, and not only has excess of iron-salts but is deficient in lime and presumably in other mineral plant food, so that leached ashes would be the most suitable application.

465. This muck, from E. C. Birge, Southport, is seen, from the statement of its composition in the water-free state, to contain nearly ninety per cent. of vegetable matter with 2.3 per cent. of nitrogen, and 1.5 per cent. of lime; it is accordingly of excellent quality. Mr. Birge states that it can be delivered on the adjacent upland at eighteen cents per cart load of twenty-five bushels. Mr. Birge asks:

1. After letting it dry on the upland, will it pay to cart to the yard one-half or three-fourths mile distant for litter?

2. Will it pay to top-dress pastures near the swamp with raw muck?

3. Will it pay to compost with lime at the swamp?

Queries 1 and 3 were answered in the affirmative. In reply to the second question, a doubt as to the advantage of its direct use was expressed. Evidently, however, nothing but actual experience can positively decide these questions, and the answers given, being offered without a careful examination of all the circumstances of the case, are merely opinions that are intended to be safe, but are not expected to be exact.

467A and **467**B, from Lewis Davis, Milford, are respectively the black upper and brown lower layers of the same deposit. Mr. Davis asked which is the best, and if either or both are worth applying to sandy loam directly or after composting with something besides yard manure.

The analysis indicates the muck to be of the best quality. The lower portion is, however, largely mixed with soil. This renders it less rich in nitrogen and lime, and therefore inferior as a fertilizer; but as the soil it contains is mostly of very fine pulverization, it is not less valuable as an amendment on light, open-textured soils. The best materials next to stable manure to compost with

would be unleached wood ashes, or fresh burned and slacked lime. By slacking the cheapest oyster-shell lime, mixed with say one-tenth as much kainite (potash salts) or low grade sulphate of potash, and composting with the muck, the latter will not only yield its nitrogen rapidly, but its lack of potash, magnesia, etc., will be supplied. To one cord or one hundred bushels of muck, ten bushels of lime may be used.

492, From W. E. Simonds, Canterbury, is also a muck of high quality, judged from the analysis, the dry substance containing over two per cent. each of lime and nitrogen.

510, Sent by H. A. Slater, North Manchester, taken from a ditch at the edge of a swamp of three or four acres which has had some wash from adjacent hillsides, and which yields a light growth of coarse hay. The sample was from a pile dug in the fall of 1879, and hauled in October, 1880, to a barn to be used as an absorbent.

511 is from a depression of three to four acres on high ground, where the wash is less than in the case of **510.** Vegetation is mainly moss with isolated bunches of grass and birch trees. The sample is from a heap that has been dug two years.

510 and **511** are both mixed with a good deal of soil, but still contain more than the average of nitrogen. The 1.57 per cent. of lime in **510** water-free, stands doubtless in connection with the fact that it carries a growth of coarse grass, while the smaller amount (.17 per cent.) in **511** partly explains the absence of grass and prevalence of moss on the swamp from whence it was taken.

In the same stage of dryness **510** is much the richer of the two, notwithstanding it contains more than twice as much soil as **511.**

For full details as to methods of handling and composting, the reader is referred to my Report on Peat and Muck, published in the Transactions of the Connecticut State Agricultural Society for the year 1858, and afterward revised and enlarged and issued by Orange Judd & Co., under the title, "Peat and its Uses as Fertilizer and Fuel."

Experiments on the Effects of Alkalies in Developing the Fertilizing Power of Peat.

During the summer of 1862, the writer undertook a series of experiments with a view of ascertaining the effect of various composting materials upon peat.

An account of these experiments was published in "Peat and its Uses," and I copy that account here, for two reasons: 1. To show the very positive effect of alkalies in rendering the nitrogen of peat available to vegetation.

2. To illustrate the benefit of pot-experiments when properly made.

The Station ought to carry on such experiments constantly, and is only hindered from doing so by the want of any suitable place for prosecuting them.

Experiments.

Two bushels of peat were obtained from a heap that had been weathering for some time on the "Beaver Meadow," near New Haven. This was thoroughly air-dried, then crushed by the hand, and finally rubbed through a moderately fine sieve. In this way, the peat was brought to a perfectly homogeneous condition.

Twelve one-quart flower-pots, new from the warehouse, were filled as described below; the trials being made in duplicate:

Pots 1 and 2 contained each 270 grams* of peat.

Pots 3 and 4 contained each 270 grams of peat, mixed with 10 grams of ashes of young grass.

Pots 5 and 6 contained each 270 grams of peat, 10 grams of ashes, and 10 grams of carbonate of lime.

Pots 7 and 8 contained each 270 grams of peat, 10 grams of ashes, and 10 grams of slaked (hydrate of) lime.

Pots 9 and 10 contained each 270 grams of peat, 10 grams of ashes, and 5 grams of lime, slaked with strong solution of common salt.

Pots 11 and 12 contained each 270 grams of peat, 10 grams of ashes, and 3 grams of Peruvian guano.

In each case the materials were thoroughly mixed together, and so much water was cautiously added as served to wet them thoroughly. Five kernels of dwarf (pop) corn were planted in each pot, the weight of each planting being carefully ascertained.

* 1 gram = 14¼ grains. 1 oz. = 28⅓ grams.

The pots were disposed in a glazed case within a cold grapery,* and were watered when needful with pure water. The seeds sprouted duly, and developed into healthy plants. The plants served thus as tests of the chemical effect of carbonate of lime, of slaked lime, and of salt and lime mixture on the peat.

The plants were allowed to grow until those best developed, enlarged above, not at the expense of the peat, etc., but of their own lower leaves, as shown by the withering of the latter. They were then cut, and, after drying in the air, were weighed, with the subjoined results.

Nos.	Medium of growth.	Weight of crops in grams.		Comparative weight of crops, the sum of 1 and 2 being taken as unity.	Ratio of weight of crops to weight of seeds, the latter assumed as unity.
1 2	Peat alone.	1.61 2.59	4.20	1	2½
3 4	Peat, and ashes of grass.	14.19 18.25	32.44	8	20½
5 6	Peat, ashes and carbonate of lime.	18.19 20.25	38.44	9	25½
7 8	Peat, ashes and slaked lime.	21.49 20.73	42.22	10	28½
9 10	Peat, ashes, slaked lime and salt.	23.08 23.34	46.42	11	30½
11 12	Peat, ashes and Peruvian Guano.	26.79 26.99	53.78	13	35½

Let us now examine the above results. The experiments 1 and 2 demonstrate that the peat itself is deficient in something needful to the plant. In both pots, but 4.2 grams of crop were produced, a quantity two and a half times greater than that of the seeds, which weighed 1.59 grams. The plants were pale in color, slender, and reached a height of but about six inches.

Nos. 3 and 4 make evident what are some of the deficiencies of the peat. A supply of mineral matters, such as are contained in all plants, being made by the addition of ashes, consisting chiefly of phosphates, carbonates, and sulphates of lime, magnesia, and potash, a crop is realized nearly eight times greater than in the previous cases; the yield being 32.44 grams, or 20½ times the weight of the seed. The quantity of ashes added, viz: 10 grams, was capable of supplying every mineral element, greatly in excess of the wants of any crop that could be grown in a quart of soil. The plants in pots 3 and 4 were much stouter than those in 1 and 2, and had a healthy color.

* To the kindness of Joseph E. Sheffield, Esq., of New Haven, the writer is indebted for the use of the glass house for setting up these experiments. The young vines did not seriously obstruct the sunlight.

The experiments 5 and 6 appear to demonstrate that carbonate of lime considerably aided in converting the peat itself into plant-food. The ashes alone contained enough carbonate of lime to supply the wants of the plant in respect to that substance. More carbonate of lime could only operate by acting on the organic matters of the peat. The amount of the crop is raised by the effect of carbonate of lime from 32.44 to 38.44 grams, or from 20½ to 25½ times that of the seed.

Experiments 7 and 8 show, that slacked lime has more effect than the carbonate, as we should anticipate. Its influence does not, however, exceed that of the carbonate very greatly, the yield rising from 38.44 to 42.22 grams, or from 25½ to 28½ times the weight of the seed. In fact, quicklime can only act as such for a very short space of time, since it rapidly combines with carbonic acid, which is supplied abundantly by the peat.

In experiments 7 and 8, a good share of the influence exerted must therefore be actually ascribed to the carbonate, rather than to the quicklime itself.

In experiments 9 and 10, we have proof that the "lime and salt mixture" has a greater efficacy than lime alone, the crop being increased thereby from 42.22 to 46.42 grams, or from 28½ to 30½ times that of the seed.

Finally, we see from experiments 11 and 12 that in all the foregoing cases it was a limited supply of nitrogen that limited the crop; for, on adding Peruvian guano, which could only act by this element (its other ingredients, phosphates of lime and potash, being abundantly supplied in the ashes), the yield was carried up to 53.78 grams, or 35½ times the weight of the seed, and 13 times the weight of the crop obtained from the unmixed peat.

Influence of Lime on the Effect of Fertilizers.

Relative Fertilizing Value of Soluble and Reverted Phosphoric Acid.—In March last, Mr. S. B. Wakeman, of Saugatuck, inquired of the Station, "if caustic lime be put on the ground and superphosphate of lime also applied, what action has the lime on the soluble phosphoric acid?"

Mr. T. B. Wakeman, of Green's Farms, wishing to manure three acres of onion ground heavily with stable manure, blood guano and superphosphate, and also to apply eight barrels of slacked lime and 1500 pounds of salt, for the purpose of destroying worms, likewise inquired whether the lime would injure the effect of the superphosphate.

These inquiries touch several important points, viz: the effect of caustic lime on the nitrogen and phosphoric acid of fertilizers, and consequently the relative value for fertilizing purposes of the various forms or states of phosphoric acid. Before reproducing here the brief answers given to the above inquiries, a short discussion of these points is offered.

If we mix lime intimately with manures containing ammonia-salts, the ammonia is set free as a gas and escapes into the air.

Again, if we mix lime with a fertilizer containing phosphoric acid, or phosphates soluble in water, there is formed so-called reverted phosphoric acid, i. e., phosphate of lime insoluble in water.

From these facts it has been inferred that lime should not be mixed with fertilizers containing either ammonia-salts or soluble phosphoric acid. This is, in fact, generally speaking, sound doctrine as applied to mixing fertilizers with lime before application. It should be remembered, however, that few fertilizers contain much ammonia-salts. Stable manure contains but three or four pounds of ammonia to the ton, and the ordinary superphosphates and special manures rarely contain more than two or three per cent. of ready-formed ammonia. On mixing with lime, enough ammonia might be liberated to affect the sense of smell, more or less powerfully, but the loss thus occasioned would be in most cases comparatively trifling, and far smaller than might be inferred from the odor, because the nose is a very sensitive test for ammonia, and because the intermixture and contact of the lime and the manure would be extremely rough and incomplete, and therefore such a mass might be left for days, giving off the smell of ammonia all the time, and then have lost but a fraction of that originally present. It has also been taught that it is a wasteful or injurious practice to apply lime to *the land* at or near the time of dressing it with stable manure, guano and superphosphates. This teaching is not always or altogether correct.

The mixing together, in the soil, of lime and fertilizers containing ammonia-salts, can scarcely occasion much loss, because the soil, by its moisture, by its humus, i. e., vegetable matter in decay, and by the absorbent silicates, which are never absent from earth that has any moderate productive power, is ready to take up at once the liberated ammonia, and prevent any sensible waste.

The very slight escape of ammonia that would result from applying together lime and manure containing ready-formed ammonia may, therefore, oftentimes be more than compensated by the farmer's convenience, or by other actual or prospective advantages. To mix together lime and a soluble phosphate, (one containing soluble phosphoric acid), at first sight would appear to be a grievous error, because the soluble phosphate is obtained by acting on an insoluble phosphate with oil of vitriol, at such an expense that one pound of soluble phosphoric acid costs as much as three or four pounds of insoluble.

To mix the soluble phosphate with lime is said to undo what was done by the oil of vitriol, and this is true in a sense, and to a degree. But the original insoluble phosphate, whether South Carolina rock phosphate, Canadian apatite, bone black, or whatever else, is a very different thing from the precipitated phosphate which results from the action of lime on soluble phosphoric acid. The former is coarse, dense and very insoluble, and under ordinary circumstances without immediate sensible effect on crops. The latter is an efficient fertilizer, quite similar in nature or at least in effects, to the phosphates of the fertile soil, being excessively fine in its division and no doubt readily taken up by the roots of plants. On the other hand, soluble phosphoric acid in some circumstances may act detrimentally, so that in such circumstances a superphosphate, mixed with lime at or previous to application, would do better than when applied without lime.

It was long ago remarked in agricultural practice in France, that certain low-grade native phosphates, which could not be economically made into superphosphates, gave little immediate or perceptible benefit when applied finely ground to various loamy or sandy lands, but on *certain other soils, rich in humus*, operated promptly and strikingly. This fact indicates that insoluble phosphates are made soluble and available to vegetation by the various acids resulting from vegetable decay. Quite in harmony with this is the experience of Dr. Ravenel, of Charleston, S. C., who has found that finely-ground Charleston phosphate rock is quite assimilable by vegetation, when applied in conjunction with vegetable matter, obtained by plowing under a large growth of the Southern pea, or letting it decay on the surface of sandy and otherwise nearly worthless land. In fact, the decaying vegetation would appear to dissolve the phosphate as effectually and more economically than sulphuric acid. That is to say, a better economical result is obtained, by applying a dollar's worth of fine ground phosphate rock with a decaying green crop, than by using the same worth of artificially dissolved phosphate, the latter containing about one-third or one-fourth as much phosphoric acid as the former.

Various experimenters have, in fact, found that humus dissolves the insoluble crude phosphates. Quite recently M. Beletzky has observed that a mineral phosphate (phosphorite) containing fifteen per cent. of phosphoric acid, put in contact with five times as much peat, (swamp muck), in presence of water, yielded in five days one-eighth of its phosphoric acid in solution to the liquid.

Hon. S. L. Goodale, for many years secretary to the Board of Agriculture of the State of Maine, states that some farmers of his acquaintance prefer the "Cumberland Phosphate," made at Portland, I believe, after it has, by keeping, suffered the "reversion" of nearly all its soluble phosphoric acid.

Various pot and field experiments, recently made in Germany and Belgium, have shown in some cases an equally good or even better effect from reverted than from soluble phosphoric acid. On a "sterile lime sand," Dr. Wein, of Munich, found that reverted phosphoric acid gave considerably better results than soluble phosphoric acid, or than soluble superphosphate of lime. It would thus appear that in some cases it may be no disadvantage to apply lime and superphosphate together; in other cases it may be a positive advantage. On the other hand, in many instances, the superiority of soluble over reverted and insoluble phosphates would seem to have been fully demonstrated, not only for sandy, loamy and clayey soils, but also for those rich in humus. In seventeen field trials, recently reported from the Experiment Station at Kiel, in Holstein, the result is that on the loamy soils, in general, a pound of reverted phosphoric acid gave about half the effect obtained from the same amount of soluble. On sandy soils, adjacent to moorland and rich in humus, the soluble operated decidedly better than the reverted. On newly reclaimed moorland, the reverted gave better results than the soluble, but on moorland that had been limed, the soluble gave the better results.

Exceptions to the most general rule were not wanting. In one case reduced phosphate surpassed soluble on a loam. Fleischer, near Bremen, found in a series of nine comparative trials on five moor soils, that the soluble phosphate surpassed the reverted, strikingly in one case, was strikingly surpassed in one case, while in seven instances both operated about equally well.

From a careful review of the facts now on record bearing on this question, it is plain that we have not the means of deciding with certainty when and why one or the other forms of phosphoric acid is best. The recently published experiments are more suggestive than conclusive. The subject has been engaging attention at the German Stations, and doubtless we shall soon obtain positive information on these points.

So far as can be concluded from the data at hand, it is probable that soluble phosphoric acid is uneconomical on soils containing superabundant humus, because such soils already have a surplus of acid. In them not only do carbonic acid and the peculiar acids of humus abound, but even acetic acid (the acid of vinegar) and similar equally energetic acids, are likely to be formed under a favorable temperature.

It has been demonstrated that agricultural plants are injured or destroyed by either a slight amount of free acid or free alkali in contact with their roots. Therefore, when the soil is itself acid, any added acid, (and soluble phosphates are usually acid), increases an already present or impending evil.

Soils rich in humus do not, however, necessarily have a surplus of acid. They may contain originally or may have added to them carbonate of lime in such quantity that the development of free acid is rendered impossible. In fact, such soils may become alkaline in hot, moist weather from the development of ammonia. The circumstances in which lime may act detrimentally on a superphosphate, are probably when the lime is present in relatively large quantity, and the soil is at the same time deficient in organic matter.

To Mr. S. B. Wakeman's inquiry, was answered substantially as follows: When *soluble phosphoric acid* is put in the soil, it gradually passes into the state of *reverted phosphoric acid*, by the action of the lime and iron of the soil. If caustic lime be applied to the land, the process is simply hastened. Whether or not this effect of the caustic lime is a disadvantage or an advantage, appears to depend on circumstances. In mucky soil or soil containing a good deal of vegetable matter, reverted phosphoric acid oftens works as well, or even much better, than soluble phosphoric acid. In fact, soluble phosphoric acid should be cautiously applied on such land. On soil where bone does little good—dry, sandy loam with little vegetable matter—soluble phosphoric acid usually operates well, better than reverted. The inference is that

lime would work well with superphosphate on soil containing abundant humus, but had better not be applied at the same time with soluble phosphoric acid on dry lands deficient in vegetable matters. Lime is best applied on grass; superphosphate on grain or hoed crops. I don't suppose, however, that on land in good condition it would ordinarily make a difference worth considering, whether the two be used together or separately, but in some cases the lime operates against the superphosphate.

To Mr. T. B. Wakeman was answered: It is not probable that a moderate application of salt and lime will damage the manure and phosphate on your onion land to a degree worth mentioning. If they could be put on some time apart, it would perhaps be better, but even if applied at the same time and at once worked in, no serious loss or detriment could occur on well-manured loamy land, suitable for onions.

Mr. T. B. Wakeman writes, Dec. 9, 1880, that the use of lime and salt has been, this season, quite effectual in staying the ravages of the worms, which otherwise have made serious havoc with the onion crop. He states, further, that in his opinion the caustic lime has not interfered with the action of the manures, and says that next Spring, lime and salt will be considerably used, both on onion and strawberry land, for the purpose of destroying worms.

Where it is intended to apply potash-salts as a fertilizer, it would be an advantage to use muriate of potash, instead of salt (muriate of soda) in slacking the lime. Muriate of potash would doubtless have, in connection with lime, substantially the same effect in destroying worms that salt exerts, and would be afterwards much more serviceable to the crop than common salt can be, because considerable quantities of potash are indispensable to all plants, while soda is either not necessary to their growth, or is required in only very small amount.

Leather Chips.

The Station has had several inquiries as to the value of Leather Chips for fertilizing purposes. Leather chips contain usually 5 to 8 per cent. of nitrogen, but this nitrogen is totally unavailable to vegetation unless the leather is brought into a state of decay or is acted upon by some powerful chemical agent. Leather is, however, specially prepared to resist decay, and hence chips of it, when brought into the soil, are very slow to benefit vegetation. The activity of leather is hastened by fine division, but there has been devised no ready and cheap means of pulverizing so tough a substance. It may indeed be rendered brittle by roasting at a moderate heat and then may be easily ground to powder. Prof. F. H. Storer has made a series of valuable pot-experiments for the purpose of testing the effects of raw and roasted leather on vegetation. These investigations, published in the Bulletin of the Bussey Institution, vol. II, pp. 58–71, 1877, have demonstrated that raw sheep-skin and sole-leather are totally incapable of feeding plants, are in fact rather detrimental to vegetation. The experiments likewise prove that roasted leather, while it shows some slight nourishing value, is still comparatively so inert that it can scarcely have any definite money value as a manure. It is in fact no better fertilizer in respect to nitrogen supply, than simple peat.

It is therefore evident that leather is not of sufficient worth as a fertilizer to have a commercial value put upon it for that purpose. Nevertheless, just as the nitrogen of peat may be brought into an available condition by composting with alkaline matters, so that of leather may be transformed, in part at least, into plant-food, and by similar means.

If leather chips be boiled in a strong potash-lye, ammonia is given off copiously, and while the farmer cannot use this fact as a method of utilizing leather, he may no doubt safely infer from it that leather chips are a serviceable ingredient of the compost, in which on the one hand, urine and ammonia-yielding animal matters, or, on the other, lime and ashes or salt and lime are ingredients. In the ordinary compost, leather chips require a long time, a year or so, to become properly disintegrated. The oil in leather hinders the penetration of water and thus opposes decay. Drenching the leather with a moderately strong potash-lye, which dissolves the oil, would therefore appear to be a useful preliminary in composting it, but the question how far such expedients can be economically resorted to on the farm, is one that experience can only determine.

By heating leather chips mixed with alkali (lime and soda) to redness, all the nitrogen may be extracted in the form of ammonia, and it is perhaps not improbable that this process might be carried out on a manufacturing scale with a profit, where leather refuse is largely accumulated.

Apple Pomace.

The question whether Apple Pomace has any fertilizing value has been proposed to the Station, and a sample was received from D. H. Van Hoosear, of East Wilton. Since Prof. F. H. Storer has examined this material, it appeared unnecessary to analyze the sample. Practical trial has established that there is very trifling fertilizing value in apple pomace, and the analysis sustains and explains this view. Prof. Storer found in it as made from Baldwin apples:*

Water,	77.21
Organic matter,†	22.29
Ash,	.50
	100.00
† With nitrogen,	.16

The ash is nearly half potash. The organic matter consisting mainly of carbhydrates, might be serviceable in a compost, in the same sense that the organic matter of swamp muck or saw dust may be, but evidently there is nothing in the apple pomace to justify much handling of a material which consists so largely of water.

Soils.

Detailed analyses of four samples of soil have been made in the hope of learning the causes of their unproductiveness. A sample of clay has also been examined.

489 and **490** are samples from adjoining fields belonging to the farm of D. H. Van Hoosear, president of the Wilton Farmers' Club. Both are what would be termed sandy loams with sufficient vegetable matter to give them a rich dark appearance when wet. The subsoil is sandy or loamy. They are said not to need draining, are not shaded, and there is no apparent reason why the soil whence these samples were taken should not be as good as the surrounding land, which is in part remarkably productive. Mr. Van Hoosear states that **489** during fourteen years of his ownership has been manured heavily, but all crops, grass, grain, corn, potatoes, have not been up to standard. As to **490** he says that during forty years he has not been able to get a good crop, although all crops have been tried, with heavy applications

* Bulletin of the Bussey Institution, vol. I, p. 365.

of stable manure, and as the land was light cattle have been foddered on it to make it more compact, but this has been of no avail.

In order to appreciate the analytical results we must compare them with the composition of soils of known character for fertility. In the Table, page 70, are given analyses of two soils, one a naturally poor sandy loam made capable of yielding a ton of tobacco per acre by copious manuring, the other a naturally fertile prairie soil. The former was analyzed by Dr. C. U. Shepard, Jr., State Chemist of South Carolina, to whom I am indebted for the valuable series of papers in which it was published. The latter was analyzed by Dr. Voelcker, Chemist to the Royal Agricultural Society of England, and is copied from Caird's "Prairie Farming in America." The analyses were all made, I believe, by essentially the same method and are fairly comparable.

The analysis of the soil and its hydrochloric solution as given on page 70, totally fails to give any explanation of the infertility of **489** and **490**. Notwithstanding these soils with 12 and 8 per cent. of water are compared with the nearly or quite dry tobacco and wheat soils, they surpass the tobacco soil in organic matters, in nitrogen, in potash, in soda, in magnesia, and in sulphuric acid. **489** surpasses the tobacco soil in lime and contains nearly as much phosphoric acid. **490** has indeed less lime but has more phosphoric acid than the tobacco soil. **489** and **490** surpass the prairie soil in quantity of organic matter, of potash, soda and magnesia. Both contain less lime and sulphuric acid, **489** has a little less phosphoric acid and nitrogen, **490** has half as much nitrogen but more phosphoric acid than the prairie soil.

Some years ago M. Grandeau studied the composition of certain soils which possessed very different productive powers but which by the usual method of chemical analysis (of the acid solution) gave similar results. He found, however, that, after removing carbonates by a very dilute acid, and treating the residues with ammonia, solutions were obtained in which potash, phosphoric acid, etc., together with a black organic matter, or humus, "*matière noire*," were present in quantity corresponding to the fertility of the soil.

Grandeau has in fact been led by these studies to adopt the theory that in fertile soils generally the presently available plant-food exists in combination with humus, and that in the ammonia extract of a soil we have a comparatively ready and certain measure of its fertility. Since these soils from E. Wilton contain a large proportion of organic matter, it was decided to examine them after the method of Grandeau, and the table on page 71 gives the results, where they may be compared with Dr. Shepard's analysis by the same method of the N. Hadley tobacco soil.

It is seen that **489** and **490** yielded as much or more ammonia extract than the tobacco soil, and that the amounts of potash extracted were quite the same, but that there was in comparison to the tobacco soil a decided deficiency of lime and magnesia.

Without at once concluding that Grandeau's notion of the value of the analysis of the ammonia-extract is correct applied to these soils, it certainly would be interesting to try upon them moderate applications of lime either caustic or air-slacked. If the result were favorable it would go to sustain Grandeau's theory.

I should add that no traces of poisonous ingredients—soluble iron-salts—could be found.

Sample **493** was received from Hon. T. S. Gold, Secretary of the Board of Agriculture, who gives the following history of it:

"The earth which I send you was taken from the surface soil where formerly stood an old stable which was kept full of cows every winter for some fifty years. The stable was removed in the spring of 1878, and the manure which had accumulated under the stable-floor taken away down to the loamy soil. The place has been exposed to the weather for over two years yet nothing grows upon it. This sample was taken in September, after a rain which wet down some six inches, the season having been rather dry. At the depth of two or three feet we find hardpan, so there could not be much leaching, and as the spot is nearly level not much washing could take place. We have always found the earth from under old buildings which have contained cattle a powerful fertilizer, but expected the rains of two years would reduce its strength so that it would allow something to grow.

Some twenty years ago I cleared away another old stable and there observed the same barrenness for several years. Now the spot cannot be determined by its vegetation."

493 manifests, by the analysis of its acid solution, no deficiency of any mineral element. Its ammonia-extract however, page 71, contains but little lime and magnesia. What perhaps explains its present infertility is the comparative absence of nitrogen. This extremely interesting fact is the more surprising because the soil has been during the winters of half a century constantly charged

Analyses of Soils.

Solution in hydrochloric acid.

	Well manured tobacco soil, North Hadley, Mass.	**489** E. Wilton, Ct.	**490** E. Wilton, Ct.	**493** W. Cornwall, Ct.	**503** East Hartford, Ct.	**491** E. Wilton, Ct.	Best wheat soil, Illinois.
Moisture,	1.096	12.100	8.380	13.200	10.715	.840	Dried
*Organic and volatile matters,	2.763	8.350	6.000	2.140	4.050	1.850	5.688
†Potash,	.037	.122	.100	.775	.048	.417	.043
†Soda,	.025	.074	.054	.053	.035	.062	.012
†Lime,	.188	.253	.117	.295	.040	.180	.505
†Magnesia,	.205	.513	.513	.493	.092	.404	.042
†Oxide of iron and alumina,	1.701	4.978	5.401	5.320	2.116	5.466	3.575
†Sulphuric acid,	.031	.043	.031	.022	.056	.005	.134
†Phosphoric acid,	.219	.178	.285	.203	.295	.091	.232
Carbonic acid and chlorine,	.011	----	----	----	----	----	.235
Sand, silica and insoluble silicates,	93.724	73.389	79.119	77.499	82.553	90,685	89.471
	100.000	100.000	100.000	100.000	100.000	100.000	100.000
*Containing nitrogen,	.103	.264	.167	.061	.103	*trace*	.300‡

† Soluble in cold hydrochloric acid. In case of **489** to **491** the acid was applied for the time and of the strength directed by Wolff. The same I suppose is true of the other soils.

‡ In this analysis nitrogen was not determined: the figure given is the average found in several similar soils by Dr. Voelcker.

Analyses of Soils.

Ammonia-extract.

	Well manured tobacco soil, North Hadley, Mass.	**489**	**490**	**493**
Humus in ammonia extract.	1.000	2.190	1.633	.072
Ash " " "	.319	.344	.293	.556*
Containing:				
Silica,	.039	.042	.031	.142
Oxide of iron and alumina,	---	.179	.148	.222
Lime,	.035	.005	.003	.009
Magnesia,	.119	trace	trace	.004
Potash,	.007	.009	.008	.032
Phosphoric acid,	.097	.083	.059	.098
Sulphuric acid, soda, &c., by difference,	.022	.026	.044	.049
	.319	.344	.293	.556
Total ammonia extract (*matiére noire*),	1.319	2.534	1.926	.628

* The ammonia extract contained much fine clay which could not be separated by filtration.

with cattle urine, and unless some special cause existed for the dissipation of this element, the sample should contain much more nitrogen than is commonly found in soils.

The very natural supposition that the barrenness of this earth is due to an excess of soluble plant-food, would appear from the analysis to be the reverse of true. The soil as analyzed is rather unproductive from deficiency than from surplus of nitrogen; probably there is deficiency of presently available lime.

The soil was tested for poisonous salts and a very minute trace of protosulphate of iron was detected, but the proportion was altogether too insignificant to affect vegetation. Evidently the carbonate of ammonia which results from the decay of urine has acted upon the original organic nitrogen of the soil and rendered it soluble just as we have seen that lime acts on the nitrogen of peat. The soluble matters have leached away through the clay subsoil doubtless because of the physical effect which dissolved salts have in coagulating clay and rendering it penetrable. Not only has nitrogen thus disappeared, but the carbonate of ammonia has carried off in solution a large share of the humus originally present and with it the alkalies and other plant-food which are found in Grandeau's ammonia-extract. The soil illustrates in its present barrenness the effects of too much saline and ammoniacal manures, and serves perhaps to explain the exhaustion which has been observed to follow a too heavy course of Peruvian Guano.

This soil—which has resulted from the disintegration of granitic rocks and exhibits abundance of feldspar and mica—is naturally rich and will shortly recover a good supply of the ash-elements of plant-food by the weathering of its minerals. It would seem that the spot whence the sample came needs nothing but nitrogen in order to become again productive in a year or two.

It is, however, possible that the soluble saline matters which we should expect to find in a soil that has been so liberally manured with urine, have been merely washed into the subsoil by the heavy rain which fell just before the sample was taken, and would, on recurrence of dry weather, ascend with the evaporating water to the surface, and accumulate there in quantity sufficient to injure vegetation.

The sample **503** is from a spot in a tobacco field, the property of Mr. George Abbey, of East Hartford, which is stated to be unproductive notwithstanding various and copious manurings. The plants are said to do well for a time after setting out, but in a few weeks become discolored and blighted and shortly perish. The soil contains no poisonous salts. The analysis of the acid solution reveals no deficiency except perhaps that of lime. Nitrogen is present in fair proportion. The sample supplied was not sufficient for studying the ammonia-extract. As I informed Mr. Abbey before undertaking the analysis, the failure of the tobacco plants as he described it pointed rather to a physical than a chemical difficulty. The blight is such as would result from a failure of water supply which might be due either to a bed of hardpan or of open gravel at a little depth.

491 is a sample of "clay" sent by D. H. Van Hoosear with regard to which the question was raised whether it would have any value as a fertilizer. As a soil it is seen to be rather rich in potash but is destitute of nitrogen and deficient in phosphoric acid. It has in fact nothing to recommend it as a fertilizer, although it might be useful to amend the texture of a coarse leachy soil. It is not, in fact, strictly speaking, a clay, i. e., it contains no considerable amount of those exceedingly fine matters which confer plasticity on clays, but is merely a fine silt or sand.

The analyses of Connecticut soils hitherto made show, as might be predicted from a knowledge of the rocks and minerals whence they are derived, that they commonly contain abundance of potash derived from the feldspar of our rocks and of magnesia coming from the mica (or isinglass) which is found in our granites and schists. Lime though not entirely deficient in most cases is not abundant, as is further evidenced by the fact that the water of our streams and springs is commonly soft. Whether or not these elements exist in presently available condition depends upon the texture of the soil, the supply of humus and the cropping they have been subjected to.

Florida Magnesian Limestone.

A sample of limestone from Orange County, Florida, was sent to the Station by Charles E. Lord, Secretary of the Farmers' Club at Chester, who writes: "Several of our towns-people are interested in Orange groves in Florida, and would be pleased to learn your opinion of the fertilizing value of this rock, which is found there in large quantities, and could be got out and transported at about the same cost as the gypsum of Nova Scotia. Would it be valuable as a top-dressing about orange trees, and would it compare with gypsum and wood ashes as an application to onions?"

The analysis of the rock gave the subjoined result:

Silica and matter insoluble in acids,	9.89
Iron oxide,	trace
Lime,	29.99
Magnesia,	9.98
Potash,	0.16
Soda,	0.41
Sulphuric acid,	0.36
Phosphoric acid,	0.95
Chlorine,	trace
Carbonic acid and water (by difference),	48.26
	100.00

The rock consists accordingly, in round numbers, of:—

Carbonate of lime,	52 pr. ct.
Carbonate of magnesia,	21
Phosphate of lime,	2
Sulphates and carbonates or silicates of potash and soda,	1
Silica, sand and insoluble matters,	10
Water,	14
	100

The rock is a magnesian limestone. Its phosphate of lime would be worth, commercially, $1.00 per ton of the pulverized rock. The alkali-salts are present in too small quantity to have much effect on the fertilizing value. On soil deficient in lime and magnesia, this rock, either pulverized or burned, would under judicious application, in connection with organic matter, make a serviceable fertilizer. Since lime is the chief ash-element of all trees, a top-dressing of the pulverized or of the burned rock, after air-slacking, would probably be of benefit to orange trees. It can hardly be an efficient substitute for gypsum and wood ashes, applied to onions.

FODDER AND FEEDING STUFFS.

Seventeen samples of Feeding Stuffs have been analyzed, viz:

9 of maize; 2 of meal, and 7 of kernel.
2 of hay.
2 of wheat flour.
2 of cotton seed meal.
1 of dried brewers' grains.
1 of vegetable-ivory dust.

Besides the above, *Bowker's Bone Meal for Cattle* has been examined, and already noticed under Fertilizers, see p. 31, where its valuation is considered.

As in former Reports, I give here a few pages explanatory of the analysis of Fodder and Feeding Stuffs. The recent publication of Dr. Armsby's *Manual of Cattle Feeding*,* enables me to refer to that book for further information on these and other points connected with the composition and use of feeding stuffs.

It is chiefly owing to the investigations that have been carried on in the European Experiment Stations, that the chemical analysis of an article of cattle food may be usefully employed in fixing its nutritive value and place in the feeding-ration, and also in deciding how much the farmer can afford to pay for it, or at what price, and to what extent he can substitute it for other materials customarily used.

* Manual of Cattle Feeding, a Treatise on the Laws of Animal Nutrition and the Chemistry of Feeding Stuffs in their application to the Feeding of Animals. With Illustrations and an Appendix of useful Tables. By HENRY P. ARMSBY, Chemist to the Connecticut Agricultural Experiment Station. New York: John Wiley & Sons, 15 Astor Place. 1880.

In order to make our analyses of cattle feed directly useful, it is needful to adduce some of the results of the prolonged study of this subject made in other countries.

The following Table of the Composition and Contents of Digestible Nutritive Ingredients and Money Value of some of the most important Feeding Stuffs (page 78), is taken from the German of Dr. Emil Wolff, of the Agricultural Academy at Hohenheim, and represents the most recent and most trustworthy knowledge on these subjects.*

The *composition* of feeding stuffs, as here stated, is the *average* result of the numerous analyses that have been made within twenty-five years, mostly in the German Experiment Stations.

In his Manual, Dr. Armsby has adopted the Table of Kühn, who gives essentially the same averages as Wolff, and in addition shows the range of composition by stating the greatest and smallest per cent. of each ingredient.

The *quantities of digestible nutrients* are partly derived from actual feeding experiments, and are partly the result of calculation and comparison.

The percentage of the *three classes* of digestible matters, viz: *Albuminoids*,† *Carbhydrates*‡ and *Fat*, form the basis of calculating the money value of feeding stuffs. The values attached to them by Dr. Wolff are the following, the German mark being considered as equal to twenty-four cents, and the kilogram equal to 2.2 pounds avoirdupois.

1	pound of	digestible	albuminoids is worth	$4\frac{1}{3}$	cents.
1	"	"	fat "	$4\frac{1}{3}$	"
1	"	"	carbhydrates "	$\frac{9}{10}$	"

These figures are intended to express the average *money values* of the respective food-elements in the German markets. Whether or not these values are absolutely those of our markets, they represent presumably the *relative* values of these elements, approximately, and we may provisionally employ them for the

* From "*Mentzel u. Lengerke's Kalender*," for 1879.

† The Albuminoids here include a proportion of *amides* whose quantity in feeding stuffs has very recently become a subject of investigation, and whose nutritive value is not yet fully understood.

‡ The "nitrogen free extract" (N. fr. Extract) in grains consists almost exclusively of carbhydrates, viz: starch, sugar, gum, and allied bodies; in grass and hay it includes, in addition, substances of whose properties we are ignorant but which, so far as they are *digestible*, rank with the carbhydrates.

purpose of comparing together our feeding stuffs in respect to money value.

These money or market values are to a degree independent of the feeding values. That is, if of two kinds of food, for example, Hungarian hay and malt sprouts, the one sums up a value of 66 cents, and the other a value of $1.31 per hundred, it does not follow that the latter is worth for all purposes of feeding twice as much as the former, but it is meant that when both are properly used, one is worth twice as much money as the other. In fertilizers we estimate the nitrogen of ammonia salts at 22½ cents per pound, and soluble phosphoric acid at 12½ cents, but this means simply that these are equitable market prices for these articles, not that nitrogen is worth twice as much as soluble phosphoric acid for making crops. In the future more exact valuations may be obtained from an extensive review of the resources of our markets, in connection with the results of analyses of the feed and fodder consumed on our farms.

The column headed "nutritive ratio" in the table on page 78 gives the proportion of digestible albuminoids to digestible carbhydrates inclusive of fat.* The albuminoids, which are represented in animal food by the casein or curd of milk, the white of egg and lean meat, and in vegetable food by the gluten of wheat (wheat gum), and other substances quite similar to milk-casein and egg-albumin, have a different physiological significance from the carbhydrates, which are fiber or cellulose, starch, the sugars, the gums, and similarly constituted matters.

The 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 which are necessary parts of the animal machine, because they are the same kind of materials, are, chemically speaking, of the same composition.

The carbhydrates, on the other hand, probably cannot serve at all for building up the muscles and other parts of 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 fifteen per cent. of their dry matter.

The carbhydrates 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. The albuminoids are to the ox or the man what brass and iron are to the machine, the materials of construction and repair.

* Fat and carbhydrates have, it is believed, nearly the same nutritive function, and it is assumed that 1 part of fat equals 2.4 of carbhydrates.

The carbhydrates 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 with coal and water not only, 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. The albuminoids, or blood- and tissue-formers, are thus consumed in the animal, as well as the carbhydrates, or fuel proper. The fact that the albuminoids admit of consumption implies that when the carbhydrates or proper fuel are insufficient, they, the albuminoids, 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 carbhydrates 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.

To allow of directly comparing the money-value of feeding stuffs with some universally accepted standard, the last column of the table (page 78) gives a comparison with good average meadow hay taken as 1.

Average Composition, Digestibility and Money Value of Feeding Stuffs as given by Dr. Wolff for Germany for 1879, except those in italics.

							Digestible nutrients.				Value.	
	Water.	Ash.	Nitrogenous Matters, Albuminoids & Amides.	Fiber.	Nitrogen-free Extract.	Fat.	Albuminoids.	Carbhydrates including fiber.	Fat.	Nutritive Ratio.*	Dollars per 100 pounds.	Comparison with meadow hay = 1.
Meadow hay, poor	14.3	5.0	7.5	33.5	38.2	1.5	3.4	34.9	0.5	10.6	0.48	0.74
" " fair	14.3	5.4	9.2	29.2	39.7	2.0	4.6	36.4	0.6	8.3	0.55	0.86
" " average	14.3	6.2	9.7	26.3	41.4	2.5	5.4	41.0	1.0	8.0	0.64	1.00
" " very good	15.0	7.0	11.7	21.9	41.6	2.8	7.4	41.7	1.3	6.1	0.74	1.17
" " extra	16.0	7.7	13.5	19.3	40 4	3.0	9.2	42.8	1.5	5.1	0.84	1.32
Clover hay, average	16.0	5.3	12.3	26.0	38.2	2.2	7.0	38.1	1.2	5.9	0.69	1.08
" " best	16.5	7.0	15.3	22.2	35.8	3.2	10.7	37.6	2.1	4.0	0.88	1.39
Timothy hay	14.3	4.5	9.7	22.7	45.8	3.0	5.8	43.4	1.4	8.1	0.69	1.09
Hungarian hay	13.4	5.7	10.8	29.4	38.5	2.2	6.1	41.0	0.9	7.1	0.66	1.04
Rye straw	14.3	4.1	3.0	44.0	33.3	1.3	0.8	36.5	0.4	46.9	0.35	0.55
Oat "	14.3	4.0	4.0	39.5	36.2	2.0	1.4	40.1	0.7	29.9	0.44	0.69
Rich pasture grass	78.5	2.2	4.5	4.0	10.1	1.0	3.4	10.9	0.6	3.6	0.27	0.42
Average meadow grass, fresh	70.0	2.1	3.4	10.1	13.4	1.0	1.9	14.2	0.5	8.1	0.22	.36
Green maize, German	85.0	1.0	1.2	4.7	7.6	0.5	0.7	7.4	0.2	11.3	.10	.16
" *Mr. Webb*, 1874	86.0	0.8	0.8	4.8	7.3	0.3	0.6	8.3	0.2	14.4	.11	.17
Cured Maize Fodder, Mr. Webb	27.3	4.2	4.4	25.0	37.9	1.3	3.2	43.4	1.0	14.4	57	.91
Potatoes	75.0	0.9	2.1	1.1	20.7	0.2	2.1	21.8	0.2	10.6	.29	.46
Carrots	85.0	0.9	1.4	1.7	10.8	0.2	1.4	12.5	0.2	9.3	.18	.28
Mangolds	88.0	0.8	1.1	0.9	9.1	0.1	1.1	10.0	0.1	9.3	.14	.22
Rutabagas	87.0	1.0	1.3	1.1	9.5	0.1	1.3	10.6	0.1	8.3	.15	.24
Turnips	92.0	0.7	1.1	0.8	5.3	0.1	1.1	6.1	0.1	5.8	.11	.16
Sugar beets	81.5	0.7	1.0	1.3	15.4	0.1	1.0	16.7	0.1	17.0	.19	.30
Maize, German	14.4	1.5	10.0	5.5	62.1	6.5	8.4	60.6	4.8	8.6	1.10	1.73
" *American*	14.4	1.5	10.7	2.0	66.5	4.9	9.0	63.3	3.7	8.0	1.12	1.75
Oats	14.3	2.7	12.0	9.3	55.7	6.0	9.0	43.3	4.7	6.1	.97	1.53
Rye	14.3	1.8	11.0	3.5	67.4	2.0	9.9	65.4	1.6	7.0	1.09	1.68
Barley	14.3	2.2	10.0	7.1	63.9	2.5	8.0	58.9	1.7	7.9	0.95	1.47
Peas	14.3	2.4	22.4	6.4	52.5	2.0	20.2	54.4	1.7	2.9	1.44	2.25
Field beans	14.5	3.1	25.5	9.4	45.9	1.6	23.0	50.2	1.4	2.3	1.51	2.36
Squashes	89.1	1.0	0.6	2.7	6.5	0.1	0.4	7.1	0.1	18.4	.08	.13
Malt sprouts	10.1	7.2	24.3	14.3	42.1	2.1	19.4	45.0	1.7	2.5	1.31	2.06
Wheat bran, coarse	12.9	6.6	15.0	10.1	52.2	3.2	12.6	42.6	2.6	3.9	1.04	1.63
" fine	13.1	5.4	14.0	8.7	55.0	3.8	11.8	44.3	3.0	4.4	1.03	1.62
Middlings	11.5	3.0	13.9	4.8	63.5	3.3	10.8	54.0	2.9	5.7	1.07	1.68
Rye bran	12.5	5.2	14.5	5.7	58.6	4.5	12.2	46.2	3.6	4.5	1.10	1.72
Palm-nut cake	10.5	4.2	16.9	17.4	41.0	10.0	16.1	55.4	9.5	4.9	1.61	2.51
Cotton seed cake decorticated	11.2	7.6	38.8	9.2	19.5	13.7	31.0	18.3	12.3	1.6	2.05	3.22
Scrap, by Goodale's process	11.5	----	64.0	----	----	4.6	57.6	----	4.1	0.2	2.67	4.17
Fish-scrap, dry ground	11.7	----	51.5	----	----	8.1	46.4	----	6.2	0.3	2.28	3.56
Dried blood	12.0	4.1	80.8	----	2.6	0.5	54.1	2.6	0.5	----	2.39	3.76
Whey	92.6	0.7	1.0	----	5.1	0.6	1.0	5.1	0.6	6.6	.11	.18
Milk	87.5	0.7	3.2	----	5.0	3.6	3.2	5.0	3.6	4.4	.34	.53

* Nutritive ratios are read, 1 : 10.6, 1 : 8.3, etc. See page 76.

MAIZE.

LXXIII, Maize Meal. Ground by Marsh, White & Co., N. Y. From old western corn. One week in store. From stock of D. B. Crittenden & Co., New Haven. Cost $25 per ton.

LXXIV, Maize Meal. Fresh ground from old New York corn. From stock of N. W. Merwin, New Haven. Cost $25 per ton.

LXXVI, Maize Kernel, "High-mixed." 1879 crop. From stock of N. W. Merwin, New Haven. Cost 65 cents per 56 lbs.

LXXVII, Maize Kernel, new western corn. Crop 1879. From stock of D. B. Crittenden, New Haven. Cost 65 cts. per 56 lbs.

LXXVIII, Maize Kernel, "High-mixed." New crop western corn. From stock of N. W. Merwin, New Haven. Cost 65 cts. per 56 lbs.

All the above were sampled and sent by J. J. Webb, Hamden, Nov. 14, 1879.

LXXIX, King Phillip Corn, 8-rowed (Flint).
LXXX, Common Yellow Corn, 8-rowed (Flint).
LXXXI, Early Scioto Corn (Dent).
LXXXII, White Flint Corn, 8-rowed.

The last four samples were received from Chas. Fairchild, Middletown, Jan. 9, 1880, and were raised in the vicinity of that place, in 1879.

The water-content of market Corn.

The numerous analyses of Indian Corn recently made here and elsewhere, most of which were printed in the last Report of this Station, have been mainly performed on samples which from long storing in heated apartments, had become much more dry than corn commonly is when marketed. Thus Dr. Jenkins found in summing up the results of 63 analyses of American maize, that the amount of water ranged from 6 to 15 per cent., the average being 10½ per cent. In Wolff's tables the average is 14.4, in Kühn's tables 13.7 per cent., the minimum being 7.6, the maximum 22.4 per cent. Dr. C. A. Goessmann, in reporting recently eleven analyses made by himself and six made by Mr. S. P. Sharples, gives them all 10 per cent. of water. In my first Report for 1877, analyses of three samples of corn meal were published which contained, respectively, 12.9, 20.7 and 21.7 per cent. of water. It therefore appeared important to make further examinations of corn as it is offered in the market, in order to learn the quantities of water which belong to the commercial article. In case of the samples whose analyses are herewith given, the water was determined upon the meal or kernel as it reached the Station, and before any moisture then present could be lost by drying. It is seen from the analyses that all the samples, with one exception, contain 15 or more per cent. of water. The meal made from old Western corn and that from old New York corn, as well as the corn raised in this State, that was cured until Jan. 10th, contained an average of 15.6 per cent. One of the samples of "High-mixed New Crop Western," taken Nov. 14th, had 16.4 per cent. In the two other samples examined at the same date, the water averaged 20.45 per cent. These determinations therefore go to indicate that—1, the water in maize kernel and maize meal, as these are found in market, may range from 13 to 22 per cent. 2, well-cured corn and meal contain from 15 to 17 per cent., and 3, new corn and meal are likely to contain 20 to 21 per cent. It is evidently therefore a matter of some importance in large transactions whether, at a given price, corn and corn meal be bought in a slightly or thoroughly cured state. In the two samples of corn meal examined at this Station in 1877, containing respectively 12.9 and 21.7 per cent. of water, if they were sold at the same price, say $1.25 per hundred pounds, the purchaser would get, in the drier sort 87 lbs., and in the damper article but 78 lbs., of actual corn-meal. In the former case this dry matter would cost $1.44, and in the latter $1.60 per hundred pounds. Or were the drier sample worth $1.25 per hundred, the damper one, if otherwise of equal quality, would be worth but $1.12.

Between the samples LXXIII and LXXVI there is a calculated difference of value of 9 cents per hundred lbs., which is mostly due to the larger quantity of water in the latter.

Every farmer is of course aware that there is a difference between new and old corn in the amount of moisture they contain, but the extent of the difference is, I believe, not generally appreciated.

Analyses of Maize.

	Maize Meal.		Kernel as sold in market.			Unshelled corn raised in Connecticut.			
	From old Western corn. LXXIII	From old N. Y. corn. LXXIV	High mixed. LXXVI	New Western. LXXVII	High mixed new Western. LXXVIII	King Phillip. LXXIX	Common Yellow. LXXX	Early Sciota. LXXXI	White Flint. LXXXII
Water,	14.56	15.32	20.68	20.22	16.41	15.97	15.77	15.24	16.82
Ash,	1.22	1.47	1.19	1.16	1.25	1.35	1.26	1.28	1.19
Albuminoids,	9.12	8.63	7.83	8.54	8.57	10.31	10.00	8.31	8.94
Fiber,	2.16	1.83	1.65	1.67	1.76	1.37	1.47	1.59	1.32
Carbhydrates,	68.89	68.77	64.95	64.86	68.16	66.50	67.06	69.78	67.84
Fat,	4.05	3.98	3.70	3.55	3.85	4.50	4.44	3.80	3.89
Composition reckoned on dry substance.									
Ash,	1.43	1.74	1.50	1.45	1.50	1.60	1.49	1.51	1.43
Albuminoids,	10.67	10.19	9.88	10.70	10.25	12.27	11.88	9.80	10.74
Fiber,	2.53	2.16	2.08	2.09	2.10	1.62	1.74	1.87	1.58
Carbhydrates,	80.63	81.21	81.88	81.31	81.55	79.15	79.62	82.34	81.57
Fat,	4.74	4.70	4.66	4.45	4.45	5.36	5.27	4.48	4.68
Digestible nutrients in air-dry substance.									
Albuminoids,	7.66	7.25	6.58	7.17	7.20	8.66	8.40	6.98	7.51
Carbhydrates,	65.56	65.32	61.66	61.59	64.72	63.02	63.58	66.18	64.26
Fat,	3.20	3.14	2.92	2.80	3.04	3.56	3.51	3.00	3.07
Nutritive ratio,	1:9.6	1:10.0	1:10.4	1:9.5	1:10.0	1:8.3	1:8.6	1:10.5	1:8.7
Estimated value per 100 lbs.	$1.06	$1.05	$0.97	$0.99	$1.03	$1.10	$1.09	$1.03	$1.04

Comparative value of the Corn-Meal and shelled Corn in market.

In the first Report of this Station, the composition of three samples of commercial maize-meal was compared with that of five varieties of unground corn, and it was remarked that the meal was considerably inferior to the corn, containing, on the average, in dry matter, one per cent. less of fiber, two per cent. less of albuminoids, and two per cent. less of fat than the unground maize. It was in order to make further comparisons between commercial meal and corn that the first five analyses above given were carried out in detail.

Comparison of averages (dry matter).

	1877. Commercial Meal.	1879. Commercial Meal.	1879. Commercial Corn.	1879. Selected Conn. Corn.	*Dr. Jenkins'* Averages Flint.	*Dr. Jenkins'* Averages Dent.
Fiber,	1.68	2.34	2.09	1.70	1.71	2.10
Albuminoids,	9.75	10.43	10.28	11.17	12.13	11.81
Fat,	3.69	4.72	4.39	4.95	5.77	5.46

From the above table of averages we see that the specimens of corn-meal examined in 1877 were inferior to those of 1879. The commercial meal and corn of 1879 were practically the same in composition. The corn on ear of 1879 contained on the average 0.8 per cent. more albuminoids than the market shelled-corn of the same year, and 1.5 to 1.8 per cent. less than Dr. Jenkins' averages of 31 analyses of flint and 19 of Dent. On the other hand, one of the samples of Connecticut corn of 1879, viz: the early Scioto, contained but 9.8 per cent. of albuminoids and 4.48 of fat, nearly approaching in inferiority the meal of 1877. Doubtless Dr. Jenkins' averages rate maize too high for the commercial standard, because they represent well-matured, selected, sound and clean corn, while the article in the wholesale market includes whatever is merchantable, although sometimes of inferior quality, and not altogether free from cob and other impurities.

Probably our home-raised corn is generally somewhat better than the western shelled-corn, because it is cleaner and drier, and the meal in market is liable to be inferior to both, because of more moisture and impurities, and perhaps also because damaged corn can be worked into it without ready detection.

On choice of varieties.

The four samples from Mr. Fairchild were selected and sent by him with the object to ascertain which kind was most valuable to raise for feed. Mr. Fairchild gave the following data as to weight, &c.:

The bushel or 38 lbs. of ears yielded 31 lbs. corn and 7 of cob, in case of common yellow and white flint, and 30½ lbs. corn in case of King Phillip and early Scioto. One bushel of shelled early Scioto weighed 56 lbs.; one bushel of each of the others weighed 57½ lbs. The early Scioto, which here is the lowest in quality and money value, is, probably, in a favorable climate, more productive than the other varieties, and from the softness of its kernel is perhaps more easily and completely digestible, which fact offsets its less favorable composition. It is not likely that the differences above observed are constant or characteristic of the varieties: very probably they are to a good degree accidental or dependent upon special circumstances attending the growth of these samples. Evidently it would be necessary to compare the composition and the yield of these kinds of corn during several years, as raised on quite similar soils, and under the same conditions of growth throughout, in order to establish any positive superiority of one over the others.

HAY.

LXXXIII, Clover Rowen. First year after seeding. Cut Aug. 21, 1879. From C. S. Gillette, Cheshire. Mostly red clover, with small admixture of weeds and grasses.

LXXXIV, Second cut after seeding. Cut about July 1, 1879. From C. S. Gillette, Cheshire. Mixture of timothy (Phleum pratense) and red top (Agrostis). A few weeds and sedges.

	LXXXIII.	LXXXIV.	Water free. LXXXIII.	Water free. LXXXIV.
Water,	17.40	13.12		
Ash,	3.89	4.11	4.70	4.73
Albuminoids,*	13.54	6.91	16.37	7.95
Fiber,	25.86	28.11	31.33	32.35
Nitrogen-free extract,	37.07	45.73	44.90	52.65
Fat,	2.24	2.02	2.70	2.32
	100.00	100.00	100.00	100.00

* Including "amides" =1.85 % in LXXXIII and 0.85 % in LXXXIV.

Digestible Nutrients in Air-dry Substance.

	LXXXIII.	LXXXIV.
Albuminoids, or protein,	8.12	3.59
Carbhydrates,	37.07	45.73
Fat,	1.32	0.99
Nutr. ratio,	1: 5.0	1: 13.4

Notes to Hay Analyses, by Dr. Armsby.

"The albuminoids of the clover hay (LXXXIII) are higher than the average of German analyses, and about equal to Wolff's 'Very good' Clover Hay. Its crude fiber is, however, relatively high, being about equal to that of Wolff's 'Average,' but lower than the average of all analyses as given by Kühn. The digestibility of protein appears to be largely determined by the percentage of crude fiber, but to be also affected by the percentage of protein. We may therefore assume the albuminoids of this sample to be rather more digestible than in Wolff's 'Average,' but less so than in his 'Very good,' estimating it at 60. For fat we may assume 59, the corresponding coefficient, without serious error. The digestible carbhydrates are represented approximately by the nitrogen-free extract of the analysis.

LXXXIV has about the composition of Wolff's 'Inferior' Meadow Hay, though it is deficient in albuminoids, and we may assume his coefficients for albuminoids and fat, viz: 52 and 49, respectively, while the nitrogen-free extract represents the digestible carbhydrates."

Cotton Seed Meal.

LXXXV, From stock of Northam & Robinson, Hartford, Ct. Sent by R. E. Pinney, Suffield. Price $25.00 per ton, in 10 ton lots.

LXXXVIII, From stock of C. H. Carrington, Naugatuck. Sent by M. S. Baldwin, Naugatuck. $30.00 per ton.

	LXXXV.	LXXXVIII.
Water,	8.87	8.87
Ash,	6.99	7.34
Albuminoids,	45.00	43.06
Crude Fiber,	4.65	4.83
Nitrogen-free extract,	22.89	23.73
Fat,	11.60	12.17

	Water free.	
	LXXXV.	LXXXVIII.
Ash,	7.69	8.05
Albuminoids,	49.35	47.24
Crude Fiber,	5.11	5.30
Nitrogen-free extract,	25.11	26.03
Fat,	12.74	13.37
	100.00	100.00

Digestible Nutrients in Air-dry Substance.

	LXXXV.	LXXXVIII.
Albuminoids,	33.30	31.86
Carbhydrates,	11.60	12.03
Fat,	10.56	11.07
Nutritive ratio,	1: 1.1	1: 1.2
Estimated value per 100 lbs.,	$2.00	$1.97

These samples of Cotton Seed Meal have been already reported on as Fertilizers (Nos. **394** and **402**, p. 36). They agree very closely in composition. Their value, estimated by Wolff's figures, is $40 per ton. The feeding experiments from which the digestibility of cotton seed meal was deduced, were made with a very impure and inferior Egyptian meal, and as Dr. Armsby implies in his Manual of Cattle Feeding, p. 347, it is probable that the digestibility of the pure meal is greater. If that be the fact, then the above estimated value is relatively too low.

Either as Fertilizer or as Cattle Food, cotton seed meal is one of the cheapest articles in the market, and deserves to be used to a much greater extent than it now is. By employing it first in the feeding trough, its fat and carbhydrates are utilized to the best advantage. Thence a large share of its nitrogen, its phosphates and potash pass into and enrich the manure.

Wheat Flour.

LXXXVI, New Process Flour, from Minnesota Spring Wheat. Sent by N. W. Merwin & Co.

LXXXVII, Fine Flour from entire wheat $W^{W}_{W}W$ brand.

Prepared from same kind of wheat as the preceding sample. Sent by N. W. Merwin & Co.

	LXXXVI.	LXXXVII.
Water,	12.79	12.89
Ash,	0.50	1.44
Albuminoids,	12.31	14.12
Crude Fiber,	0.07	1.22
Nitrogen-free extract,	73.14	68.32
Fat,	1.19	2.01

Water free.

	LXXXVI.	LXXXVII.
Ash,	.57	1.65
Albuminoids,	14.12	16.20
Crude Fiber,	.08	1.39
Nitrogen-free extract,	83.86	78.46
Fat,	1.37	2.33
	100.00	100.00

Dust of Vegetable Ivory.

LXXXIX, Refuse of button factory. Sent by M. S. Baldwin, Naugatuck.

	LXXXIX.	Maize Cob, average.	Date Stones, average.
Water,	18.78	9.16	9.27
Ash,	1.08	1.32	1.04
Albuminoids,	3.37	2.22	5.46
Crude Fiber,	7.50	32.04	23.06
Nitrogen-free extract,	68.57	54.85	52.67
Fat,	.70	.41	8.50
	100.00	100.00	100.00

Water free.

	LXXXIX.	Maize Cob, average.	Date Stones, average.
Ash,	1.33	1.45	1.15
Albuminoids,	4.15	2.44	6.02
Fiber,	9.23	35.31	25.24
Nitrogen-free extract,	84.43	60.35	58.05
Fat,	.86	.45	9.37
	100.00	100.00	100.00

Nothing, at first sight, would appear to be of less value as cattle food, than the so-called vegetable ivory, the fruit of the *Phytelephas*, a tree of South America. Mr. Baldwin writes, however, that "it has been used as feed for cattle. It is claimed that they eat it with great relish, and fatten upon it." The analysis shows it to contain 68½ per cent. of non-nitrogenous extract, which consists largely if not entirely of carbhydrates, the precise nature of

which is under investigation. The vegetable ivory resembles maize cob in composition, except that it contains, water-free, 26 cent. less fiber and 24 per cent. more carbhydrates, as well as somewhat more albuminoids and fat.

The vegetable ivory is nearly equalled in its carbhydrates by date stones, which closely resemble it in appearance, hardness and apparent worthlessness as cattle food. The date stones contain, however, 2 per cent. more albuminoids and 8½ per cent. more fat. Date stones, the analysis of which we owe to Prof. Storer,* are, according to the testimony of travelers, made use of, in Arabia and Africa, after pounding and soaking in water, as food for camels, cows and sheep.

The vegetable ivory unquestionably cannot rank high as a cattle food, either because of its abundance or on account of its nutritive quality; it may, nevertheless, be worth economizing, where its dust or fine turnings are to be had, but should evidently be fed in conjunction with cotton seed meal, brewers' grains or other concentrated foods that can supply the albuminoids and fat, in which it is relatively deficient.

Kiln-Dried Brewers' Grains.

Brewers' Grains, i. e., the residue of barley after it has been malted and used for making beer-wort, has long enjoyed a high repute as cattle food, especially for milk cows; and notwithstanding the fresh grains contain an average of 78 per cent. of water, they are much sought after by farmers living within a few miles of the breweries. During the warmer season, however, large quantities sour and spoil before they can be fed. The only plan of saving them hitherto has been by putting them into pits after the manner of ensilage. Recently it has been attempted to make them capable of indefinite preservation and of easy handling by removal of most of the water which not only constitutes three-fourths of their weight when fresh, but renders them so susceptible to damage. The sample whose analysis is herewith given has been thus prepared. This sample was brought to the Station by A. J. Ramsdell, Esq. of New Haven.

* Bulletin of the Bussey Institution, vol. I, pp. 373–7.

	Kiln-dried Brewers' grains, XCIII.	Oats, average.
Water	2.57	13.7
Ash	3.97	2.7
Albuminoids	20.38	12.0
Crude Fiber	11.79	9.0
Nitrogen-free extract	54.89	56.6
Fat	6.40	6.0
	100.00	100.00

The amount of water above found is perhaps smaller than can well be practically realized on a large scale. On exposure to air, the grains containing but 2½ per cent. of water will no doubt gradually absorb several per cent. of moisture. With even 10 per cent. of water the dried brewers' grains will be, so far as chemical analysis can indicate, equal or superior to any grain or seed commonly used among us as food for animals. They correspond most nearly to oats in their composition, containing the same proportion of fat, a little more fiber and ash and some 8 per cent. more of the most costly and valuable food element, viz. albuminoids. Peas, beans and flax seed are the only seeds raised at the North which contain so much albuminoids. If experience shall show that the drying of brewers' grains can be carried on economically, the process will save a large amount of valuable cattle food from waste.

I understand it is claimed by some that the drying of brewers' grains seriously injures them for feeding purposes. This notion is in agreement with the idea put forward by the partisans of ensilage, some of whom assert that dried corn-fodder is greatly inferior to a corresponding quantity of the same put down as ensilage. In total absence of any exact comparative trials these claims must be regarded as entirely questionable. Without doubt dry brewers' grains may be considered equally nutritious with dry grains of any sort, that correspond to them in chemical composition.

POISONS.

London Purple.

This cheap substitute for Paris Green has been reported to be efficacious as an insecticide. A sample sent by P. M. Augur, Esq., was found to contain 47·3 per cent. of *arsenic acid.* The complete analysis by Prof. Collier shows the arsenic acid to be united to lime. The arsenate of lime is sufficiently soluble in water and in the digestive fluids of animals to act as an effective poison. The London Purple may therefore be regarded as fairly the equivalent of Paris Green for destructive purposes.

The West Avon Poison Case.

On Sunday morning, May 2nd, 1880, eight milk cows belonging to Messrs. Edward Woodford & Son, of West Avon, first began to show loss of appetite and at night refused their customary feed of ground corn and rye. In the *Connecticut Farmer* of May 15, Mr. P. R. Day* relates that on Tuesday he saw the animals standing with arched backs, heads pressing against the fence or over the watering trough, into which they would occasionally put their noses to sip a little and let it drop from their feverish mouths. One was blind and the eyes of all were dull and sunken. There was a profuse flow of urine; the slight bowel discharge was mostly of a dysenteric character.

Among the earlier symptoms were a grunt of pain at each respiration, twisting their jaws, crunching of the teeth, afterwards convulsions, blind running against the fences, then rapid whirling from left to right in a circle, then falling to the ground, with agonizing bellowings, until death supervened. The first death occurred Wednesday afternoon, the second and third Wednesday night, the fourth Thursday morning, the fifth and sixth the same afternoon and night, the seventh Friday night, the eighth Sunday morning, one week from the first appearance of the illness. Dr. Cressy's *post mortem* showed extensive inflammation and corrosion of the mucous membrane of the digestive tract, while all other organs were healthy. The appearances indicated that the animals had swallowed some energetic poison. Portions of stomach- and bowel-tissue—the muscular coats—were brought to the Experi-

* The statement here given of the symptoms and *post mortem* appearances is condensed from Mr. Day's account.

ment Station in order to be subjected to examination for poisons. Dr. R. H. Chittenden, Instructor in Physiological Chemistry and Toxicology in the Sheffield Scientific School, made a full analysis but failed to identify any poison. In fact, so long a time had elapsed between taking poison and death and the tissues had been so denuded of the mucous membrane, that there was little hope of finding poison in them. Application was made, May 11, to Dr. Cressy to obtain, if possible, some of the feed which had been given to the cows, and shortly a small quantity of meal was received from the Messrs. Woodford. The meal bin became empty on Monday, May 3, the day after the cows became sick, and was that day replenished. The sample sent to the Station was obtained by nearly emptying the bin of the new feed and carefully gathering up what remained on the bottom and in the corners. In this sample the poison was identified without difficulty as *Oxalic Acid*. It is stated that all the animals which were fed from that bin died as described. Horses, fed on the same kind of feed, but from another box, were unaffected.

Paris Green on Corn-Stalks.

Under date of Sept. 17, Mr. D. C. Spencer of Old Saybrook wrote the Station as follows: "Last Spring I applied Paris Green, mixed with water, to my corn when it was about three to five inches high, to stay the ravages of the army worm. I desire to know whether you have analyzed any corn thus treated, or can inform me if it will now be safe to feed the corn-stalks and husks? If not, will the Station analyze a sample for me?"

Mr. Spencer was requested to forward to the Station a dozen to fifteen stalks taken from different parts of the field. The sample came in good order, well tied up in papers and secured with sacking. The stalks were run through a straw cutter, and all the dust, together with a good portion of the well-mixed cuttings, were examined by Dr. Jenkins for arsenic. No trace of this poison could be found by the processes which serve to detect $\frac{1}{50000}$th of a grain of white arsenic. It thus appears that the Paris Green applied to the young plants had been completely removed by the rain. It has been well established by Dr. McMurtrie that vegetation takes up into its interior no arsenic from the soil with which Paris Green has been mingled in the quantities which are used for destroying insects, a result which is fully confirmed by this examination.

WHAT BECOMES OF THE RAIN-FALL?

Its Evaporation and Percolation.

Inquiry.

Professor S. W. Johnson:

Dear Sir—At a meeting of the Killingworth Farmers' Club last winter, the question was raised whether there was not inconsistency between the teachings of science in regard to the action of water as a distributing agent for the fertilizing elements of manure, and the practice of surface application of manures to fields long in advance of plowing.

The action of water in bringing fertilizing elements from the highway upon fields favorably situated for receiving them was referred to in illustration, and the question in substance was: If water does take up and carry wherever it goes, the valuable elements of manure, must there not be in many situations risk of very serious loss by this practice? The one upon whom it devolved to answer the question was probably not very well qualified for his task. What he said was in substance as follows:

"There is no practicable method of handling manure which does not involve some waste. It decomposes rapidly under ordinary conditions and its valuable elements are volatile or soluble or both. Water which falls upon manure in the field will certainly take up some of its valuable elements and carry them in whatever direction it goes until some stronger force releases them. Gravity will release those held simply in suspension before they get very far. Those held in solution the soil will seize upon and hold if they get within its reach. But where does the water go to? Ordinarily it goes into the soil at or very near the point where it falls. The soil of a cultivated field has many times the absorptive power that the roadbed of a highway has, and while in heavy rains and upon steep hillsides a considerable amount may run off, the percentage is less than would seem and is not ordinarily enough to occasion serious waste or to overbalance the advantages, economical and otherwise, of this method of application."

A wide difference of opinion was developed as to the proportion of rain-fall which escaped from the surface of sloping fields, and upon this point more than any other the question seemed to turn. Upon this point no one present had anything but guesses to offer and the guesses varied widely.

Now my object in writing to you is to ask if any observations have ever been made which give an answer to the question. Where, and how, does the water that falls upon the surface of a cultivated field, during the year, escape? What is its destination, and by what road does it travel? I know of course that the conditions of the question are uncertain and that no answer at once simple and exact can be given, but one that approximates to accuracy would, I think, be interesting and valuable. Should you agree with me in this opinion, I should be glad to have you tell us what is known of the matter through the columns of the *Connecticut Farmer*.

Very truly yours,

J. M. HUBBARD.

Middletown, Ct., May 17, 1880.

*Answer.**

J. M. HUBBARD, Esq.:

My Dear Sir—It is evident that the water which falls upon the soil of a cultivated field partly passes through the soil, partly remains in it, partly evaporates into the air and may partly flow off the inclined surface to a lower level.

To what extent these several modes of disposal affect the rain-fall evidently depends upon a variety of conditions. Among these conditions are the quantity, frequency and rate of rain-fall, the depth and texture of the mass of soil, the texture and state of dryness of the surface of the soil, the presence or absence of growing vegetation, the weather and climate, as they influence evaporation.

The ordinary rain-gauge affords the means of ascertaining how much rain falls on any field. The lysimeter, a rain-gauge filled with soil, first constructed about 80 years ago in England by Dr. Dalton, shows how much water percolates or passes through the soil. The difference is what evaporates from or remains in the soil. The amount of water that remains in the soil at any given moment is ascertained by the loss of weight which a sample undergoes on drying.

The first observations to which I am able to refer, giving comparisons of the rain-gauge and the lysimeter are those made by Mr. Dickinson of Herts, England, of which an account by Josiah Parkes is given in Vol. V. of the Journal of the Royal Agricultural Society of England. Mr. Dickinson made regular daily observations for eight years, from 1836 to 1843 inclusive. His lysimeter was "an open-top cylinder 12 inches in diameter, sunk vertically in the earth, level with its surface, having a false bottom perforated with holes, like a cullender, which supported three feet depth of soil within the cylinder, through which and through the cullender the excess of the rain—or the portion not evaporated—filtered to the close bottom of the vessel" where it was drawn off and measured. This lysimeter "was filled with the soil of the region, *a sandy, gravelly loam* and had constantly *grass growing on it*."

* Reprinted from the *Connecticut Farmer* with additions.

The average total rain-fall was $26\frac{6}{10}$ inches per annum; of this $11\frac{3}{10}$ inches or $42\frac{1}{2}$ per cent. filtered through the soil so that $57\frac{1}{2}$ per cent. of the rain-fall evaporated from or remained in the soil. In so long a period, we may assume without serious error that the soil at the close of the observations contained as much water as it did at the beginning, and therefore that $57\frac{1}{2}$ per cent. of the rain-fall evaporated from the surface.

But the rain-fall and the evaporation were naturally different from one year to another. The annual rain-fall ranged from 21 to 32 inches, or 2,137 to 3,139 long tons per acre, the annual evaporation was from 43 to 67 per cent. of the rain-fall.

During the six colder months, from October to March inclusive, the average rain-fall was nearly 14 inches; the evaporation was but $3\frac{56}{100}$ inches, or $25\frac{1}{2}$ per cent., the filtration being $10\frac{39}{100}$ inches, or $74\frac{1}{2}$ per cent.

During the six warmer months, from April to September inclusive, the average rain-fall was $12\frac{67}{100}$ inches, of which the evaporation was $11\frac{77}{100}$, equal to $92\frac{9}{10}$ per cent., and the percolation $\frac{9}{10}$ inch, or $7\frac{1}{10}$ per cent. During the warmer months of 1840 and 1841 no percolation took place at all. In 1836 the summer percolation was 17 per cent. of the rather less than average rain-fall.

The results of similar observations made by Dalton (3 years), Greaves (2 years), and Lawes & Gilbert (5 years), in England, gave respectively for the annual percolation 25, 27 and 36 per cent. of the rain-fall which was 26 to 28 inches. Experiments in Switzerland by Maurice (2 years), Risler (2 years), and by Gasparin (2 years) in France, gave the percolation at 39, 20 and 30 per cent. of the rain-fall which was 26 and 28 inches, except in Risler's case where it was 41 inches.

In this country we have the observations of Dr. Sturtevant at

South Framingham, near Boston, and of Professor Stockbridge at Amherst. Dr. Sturtevant observed during two years an annual rain-fall of $43\frac{1}{2}$ inches, and an average percolation of $18\frac{6}{10}$ per cent., through a gravelly loam 25 inches deep covered with growing grass. The percolation in 1876 was $10\frac{8}{10}$ per cent., that in 1877 was $26\frac{4}{10}$ per cent. of the nearly identical rain-fall. Professor Stockbridge's observations extended from May to November inclusive, of the year 1878. They were made on a "very leachy" soil 3 feet deep, the upper 10 inches of which was a sandy loam with intermixed pebbles, underlaid for 14 inches by gravelly loam, beneath which were 14 (?) inches of stones and gravel. The surface was kept bare of all vegetation.

The rain-fall for the 7 months was 25.7 inches, the percolation was 20 per cent. During *the same period* the South Framingham lysimeter received $27\frac{6}{10}$ inches of rain and its percolation was $14\frac{7}{10}$ per cent.

While the per cent. of percolation is greater in England than in this country, the total amounts measured in inches, that penetrate the soil, are not so different in the various countries. The English results of Dickinson were $11\frac{3}{10}$ inches, of Greaves $6\frac{9}{10}$ inches, of Lawes 10 inches, the Swiss figures of Maurice were $10\frac{1}{10}$ inches, of Risler $12\frac{3}{10}$ inches, the French of Gasparin $5\frac{6}{10}$ inches, the American of Sturtevant in 1876 $5\frac{7}{10}$ inches, in 1877 $11\frac{4}{10}$ inches, and those of Stockbridge for 7 months of 1877 $5\frac{14}{100}$ inches. These figures enable us to say that the filtration of water through the lysimeter amounts to from 5 to 10 inches annually with a rain-fall of 26 to 44 inches. The heavier rain-falls are evidently compensated by greater and more rapid evaporation. Evaporation and rain-fall vary within much wider limits than percolation, which is relatively constant.

The greatest amount of percolation usually occurs during the cooler half of the year from October to March inclusive. During the warmer six months the percolation is comparatively small.

Some better idea of the amount of water that falls, percolates and evaporates, per acre, yearly, may perhaps be obtained with help of the fact that 1 inch of rain on an acre of surface, equals 27,154 U. S. gallons or 862 barrels.

Dr. Wollny of the Munich experiment Station for the study of Soils, found that the same calcareous loamy soil exposed to the same rain-fall permitted 38 per cent. of the water to filter through when the surface was bare of vegetation, while but 20 per cent.

percolated when the soil carried grass or clover, the experiment lasting from April 14 to November 18, 1874.

In another series of trials, three soils, namely sand, peat and clay were compared side by side in three conditions, viz: 1, bare of vegetation, 2 in grass, and 3 covered with a layer of horse manure $2\frac{1}{2}$ inches deep. The percolation through these soils was as follows in per cent. of the rain-fall: Bare sand 64, bare peat 44, bare clay 32; grassed, sand 14, peat 9, clay 1; mulched, sand 45, peat 39, clay 49. This experiment lasted from April 23 to October 31, 1875. It shows 1st how superior clay and peat are to sand as mechanical absorbents of water, 2d that vigorous vegetation greatly diminishes the percolation, because the plants take up and exhale large quantities of water, 3d that a *heavy mulch* makes the percolation less than it is in naked sand or peat but increases the percolation in clay.

In 1876 Dr. Wollny made a similar series of observations with sand, peat and clay, both naked and covered with horse manure to the depth of $\frac{6}{10}$ inch. Under this *light mulch* the percolation was somewhat greater, i. e. the evaporation was less than from bare soil. A coating of gravel had the same effect in lessening evaporation and increasing percolation as the mulch.

All the above observations refer to soils with a *level surface.* Some of them, viz., those of Lawes & Gilbert and of Stockbridge, refer to soils in their agricultural state of compactness, i. e. to soils not in any way loosened up below the plow-depth, the undisturbed soil having been *surrounded by* the lysimeter. In the other cases, mostly, the soil was dug away to sink the lysimeter and then filled into the cavity thus made. It being impossible to restore a disturbed sub-soil to its original compactness the observations made under conditions thus differing are not strictly comparable, although they cannot differ very widely.

Again, the very fact that a stratum of soil is undermined for collecting the water that percolates through it, decidedly affects percolation and evaporation,—usually diminishes the percolation and increases evaporation, by breaking the continuity of the porous earth which when continuous sucks down water from the surface when this is the wetter, and sucks up water from the subsoil when that is the wetter, thus limiting the movement of the water of the soil within a narrower range than it naturally would have.

As regards the flow of water from sloping fields there are no measurements extant to my knowledge, and it is evident that the amount of flow must vary indefinitely with the degree of slope and other circumstances. The surface of soil that has long been exposed to drought is difficult to wet, in fact, at first repels moisture, and a "cloud-burst" or sudden heavy rain may flow off in large proportion from a surface of very slight inclination, when the latter has become dust-dry. On the other hand, the water of a slow-beginning but long-continued and more abundant rain may all penetrate the well-moistened surface of a considerable slope.

A gravelly or coarse-sandy surface is always ready to take up the heaviest rainfall. A fine loam, if moist, will swallow rain rapidly, but dry dusty loam imbibes it slowly. Moist peat (swamp muck) or vegetable mold can hardly be overcharged by any rain, but snuff-dry peat, like a dry and shrunken sponge, requires considerable time to recover moisture.

These various results and considerations answer your question as satisfactorily as the facts within my reach permit.

Yours truly, S. W. JOHNSON.

SEED TESTS.

The Station has not been called upon by consumers to examine any seeds during 1880. That the Station might be of great service to farmers in this way there can be no doubt. It is very common to hear that a crop is lost or half lost because of the poor quality of seed.

On the other hand, some of our dealers are appealing to the Station for information as to the quality of the seeds they purchase, and I give below a summary of results mostly obtained during 1880, in making tests for the trade, with onion, lettuce, and cucumber seeds. In case of onion seeds the tests are classed according to the age of the seed, as well as its variety. Most of these seeds were grown in Connecticut. A number came from Western States, some from California. The samples of onion seed were examined immediately after their arrival at the Station.

The results confirm in a very striking manner the opinion of experienced seedsmen that seeds rapidly deteriorate in quality by keeping. They also show that seeds of the same variety and age may differ in quality by as much as 30 per cent.; this difference depending upon the circumstances of growth, curing and keeping.

In making seed-tests, it is found that a portion of the seeds germinates within a reasonable time, 10–14 days, a second portion becomes soft and dead, and thereupon moulds or decays, while a third usually small proportion remains sound. If the experiment be prolonged these sound seeds either sprout or decay. Dr. Nobbe, who has had the most extensive experience in seed-examinations advises to add to the per cent. of actually sprouted seeds of all perennial forage plants, grasses, clover, etc., one-third that of the seeds that remain sound, implying that, on the average, such a proportion of the ungerminated but sound seeds would germinate under favorable conditions. This sum-total he designates *seed capable of germination.* Most generally in case of onion seed, and other annuals, those seeds which do not germinate within 10–14 days do not germinate at all, but on prolonging the trial gradually soften and decay.

In some few instances with onion seed two years old, the seeds go on sprouting for three weeks or more. Out of twenty instances where the trial of old onion seeds has been prolonged beyond 10–12 days there has been in but four cases additional germination to the extent of 3 per cent. In one of these cases the additional germination amounted to 12 per cent. Evidently the onion seeds which sprout after 10–14 days are of no practical use, as the thinning and weeding processes interfere with their growth. In our Reports, we shall give the per cent. of seed actually sprouted, and in case of perennials, shall add to it one-third of those remaining sound, to obtain the per cent. of "*seed capable of germination*" in the sense advised by Dr. Nobbe.

RESULTS OF SEED TESTS.

BY DR. E. H. JENKINS.

Variety.	Station No.	Seed sprouted (per cent.)	Seed remained sound (per cent.)	Seed rotted (per cent.)	½ sprouted seed germinated in days.	1,000 seeds weigh (grammes.)
Cucumber Seed.						
	62	37.5	0.0	62.5	4	25.95
	63	6.0	0.0	94.0	8	27.99
	64	84.5	0.0	15.5	4	27.49

No. 62 represents the cucumber seed as it came in bulk. Part of the seed appeared good, another part had apparently begun to sprout before it was prepared for market. No. 63 represents the damaged portion. No. 64 that which was apparently undamaged.

Variety.	Station No.	Seed sprouted (per cent.)	Seed remained sound (per cent.)	Seed rotted (per cent.)	½ sprouted seed germinated in days.	1,000 seeds weigh (grammes.)
Onion Seed less than 1 year old.						
Wethersfield Large Red,	85	74.0	13.0	13.0	4	----
	86	80.0	3.0	17.0	7	----
	117	89.5	1.0	9.5	less than 7	2.89
	126	88.0	6.0	6.0	5	4.17
Average,		82.9	5.8	11.3	5	3.53
Danvers Yellow,	69	86.8	3.5	9.7	3	4.13
	97	98.0	1.5	0.5	6	----
	98	90.8	5.0	4.2	4	----
	101	92.2	5.5	2.3	4	----
	102	80.3	7.5	12.2	4	----
	109	85.2	8.5	6.3	4	----
	110	97.8	1.5	0.7	4	----
	118	88.5	1.0	0.5	less than 7	2.66
	133	91.3	4.0	4.7	5	----
	134	92.2	4.0	3.8	5	----
	135	87.3	9.0	3.7	5	----
	136	88.5	6.5	2.0	4	----
	55	64.8	11.0	24.2	7	3.59
	58	94.3	2.0	3.7	4	4.05
Average,		88.4	5.0	6.6	4½	3.60
Extra Early Red,	80	82.5	12.0	5.5	4	----
White Portugal,	114	91.8	2.5	5.7	4	----
	115	88.0	7.0	5.0	6	----
	116	89.0	5.5	5.5	4	----
	65	95.2	1.0	3.8	6	3.63
Average,		91.0	4.0	5.0	5	----
White Globe,	113	93.8	2.0	4.2	4	----
	129	89.7	7.0	3.3	4	----
	57	96.0	0.5	3.5	3	3.83
Average,		93.2	3.2	3.6	4	----
Yell'w Gl'be Danvers,	127	88.5	6.0	5.5	5	3.76
Early Red Globe,	84	85.8	7.5	6.7	4	----
Red Globe,	128	86.0	8.5	5.5	6	4.31
Large Red,	131	75.3	18.5	6.2	4	----
	132	85.3	5.3	9.4	4	----
	53	82.3	9.0	8.7	3	3.95
Average,		80.9	10.9	8.2	4	----
Yellow Dutch,	111	80.0	5.0	15.0	4	----
Average of all varieties,		**87.2**	**5.8**	**7.0**	**4**	**3.73**
Onion Seed between 1 and 2 years old.						
Danvers Yellow,	70	60.5	31.5	8.0	5	3.40
	99	41.8	42.2	16.0	6	----
	100	41.3	35.5	23.2	6	----
	54	55.7	18.0	26.3	7	3.34
Average,		49.8	31.8	18.4	6	3.37
White Portugal,	130	64.5	27.5	8.0	7	----
White Globe,	56	85.2	7.0	7.8	4	3.62
Red Globe,	112	90.5	5.0	4.5	4	----

Variety.	Station No.	Seed sprouted (per cent.)	Seed remained sound (per cent.)	Seed rotted (per cent.)	½ sprouted seed germinated in days.	1,000 seeds weigh (grammes.)
Extra Early Red,	59	64.5	23.5	12.0	4	3.86
Large Red,	52	72.3	18.5	9.2	4	3.73
Average of all varieties,		64.0	23.0	12.8	5.2	3.59
Onion Seed between 2 and 3 years old.						
Wethersfield Large Red,	87	22.0	65.0	13.0	6	----
	88	27.5	64.0	8.5	6	----
	90	18.8	42.5	38.7	6	----
	91	66.2	30.5	3.3	6	----
	96	17.0	56.5	26.5	6	----
Average,		30.3	51.7	12.0	6	----
Danvers Yellow,	71	47.3	48.5	4.2	6	3.51
	106	32.7	57.0	10.3	6	----
Average,		40.0	52.7	7.3	6	----
Average of all varieties,		**33.0**	**52.0**	**15.0**	**6**	----
Onion Seed between 3 and 4 years.						
Wethersfi'ld Large R.,	51	28.0	?	?	7	3.83
Danvers Yellow,	103	1.7	82.5	15.8	10	----
	104	1.8	75.5	12.7	10	----
	107	2.7	32.5	64.8	6	----
Average,		2.1	53.5	34.4	9	----
Extra Early Flat Red,	81	1.8	82.5	15.7	10	----
Average of all varieties,		**7.2**	**68.3**	**24.5**	**8.5**	----
Onion Seed between 4 and 5 years.						
Wethersfield Large Red,	92	0.3	95.5	4.2	10	----
	93	0.5	88.0	11.5	10	----
	94	0.5	91.0	8.5	3	----
	95	0.3	87.5	12.2	10	----
Average,		0.4	90.5	9.1	8	----
Danvers Yellow,	108	0.3	93.0	6.7	10	----
Ex. Early Flat Red,	82	2.0	78.0	20.0	10	----
	83	0.8	84.0	15.2	3	----
Average,		1.0	85.0	14.0	8	----
Average of all varieties,		**0.7**	**88.1**	**11.2**	**8**	----
Onion Seed between 5 and 6 years.						
Danvers Yellow,	105	0.0	92.0	8.0	-	----
Lettuce Seed.						
	119	96.0	0.0	4.0	3	1.31
	120	98.5	0.0	1.5	3	1.10
	122	96.0	2.0	2.0	3	1.00
	123	97.3	2.0	0.7	3	1.43
	124	98.3	1.5	0.2	3	1.36
Average,		97.2	1.1	1.7	3	1.24

The Station's Instructions for sampling seeds, are as follows:

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

Instructions for Sampling Seeds.

The Agricultural value of seeds intended for Farm and Garden use is learned by examining a small average sample. A weighed amount of seed is taken, the pure seeds are culled out and weighed, foreign matters and especially noxious seeds are identified, the vitality of the pure seed is tested by careful sprouting trials and a report is drawn up of the results.

As the test of germinating power requires some time for its completion, a report on samples sent in cannot be ordinarily expected in less than two weeks.

The examination of *grass-mixtures* can only be undertaken in special cases. It requires a large outlay of time and labor which is not often justified by the results.

In selecting a sample for examination the greatest care should be used to have it represent accurately the whole amount from which it was taken.

1. Mix well together with the hand and arm the contents of the package (bag or barrel) or packages of seed.

2. Take out five or six small handfuls or cupfuls* from various parts of the package, mix these together and take a part of this mixture for the sample.

3. Send of the smaller seeds—red top, white clover, timothy, etc., two (2) ounces; of beets, turnips, red clover, etc., four (4) ounces; of wheat and cereals, and of peas and other legumes, eight (8) ounces.

4. Samples may be sent by mail, or otherwise, prepaid, and should be *plainly labeled* and addressed to

CONN. AGRICULTURAL EXPERIMENT STATION,
New Haven, Conn.

*(A small cup may be closed with the palm of the hand, forced down to the desired place, then filled and withdrawn).

Seeds sent in for gratuitous examination must be described on the subjoined Form.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

Form for Description of Sample.

STATION NO. REC'D AT STATION. 188 .

Each sample of Seed sent for gratuitous examination must be accompanied by one of these forms, with the blanks *below* filled out as fully as practicable.

The filled out Form, if sent with the sample, will serve as a label; but it must be returned in good order for filing in the Station Records.

Send with each sample a specimen of any printed circular, or statement that accompanies the seed or is used in its sale.

Name or label of seed, ------------------------------------

Name and address of Producer or Importer, ------------------

Name and address of Dealer from whose stock this sample is taken,

----

Date of taking this Sample, --------------------------------

Selling price per pound or bushel, -------------------------

Known or reputed age of seed, ------------------------------

Number of packages from which sample is taken, -------------

Quantity of stock which the sample represents, -------------

Was sample taken according to Station Instructions, or how?

Signature and P. O. address of person taking and sending the sample.

The results of the examinations are entered in a suitable record book, and are also reported to the parties sending, on forms of which the following is an example.

Report of Seed Test.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN, CONN., 188 .

Examination of -- seed.

Station No. Sender's Mark. Rec'd. 188 .

From --

Pure seed, ---------------------------------- per cent. by weight.

Impurities, ---------------------------------- per cent. by weight.

Pure seed sprouted during --------- days. per cent. by number.

Pure seed decayed during --------- days. per cent. by number.

Pure seed sound (unsprouted) after --- days. per cent. by number.

Of sprouted seed, ½ germinated in --- days.

1000 seeds weighed ---------------------------------- grams.

Per cent. value, ----------------------------------

The "per cent. value" of a sample of seed is obtained by multiplying its per cent. (by weight) of pure seed into the per cent. (by number) found, or able, to germinate, and dividing by 100. It refers the number of seeds found, or able, to germinate, from "pure seed" back upon the sample itself, in terms of per cent. In case of *perennials only* it takes account of ⅓ of the unsprouted sound seeds.

THE DETERMINATION OF PHOSPHORIC ACID IN COMMERCIAL FERTILIZERS.

In the second Report of this Station a volumetric method for the determination of phosphoric acid was described, which, in a number of trials, gave very satisfactory results. Further investigation showed, however, that this method could not be relied upon, because the changes of color which serve to indicate the completion of the reaction are rendered gradual and uncertain by the presence of considerable quantities of either salts of phosphoric or tartaric acid.

Our attention was then turned to the direct precipitation of magnesium-ammonium phosphate in citric solution and in presence of iron, alumina and lime. By an extensive series of trials Mr. Wells found that very good analyses could be made by this method, and he had already learned how to apply it to all the classes of fertilizers that the Station is called upon to analyze, and, together with Dr. Jenkins and Dr. Armsby, had made numerous comparative trials by it and the molybdic method, when we learned from the foreign journals that Dr. Petermann, Director of the Experiment Station at Gembloux in Belgium, had anticipated us.

The method is in our opinion quite accurate enough for the analysis of fertilizers, and is now regularly employed for that purpose in the Station, since its use saves much time and labor.

We owe to Warington * the first employment of citric acid to prevent precipitation of Fe and Al. Spiller † first showed that Ca is also held in solution by ammonium citrate. Brassier ‡ first applied this fact to phosphoric acid estimation, but held that sulphuric acid must be separated in order to get entirely satisfactory results.

Joulie ‖ considered the sources of error in Brassier's method and claimed to have overcome them by use of a solution of magnesium citrate with citric acid. Evidently, however, his plan was a failure.

Ville § had previously described a method based upon Brassier's, but from his own account it was not satisfactory.

* Jour. Chem. Soc. London, 1863, 304.
† Jour. Chem. Soc. London, 1858, 112.
‡ Ann. de Chim. et de Phys. [4], vii, 355.
‖ Chem. News, xxvii, 228.
§ Compt. Rend., lxxv, 344.

Petermann,* first brought the process into a satisfactory form, but gave no sufficient details of the mode of working.

Brunner† has given a brief account of his experience with the method, which he considers to be satisfactory for technical purposes.

Grupe and Tollens‡ have also published some preliminary studies of the process.

Mr. Wells' experiments were concluded before the two last-named papers were published, and before Petermann's paper was received at the Station. Here follows Mr. Wells' account of his work.

On Determination of Phosphoric Acid in Citric Solution.

BY H. L. WELLS, PH.B.

This investigation covers the following points :—

1. In the precipitation of NH_4MgPO_4 as ordinarily practiced, does NH_4Cl have a solvent action on the precipitate?

2. To what extent does ammonium citrate in solution dissolve NH_4MgPO_4 ?

3. When ammonium citrate is present, is magnesium citrate thrown down with NH_4MgPO_4 in such quantity as to make it necessary to dissolve and reprecipitate.

4. What effect has $CaSO_4$ in solutions in which NH_4MgPO_4 is precipitated in the presence of ammonium citrate?

5. What effect has $CaCl_2$ in the same case?

6. What effect have ferric salts?

7. What effect have aluminum salts?

8. After deciding on these points and shaping the method accordingly, practical trials were made controlling the determinations by the molybdic method.

In each experiment a measured quantity of a slightly acid solution of Na_2HPO_4 was used whose content of P_2O_5 was determined by precipitating with magnesia mixture and weighing the magnesium pyrophosphate. To this solution was added the quantities of magnesia mixture,§ ammonium citrate and other solutions required and finally an amount of ammonia solution (sp. gr. 0.96) equal to one-third of the previous volume of the liquid. The whole was stirred vigorously several times at intervals of half an hour, more or less, allowed to stand twelve hours, filtered on asbestos, ignited and weighed in Gooch's crucibles.

* Versuchs-Stationen, xxiv, 327.

† Fres. Zeitschr., 1880, p. 142.

‡ Ber. d. Deuts. Ch. Ges. XIII, 1269.

§ See note on p. 115.

Three different solutions of sodium phosphate were used in these experiments, viz:

100 c.c. of solution I, used in experiments 1–8, precipitated with magnesia mixture gave the following amounts of magnesium pyrophosphate:

	a	.3151 grams.
	b	.3145 grams.
Average		·3148 grams.

100 c.c. of solution II, used in experiments A–H and 9–85, precipitated in a small volume of solution gave:

	a	.2708 grams.
	b	.2714 grams.
Average		.2711 grams.

100 c.c. of solution III, used in experiments 86–140 gave:

	a	.3037 grams.
	b	.3041 grams.
	c	.3034 grams.
	d	.3041 grams.
Average		.3038 grams.

100 c.c. of solution III, precipitated and filtered, the precipitate dissolved in hydrochloric acid and reprecipitated with the addition of a very little Mg. mixture gave

	a	.3034 grams.
	b	.3021 grams.
	c	.3024 grams.
	d	.3031 grams.
Average		.3028 grams.

These results show an average variation of .00035 grams from the mean of all the determinations, or .0007 between the highest and lowest and an extreme variation of .0013 between the highest and lowest. The error of experiment amounts to from one-tenth to four-tenths of one per cent. of the total amount of pyrophosphate.

1. In the ordinary mode of precipitating NH_4MgPO_4 does NH_4Cl have a solvent action on the precipitate?

The results obtained were as follows:

	Magnesia Mixture.	NH_4Cl (total.)	Total volume.	Weight of $Mg_2P_2O_7$.	Per cent.
A	20 cm.³	1.4 grm.	160 cm³.	.2761 grm.	101.7
B	20	2.8	160	.2702	99.6
C	20	3.9	185	.2709	99.9
D	20	5.3	185	.2704	99.7
E	20	6.4	215	.2703	99.7
F	20	7.8	215	.2700	99.5
G	20	13.9	295	.2701	99.6
H	20	13.9	430	.2703	99.7

A. contained no more ammonium chloride than was present in the magnesia mixture used. The precipitate probably contained magnesium hydrate. Experience has shown that it is necessary to have more ammonia salts present than the magnesia mixture itself contains in order to secure accurate results.

In the other trials the largest error was .5 per cent. of the total amount of phos. acid, showing that the amount of NH_4Cl and the volume of the solution may vary considerably without greatly affecting the result.

2. To what extent does ammonium citrate in solution dissolve NH_4MgPO_4?

In these experiments the precipitated NH_4MgPO_4 was dissolved on the filter in hydrochloric acid, a few drops of Mg. mixture were added and the solution reprecipitated with NH_3. This was done to remove any magnesium citrate which might have come down in the first precipitation.

Following are the results obtained—

No.	Magn. mix.	Citric acid.	Vol.	$Mg_2P_2O_7$ found.	$Mg_2P_2O_7$ required.	Difference grams.	Per cent.
46	15 cm³.	15 grm.	400 cm³.	.2668 grm.	.2711 grm.	—.0035 grm.	98.4
47	20	15	400	.2668	.2711	—.0035	98.4
48	40	15	400	.2670	.2711	—.0033	98.5
49	80	15	400	.2680	.2711	—.0023	98.9
50	100	15	400	.2685	.2711	—.0018	99.0
98	20	0	250	.3034	.3028	+.0006	100.2
99	20	0	250	.3027	.3028	—.0001	99.9
100	20	1	250	.3033	.3028	+.0005	100.2
101	20	2	250	.3033	.3028	+.0005	100.2
102	20	5	250	.3029	.3028	+.0001	100.0
103	20	10	250	.3024	.3028	—.0004	99.8
104	20	15	250	.3013	.3028	—.0015	99.5
105	20	20	250	.2980	.3028	—.0048	98.4
106	20	23	250	.2974	.3028	—.0054	98.2
107	20	23	250	.2981	.3028	—.0047	98.4
108	20	23	250*	.3002	.3028	—.0024	99.1
109	20	23	250*	.3019	.3028	—.0009	99.7
110	20	23	500	.3000	.3028	—.0028	99.0
111	20	23	500	.2994	.3028	—.0034	98.5
112	20	23	500	.3013	.3028	—.0015	99.5

* Double the usual amount of ammonia.

Experiments 46–50 show that the presence of 15 grams of citric acid may make the result come considerably too low, but that this tendency is counteracted somewhat by a large amount of magnesia mixture. Experiments 104 and 112 are exceptional.

Experiments 100–107, 110 and 111 show that amounts of citric acid less than 15 grams in 250–500 c.c. of solution have only a very slight solvent action, while larger quantities have considerable effect. 108 and 109 show that this solvent action is almost wholly counteracted by using a larger amount of ammonia.

3. In the presence of ammonium citrate is magnesium citrate thrown down with NH_4MgPO_4 in such quantity as to make it necessary to dissolve and reprecipitate?

In these experiments the precipitate was not dissolved, but was weighed directly.

In the following table the results are arranged according to the amount of citric acid employed. An asterisk signifies that double the usual quantity of ammonia was used.

No.	Magn. mix.	Citric acid.	Vol.	Found.	Required.	Difference.	Per cent.
15	20 cm³.	1 grm.	163 cm³.	.2723 grm.	.2711 grm.	+.0012 grm.	100.5
35	2	1	140	.0262	.0271	—.0009	96.7
36	20	1	164	.0273	.0271	+.0002	100.8
16	20	2	166	.2715	.2711	+.0004	100.2
17	20	2	166	.2719	.2711	+.0008	100.3
34	20	2	400	.2712	.2711	+.0001	100.0
37	20	2	200	.0276	.0271	+.0005	101.8
33	20	3	400	.2702	.2711	—.0009	99.7
18	20	5	315	.2699	.2711	—.0012	99.5
29	80	5	260	.2762	.2711	+.0051	101.8
30	80	5	400	.2778	.2711	+.0067	102.4
31	20	5	180	.2688	.2711	—.0023	99.1
32	20	5	400	.2689	.2711	—.0022	99.1
38	10	5	276	.0274	.0271	+.0003	100.9
39	20	5	400	.0271	.0271	+.0000	100.0
44	80	5	400	.0278	.0271	+.0007	102.6
113	20	7	350*	.3045	.3028	+.0017	100.6
6	20	10	—?	.3151	.3148	+.0003	100.1
19	20	10	200	.2672	.2711	—.0039	98.6
20	20	10	400	.2677	.2711	—.0037	98.8
23	80	10	400	.2725	.2711	+.0014	100.5
27	20	10	300*	.2679	.2711	—.0032	98.9
40	20	10	400	.0274	.0271	+.0003	101.1
41	20	10	400	.0270	.0271	—.0001	99.6
114	20	10	350*	.3023	.3028	—.0005	99.8
7	20	15	---	.3110	.3148	—.0038	98.7
21	20	15	565	.2658	.2711	—.0053	98.0
22	20	15	420	.2664	.2711	—.0047	98.2
24	80	15	400	.2718	.2711	+.0007	100.2
25	20	15	220	.2665	.2711	—.0046	98.3
26	20	15	625	.2677	.2711	—.0034	98.8
28	20	15	330*	.2672	.2711	—.0039	98.6
42	20	15	400	.0268	.0271	—.0003	98.9
43	20	15	400	.0267	.0271	—.0004	98.5
45	80	15	400	.0280	.0271	+.0009	103.3
46	15	15	400	.2668	.2711	—.0043	98.4
47	20	15	400	.2668	.2711	—.0043	98.4
48	40	15	400	.2670	.2711	—.0041	98.5
49	80	15	400	.2680	.2711	—.0031	98.8
50	100	15	400	.2685	.2711	—.0026	99.0
115	20	15	350*	.3006	.3028	—.0022	99.2
116	20	23	350*	.2985	.3028	—.0043	98.5

The experiments in which 7 grams or less of citric acid were used show that such an amount does not seriously affect the accuracy of the result. The two errors already noticed, viz: the precipitation of magnesium citrate and the solution of NH_4MgPO_4 in ammonium citrate very nearly offset each other. Throwing out Nos. 35, 36, 37, 29, 30, 38, 39, and 44, the averages are with 1 gram $\overline{Ci}$ 100.5 per cent.; with 2 grams 100.3 per cent.; with 3 grams 99.7 per cent.; with 5 grams 99.2 per cent.; with 7 grams (where double the usual volume was employed) 100.6 per cent. Nos. 29, 30 and 44 are not comparable on account of the very large amount of magnesia mixture used. Nos. 35, 36, 37, 38 and 39 contained very small amounts of P_2O_5. The absolute error is small, in these cases, excepting perhaps 35 (where little magnesia mixture was used), quite within the unavoidable errors of experiment, but the percentage error is larger.

Nos. 29, 30 and 44 indicate that with 5 grams of citric acid a very large excess of magnesia mixture (80 c.c.) introduces serious error.

20 c.c. of magnesia mixture is sufficient to precipitate .4 grams P_2O_5, so that in all cases more than twice as much magnesia mixture was used as was absolutely necessary.

Below are tabulated the results of experiments where 10 grams of citric acid were used, arranged according to the volume of solution.

No.	Magn. mixture.	Volume.	Per cent.
19	20 cm³.	200 cm³.	98.6
27	20	300*	98.9
114	20	350*	99.8
20	20	400	98.8
40	20	400	101.1†
41	20	400	99·6†
23	80	400	100.5
6	20	?	100.1

Below are tabulated those experiments where 15 grams of $\overline{Ci}$ were used, arranged according to the volume of solution.

No.	Magn. mix.	Volume.	Per cent.	No.	Magn. mix.	Volume.	Per cent.
25	20 cm³.	220 cm³.	98.3	50	100 cm³.	400 cm³.	99.0
28	20	330*	98.6	42	20	400	98.9†
115	20	350*	99.2	43	20	400	98.5†
46	15	400	98.4	45	80	400	103.2†
47	20	400	98.4	22	20	420	98.2
48	40	400	98.5	21	20	565	98.0
24	80	400	100.2	26	20	625	98.8
49	80	400	98.8				

* Double the usual amount of ammonia.

† In these experiments the small amount of P_2O_5 used exaggerates the per cent. error or difference ten times as compared with the others.

These figures indicate that with 15 grams or more of citric acid in solution, the results will be more than 1 per cent. too low unless there is some compensation. A very large excess of magnesia mixture will tend to lessen this error.

Dilution and a larger amount of ammonia also appear to tend in the same direction, but in respect to their influence the results are unsatisfactory.

It will be noticed that the absolute error is much smaller and the percentage error is no larger in those cases where the total amount of P_2O_5 is smaller.

A comparison of these results with those under 2 indicates that nothing is gained by dissolving and reprecipitating the $MgNH_4PO_4$.

4. What effect has $CaSO_4$ in solutions in which NH_4MgPO_4 is precipitated in the presence of ammonium citrate?

The details of the experiments on this point are given below.

No.	Mag. mix. cm³.	Citric acid. grm.	$CaSO_4+2H_2O$ grm.	Vol. cm³.	$Mg_2P_2O_7$ found. grm.	$Mg_2P_2O_7$ required. grm.	Difference ($Mg_2P_2O_7$.) grm.	Ammonia.	Per cent.
51	20	2	.5	240	.2803	.2711	+.0092	¼ dil.	103.4
52	20	3	.5	240	.2740	.2711	+.0029	"	101.0
53	20	2	.5	400	.2745	.2711	+.0036	"	101.2
54	20	3	.5	400	.2746	.2711	+.0037	"	101.2
55	20	5	.5	400	.2734	.2711	+.0023	"	100.8
56	20	2	.5	230	.0296	.0271	+.0025	"	109.2
57	20	3	.5	230	.0286	.0271	+.0015	"	105.5
58	20	5	.5	230	.0276	.0271	+.0005	"	101.8
59	20	5	.5	400	.0282	.0271	+.0011	"	103.9
60	20	5	.5	400	.2728	.2711	+.0017	"	100.6
61	20	7	.5	400	.2728	.2711	+.0017	"	100.6
62	20	10	.5	400	.2718	.2711	+.0007	"	100.3
63	20	15	.5	400	.2709	.2711	—.0002	"	99.9
64	20	5	.5	400	.0278	.0271	+.0007	"	102.5
65	20	7	.5	400	.0275	.0271	+.0004	"	101.4
66	20	10	.5	400	.0269	.0271	—.0002	"	99.3
67	20	15	.5	400	.0270	.0271	—.0001	"	99.6
72	20	5	.5	180	.2736	.2711	+.0025	"	100.9
73	20	15	.5	235	.2701	.2711	—.0010	"	99.6
117	20	7	.25	350	.3060	.3028	+.0032	¼ conc.	101.0
118	20	10	.25	350	.3052	.3028	+.0024	"	100.8
119	20	15	.25	350	.3040	.3028	+.0012	"	100.4
120	20	23	.25	350	.3020	.3028	—.0008	"	99.7
121	20	7	1	350	.3093	.3028	+.0065	"	102.1
122	20	10	1	350	.3085	.3028	+.0057	"	101.2
123	20	15	1	350	.3053	.3028	+.0025	"	100.8
124	20	23	1	350	.3041	.3028	+.0013	"	100.4

The results in general are high: in all cases where less than 5 grams of citric acid was used with .5 gram $CaSO_4+2H_2O$ they are 1 per cent. or more too high. Where 5 or more grams of $\overline{Ci}$ were employed they were in all cases satisfactory except in 117, 121 and 122, where double the usual quantity of ammonia was employed.

5. What effect has calcium chloride on the precipitation of NH_4MgPO_4 in the presence of $\overline{Ci}$?

The details of the experiments made are given in the following table.

The same results essentially were obtained as with $CaSO_4+2H_2O$, that is: the presence of calcium chloride tends to make the results too high. With more than 10 grams of $\overline{Ci}$ the error was less than 1 per cent. when quantities of calc. chloride were present equivalent to from .25-1.0 grams of calc. sulphate.

No.	Mag. mix. cm³.	$CaCl_2$. grm.	Citric acid. grm.	Vol. cm³.	$Mg_2P_2O_7$ found. grm.	$Mg_2P_2O_7$ required. grm.	Difference. grm.	Ammonia.	Per cent.
125	20	.15*	7	350	.3078	.3028	+.0050	½ conc.	101.6
126	20	.15*	10	350	.3062	.3028	+.0034	"	101.1
127	20	.15*	15	350	.3054	.3028	+.0026	"	100.8
128	20	.15*	23	350	.3028	.3028	.0000	"	100.0
129	20	.6†	7	350	.3106	.3028	+.0078	"	102.6
130	20	.6†	10	350	.3078	.3028	+.0050	"	101.6
131	20	.6†	15	350	.3058	.3028	+.0030	"	100.7
132	20	.6†	23	350	.3032	.3028	+.0004	"	100.1
133	20	.15*	7	350	.0306	.0303	+.0003	"	100.9
134	20	.15*	10	350	.0305	.0303	+.0002	"	100.6
135	20	.15*	15	350	.0308	.0303	+.0005	"	101.6
136	20	.15*	23	350	.0296	.0303	—.0007	"	97.6
137	20	.6†	7	350	.0317	.0303	+.0014	"	104.2
138	20	.6†	10	350	.0313	.0303	+.0010	"	103.2
139	20	.6†	15	350	.0305	.0303	+.0002	"	100.6
140	20	.6†	23	350	.0294	.0303	—.0009	"	97.0

* Equivalent to .25 gr. $CaSO_4+2H_2O$.
† Equivalent to 1 gr. $CaSO_4+2H_2O$.

With large or small amounts of phosphoric acid the results are equally satisfactory.

6. What effect on the precipitation have sesqui-salts of iron? Following are the details of the experiments—

No.	Mg. mix.	$\overline{Ci}$.	Fe_2O_3.	Vol.	$Mg_2P_2O_7$ found.	$Mg_2P_2O_7$ required.	Diff.	Per cent.
10	20 cm³.	5 gm.	.5 gm.	? cm³.	.2756 gm.	.2711 gm.	+.0045 gm.	101.6
12	20	8	.5	?	.2705	.2711	—.0006	99.8
68	20	5	.5	228	.0284	.0271	+.0013	104.8
69	20	7	.5	400	.0283	.0271	+.0012	104.4
70	20	10	.5	400	.0280	.0271	+.0009	103.3
71	20	15	.5	400	.0270	.0271	—.0001	99.6
74	20	5	.5	400	.2705	.2711	—.0006	99.7
75	20	7	.5	400	.2732	.2711	+.0021	100.7
76	20	10	.5	400	.2710	.2711	—.0001	99.9
77	20	15	.5	400	.2689	.2711	—.0022	99.1

In 10, 68 and 74 the $\overline{Ci}$ present was insufficient to produce a greenish yellow color; the solutions were red and the precipitates contained iron. In three cases where a small amount of phosphoric acid was present, the results came much too high, and the absolute error was rather too large to be considered due to the errors of experiment. The error decreased as the amount of citric acid increased, and in 71 with 15 grams of $\overline{Ci}$ the result was satisfactory.

With a larger quantity of P_2O_5 the results came within 1 per cent of the actual amount, with the exception of 10, where 5 grams $\overline{Ci}$ were used.

7. What effect on the precipitation has the presence of salts of aluminum? Following are the results—

No.	Mg. mix.	$\overline{Ci}$.	Al_2O_3.	Vol.	$Mg_2P_2O_7$ found.	$Mg_2P_2O_7$ required.	Diff.	Per cent.
9	20 cm³.	5 gm.	.5 gm.	? cm³.	.2602 gm.	.2711 gm.	—.0109 gm.	96.0
11	20	8	.5	?	.2681	.2711	—.0030	98.9
13	20	11	.5	?	.2680	.2711	—.0031	98.8
78	20	5	.5	400	.2699	.2711	—.0012	99.5
79	20	7	.5	400	.2702	.2711	—.0009	99.7
80	20	10	.5	400	.2700	.2711	—.0011	99.6
81	20	15	.5	400	.2674	.2711	—.0037	98.6
82	20	7	.5	400	.0275	.0271	+.0006	101.4
83	20	10	.5	400	.0262	.0271	—.0009	96.7
84	20	15	.5	400	.0258	.0271	—.0013	95.2

In general the presence of aluminum salts depresses the results. With .5 grms. Al_2O_3, 5-15 grms. $\overline{Ci}$, 20 c. c. magnesia mixture, and 400 c. c. total volume of solution, the error falls within 1 per cent.

Summary.

The conditions which tend to introduce a plus error are these:

1. Excessive amount of magnesia mixture in the presence of $\overline{Ci}$.
2. Presence of calcium as sulphate or chloride.
3. Presence of ferric salts.

The circumstances which tend to make a minus error are:

1. Solvent action of ammonium citrate on $MgNH_4PO_4$.
2. Presence of aluminum salts in the solution.

The most serious error is likely to come from the solvent action of ammonium citrate, and it is to be avoided by increasing the amount of magnesia mixture as the amount of citrate increases, by moderate dilution, and when the amount of citrate is very large (23 grams as in the case of reverted P_2O_5— estimations) by increasing the amount of ammonia employed.

The following quantities of reagents were used in the subjoined analyses of commercial fertilizers.

In case of superphosphates, the analysis by the citric method has sometimes been made on a single portion of 2 grams, which was first washed on a filter with water to extract soluble P_2O_5, then digested with ammonium citrate, as directed by Fresenius, Neubauer and Luck, and "reverted" P_2O_5 thrown down from the solution, and lastly the residue was boiled with HCl, and that solution treated for "insoluble" P_2O_5. In other cases total P_2O_5 has been determined in a separate portion and reverted P_2O_5 obtained by difference.

In case of commercial fertilizers, the presence of calcium salts nearly or entirely compensates the solvent effect of the citrate.

I. *Bones and natural phosphates* (20–30 per cent. P_2O_5).—Use 1 gram substance, 10–15 grams $\overline{Ci}$, 30–40 c.c. Mg mixture, 350–400 c.c. solution, of which one-quarter is ammonia of specific gravity 0.96.

II. *Superphosphates.* SOLUBLE P_2O_5, 1–2 grams substance, 5–10 grams $\overline{Ci}$, 20–30 c.c. Mg mixture, 350 c.c. solution.

REVERTED P_2O_5, 1–2 grams substance, 11½ or 23 grams $\overline{Ci}$, 40 c.c. Mg mixture, and more ammonia than usual.

INSOLUBLE P_2O_5. 2 grams substance, $\overline{Ci}$, etc., same as soluble.

Comparisons between the Citric and Molybdic methods.

BY MESSRS. WELLS, JENKINS AND ARMSBY.

The results in ( ) are by difference, or in case of total, by addition.

Station No.		By Molybdic method.		By Citric method.		$\overline{Ci}$ used.	Subst. taken.
345	Sol. P_2O_5,	7.63	7.77 p. c.	7.65	7.70 p. c.	5 gr.	1 gr.
	Insol. P_2O_5,	.92	.94	1.00	.96	5	2
	Total P_2O_5.	9.56	9.57	9.61	9.60	8	.5
348	Rev. P_2O_5,	14.39		14.13	14.46	23	2
	Insol. P_2O_5,	11.52		11.18	11.60	?	
	Total P_2O_5,	25.91		25.80	25.95	?	
351	Sol. P_2O_5,	4.01		3.85	3.93	?	.8
	Insol. P_2O_5,	5.37		5.20		?	1.6
363	Sol. P_2O_5,	4.76	4.89	4.75	4.62	5	.8
	Rev. P_2O_5,	(.51)		.55	.56	23	2
	Insol. P_2O_5,	.43	.46	(.51)			
	Total P_2O_5,	5.91	5.67	5.75	5.78	7	1

Station No.		By Molybdic method.		By Citric method.		$\overline{Ci}$ used.	Subst. taken.
364	Total P_2O_5,	21.12	21.13	20.99	20.95	10	1
365	Sol. P_2O_5,	5.51	5.47	5.42	5.43	5	.8
	Rev. P_2O_5,	(2.13)		2.02	1.98	23	2
	Insol. P_2O_5,	4.39	4.30	(4.52)			
	Total P_2O_5,	11.91	12.02	11.96	11.94	10	1
372	Total P_2O_5,	7.23		7.27	7.28	5	1
373	Sol. P_2O_5,	1.38	1.47	1.28	1.31	5	2
	Rev. P_2O_5,	(3.07)		2.78	2.74	23	2
	Insol. P_2O_5,	.95	.79	(1.11	1.13)*	10	2
	Total P_2O_5,	5.38	5.38	(5.18)			
366	Total P_2O_5,	17.60	17.56	17.57	17.59	12	1
374	Sol. P_2O_5,	1.26	1.20	1.01	.85	5	2
	Rev. P_2O_5,	(7.60)		6.49	6.97†	23	2
	Insol. P_2O_5,	5.40	5.75	(6.46	6.02)	10	2
	Total P_2O_5,	14.40	14.40	(13.90)			

* Rev. and Insol. = 3.89 3.87.
† Rev. and Insol. = 12.95 12.99.

Station No.		By Molybdic method.		By Citric method.		$\overline{Ci}$ used.	Subst. taken.
376	Sol. P_2O_5,				3.18	10	2
	Rev. P_2O_5,	10.40			5.45	23	2
	Insol. P_2O_5,				1.35	10	2
					9.98		
377	Sol. P_2O_5,				2.31	10	2
	Rev. P_2O_5,	8.79			5.19	23	2
	Insol. P_2O_5,				1.13	10	2
					8.63		
378	Sol. P_2O_5,				4.76	10	2
	Rev. P_2O_5,	12.38			5.04	23	2
	Insol. P_2O_5,				2.12	10	2
					11.92		
379	Sol. P_2O_5,				4.08	10	2
	Rev. P_2O_5,	11.86			6.12	23	2
	Insol. P_2O_5,				1.24	10	2
					11.44		
380	Sol. P_2O_5,				4.06	10	2
	Rev. P_2O_5,	13.33			2.02	23	2
	Insol. P_2O_5,				7.30	10	2
					13.38		
381	Sol. P_2O_5,				6.84	10	2 gr.
	Rev. P_2O_5,	11.17			1.75	23	2
	Insol. P_2O_5,				2.44	10	2
					11.03		
384	Sol. P_2O_5,				6.05	10	2
	Rev. P_2O_5,	13.96			1.65	23	2
	Insol. P_2O_5,				6.26	10	2
					13.96		
382	Total P_2O_5,	12.97	13.03	13.03	13.05	15	1

Station No.		By Molybdic.		By Citric.		$\overline{Ci}$ used	Subst. used.
383	Total P_2O_5,	27.18	27.20	27.42	27.31	15	1
	Sol. P_2O_5,			2.33	2.40		2
386	Rev. P_2O_5,	14.21		7.25	7.43		2
	Insol. P_2O_5,			4.48	4.20		2
	Total P_2O_5,			(14.05)			2
388	Total P_2O_5,	25.21	25.02	25.04	25.03	15	1
390	Total P_2O_5,	1.79	1.79	1.77	1.77	7	1
393	Total P_2O_5,	7.16	7.19	7.20	7·20	7	1

Station No.		Molybdic.	Citric.
427	Total,	26.22	26.26—26.31
440	Total,	24.43	24.40—24.36
422	Total,	22.04	22.16—22.18
443	Total,	21.64	21.94—21.96
442	Total,	19.96	20.04—20.00
434	Total,	19.34	19.57—19.55
	Sol.,		5.57— 5.56
430	Rev.,		1.57— 1.46
	Total,	13.11	13.18—13.15
	Sol.,		6.03— 5.94
424	Rev.,		1.03— 1.16
	Total,	11.28	11.25—11.30
	Sol.,		6.92— 6.93
437	Rev.,		1.11— 1.17
	Total,	10.77	10.81—10.77
433		7.28	7.27— 7.28
	Sol.,		5.54— 5.63
421	Rev.,		0.45— 0.49
	Total,	7.22	7.16— 7.18
	Sol.,		5.71— 5.76
423	Rev.,		.48— .55
	Total,	6.88	6.78— 6.85
439		6.46	6.40— 6.42
	Sol.,		5.76— 5.67
435	Rev.,		.31— .44
	Total,	6.33	6.31— 6.27
	Sol.,		4.67— ...
417	Rev.,		.49— .56
	Total,	5.87	5.87— 5.84
	Sol.,		2.55— 2.56
416	Rev.,		2.01— 2.14
	Total,	5.23	5.54— 5.71
	Sol.,		3.39— 3.40
426	Rev.,		1.59— 1.53
	Total,	6.06	5.94— 5.94
	Sol.,		2.92— 2.81
425	Rev.,		1.59— 1.53
	Total,	4.27	4.26— 4.28
418		1.51	1.35— 1.32

The above comparisons are not a selection, but include all the results obtained up to July, 1880. They were made rapidly and in some cases on material that did not admit of entirely homogeneous sampling. The correspondence of soluble and total P_2O_5, when alike directly determined by the two methods, is in nearly every case satisfactory.

Reverted and insoluble P_2O_5 do not agree so well, as might be expected, because the extraction by ammonium citrate is not without its uncertainties.

Magnesia Mixture.—The mixture used by Mr. Wells was made as follows: 110 grams crystallized $MgCl_2 6H_2O$, 140 grams NH_4Cl, 700 c.c. solution of ammonia sp. gr. 0.96, and water to make one liter. Instead of $MgCl_2 6H_2O$, 27 grams of recently calcined magnesia may be dissolved in the equivalent quantity of HCl, the solution boiled with a little calcined magnesia in excess and filtered.

LAW CONCERNING SALE OF FERTILIZERS.

GENERAL STATUTES OF CONNECTICUT.

REVISION OF 1875.

Title 16, Chapter 15.

SEC. 15. Every package of fifty pounds or more of commercial manure sold, or kept for sale, at over one cent a pound, unless prepared essentially from fish and sold as such, shall be marked with its weight and the name and place of business of the manufacturer, or seller, and with a true analysis of the chemical elements and their several amounts contained therein.

SEC. 16. The Secretary of the State Board of Agriculture may procure the analysis of any fertilizer offered for sale, and prosecute any persons who violate the provisions of the preceding section.

Title 20, Chapter 12.

SEC. 5. Any manufacturer, or trader, who shall sell, or offer for sale, any package containing fifty pounds or more of commercial manure, not marked as required by law, or who shall affix thereto a stamp, impress, or card, claiming that it contains five per cent. more of any fertilizing ingredient than it does in fact, shall forfeit ten dollars for each hundred pounds thereof so offered for sale.

"AN ACT ESTABLISHING THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

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

"SECTION 1. That for the purpose of promoting agriculture by scientific investigation and experiments, an institution is hereby established, to be called and known as The Connecticut Agricultural Experiment Station.

"SEC. 2. The management of this institution shall be committed to a Board of Control, to consist of eight members, one member to be selected by the State Board of Agriculture, one member by the State Agricultural Society, one member by the Governing Board of the Sheffield Scientific School at New Haven, and one member by the Board of Trustees of the Wesleyan University at Middletown, and two members to be appointed by the Governor of this State, with the advice and consent of the Senate. The

Governor of the State, and the person appointed as hereinafter provided to be the Director of the Station, shall also be *ex officio* members of the Board of Control.

"SEC. 3. After the appointment of the members of the Board of Control as aforesaid, said members shall meet and organize by the choice from among their number of a President, a Secretary, and a Treasurer, who shall be elected annually, and shall hold their respective offices one year, and until the choice of their successors. Five members of said Board shall constitute a quorum thereof for the transaction of business.

"SEC. 4. Said Board shall meet annually after the first meeting thereof, on the third Tuesday in January in each year, at such place in the city of Hartford as may be designated by the President of said Board, and at such other times and places, upon the call of the President, as may be deemed necessary, and may fill vacancies which may occur in the officers of said Board.

"SEC. 5. Said Board of Control shall locate and have the general management of the institution hereby established, and shall appoint a Director, who shall have the general management and oversight of the experiments and investigations which shall be necessary to accomplish the objects of said institution, and shall employ competent and suitable chemists and other persons necessary to the carrying on of the work of the Station. It shall have power to own such real and personal estate as may be necessary for carrying on its work, and to receive title to the same by deed, devise, or bequest. It shall expend all moneys appropriated by the State in the prosecution of the work for which said institution is established, and shall use for the same purpose the income from all funds and endowments which it may hereafter receive from other sources, and may sue and be sued, plead and be impleaded, in all courts, by the name of The Connecticut Agricultural Experiment Station. It shall make an annual report to the Legislature which shall not exceed two hundred printed pages, of which not exceeding three thousand copies shall be printed.

"SEC. 6. The sum of five thousand dollars annually is hereby appropriated to said Connecticut Agricultural Experiment Station, which shall be paid in equal quarterly installments to the Treasurer of said Board of Control, upon the order of the Comptroller, who is hereby directed to draw his order for the same; and the Treasurer of said Board of Control shall be required, before entering upon the duties of his office, to give bond with surety to the Treasurer of the State of Connecticut in the sum of ten thousand dollars, for the faithful discharge of his duties as such Treasurer.

"SEC. 7. Upon the death or resignation of any of the members of the Board of Control, the authority or institution by which such deceased member was originally appointed shall fill the vacancy so occasioned.

"SEC. 8. Professor Samuel W. Johnson, of New Haven, is hereby empowered to appoint and call the first meeting of said Board of Control as soon as may be practicable after the appointment of the members thereof, and he shall notify all said members of the time and place of said meeting. Two of said members shall hold office for one year, two of them for two years, and two of them for three years; and at said first meeting they shall determine by lot which of said members shall hold office for one year, which for two years, and which for three years. All members of said Board thereafter chosen or appointed, except such as are appointed or chosen to fill vacancies in said Board, shall continue in office for the term of three years from the first day of July next succeeding such appointment.

"SEC. 9. This act shall take effect from its passage.

Approved March 21, 1877."

AN ACT RELATING TO THE PRINTING OF THE REPORT OF THE STATE BOARD OF AGRICULTURE AND OF THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

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

SEC. 1. The Comptroller shall annually cause to be printed, at the expense of the State, five thousand copies each of the report of the State Board of Agriculture and of the Connecticut Agricultural Experiment Station.

SEC. 2. All acts and parts of acts inconsistent herewith are hereby repealed.

Approved, March 19, 1879.

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