STATE OF CONNECTICUT.

ANNUAL REPORT

OF

THE CONNECTICUT AGRICULTURAL

EXPERIMENT STATION

FOR 1879.

PRINTED BY ORDER OF THE LEGISLATURE.

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1880.

OFFICERS

OF

The Connecticut Agricultural Experiment Station,

1879.

STATE BOARD OF CONTROL.

	His Exc. C. B. ANDREWS, Litchfield, *President.*	*Ex-officio.*
	Hon. E. H. HYDE, Stafford, *Vice-President.*	Term expires, 1882.
	ORANGE JUDD, Middletown.	" 1879.
	T. S. GOLD, West Cornwall,	" 1880.
	EDWIN HOYT, New Canaan.	" 1880.
Executive Committee.	JAMES. J. WEBB, Hamden,	" 1881.
	W. H. BREWER, New Haven, *Sec'y and Treas.*	" 1881.
	S. W. JOHNSON, New Haven, *Director.*	*Ex-officio.*

Chemists.

E. H. JENKINS, Ph.D.

H. P. ARMSBY, Ph.D.

H. L. WELLS, Ph.B.

Mr. Judd declined re-election to the Board of Control in December, 1879, and Prof. W. O. Atwater was appointed in his place. The other officers for 1880 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.

All chemical analyses, seed examinations, etc., proper to an 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. In taking samples of Commercial Fertilizers and Seeds for examination, the Station's "Instructions for Sampling" must be strictly followed, and its blank "Forms for Descriptions of Samples" must be filled out and sent with the samples.

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 Associatious 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.

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

CONTENTS.

ERRATA.

Page 23, line 8 from top, for quarter read greater.
Page 27, in analysis of **294** for 2 read 24.
Page 30, line 1 of first table, for $12.67 read $22.67.
Page 30, last line of same table, for $35.00 read $30.00.
Page 43, line 14 from bottom, for 21.77 read 21.97.
Page 46, line 10 from top, for 23.00 read 23.90.
Page 47, line 5 from bottom, for in read as.
Page 50, line 18 from bottom, insert * before "containing nitrogen."
Page 51, line 13 from top, insert * before "containing nitrogen."
Page 53, line 4 from bottom, for **304** read **300**.
Page 68, line 11 from top, for plants read fruit.
Page 70, line 16 from bottom, for limits read limit.
Page 70, line 15 from bottom, for tend read tends.
Page 73, line 4 from top, for cent read cents.
Page 76, in description of sample LXII add, and timothy, after clover.
Page 76, to description of sample LII add, sent by T. S. Gold, West Cornwall.
Page 89, in analysis of White Ohio, read 79.05 instead of 78.95.
Page 90, line 2 from top, for 11 read 13.
Page 96, strike out lbs. in last column of table.
Page 112, note to table, for 143 read 14.3.
Page 112, line 7 of table, for LVIII read LVII.
Page 113, line 4 of second table, for 3.616 read 3.686.
Page 114, line 21 from bottom, for investigation read investigations.
Page 115, line 11 from top, for Mercker read Märcker.

REPORT OF THE BOARD OF CONTROL.

To the General Assembly of the State of Connecticut:

The Board of Control of THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION has the honor to submit the following Report.

During the year 1879, the work of the Station has gone on without interruption, and, as heretofore, under the direction of Professor S. W. Johnson. He was assisted the whole year by Messrs. E. H. Jenkins and H. P. Armsby, by Mr. H. L. Wells for seven and one half months, and by Messrs. S. L. Penfield and W. T. Sedgwick, for shorter periods.

The full Board has held one meeting and the Executive Committee thirteen meetings during the year, one at least in each month.

For the expenses and work of the Station we refer your honorable body to the appended Reports of the Treasurer and Director, presented to this Board at its annual meeting held in Hartford, Jan. 20th, 1880.

By arrangement with the State Board of Agriculture, and with the approval of the Comptroller, the printed report of the Experiment Station will be bound up with the Report of the Board of Agriculture, and will be distributed with that Report from the office of the Secretary of the Board of Agriculture.

By order of the Board.

CHARLES B. ANDREWS,
President.

WILLIAM H. BREWER,
Secretary.

TREASURER'S REPORT.

WM. H. BREWER, *in account with the Connecticut Agricultural Experiment Station.*

RECEIPTS.

Balance from last Report,	$463.28	
Laboratory Receipts,	422.35	
From State Treasurer,	5,000.00	
		$5,885.63

PAYMENTS.

Salaries,	$4,135.00	
Travelling Expenses of the Board,	48.50	
Stationery, Printing and Postage,	168.23	
Gas and Fuel,	214.42	
Laboratory Expenses,	771.57	
Miscellaneous,	20.20	
Cash on hand,	527.71	
		$5,885.63

There is now due the Station twenty (20) dollars for chemical analyses, and the bills outstanding against the Station are estimated to amount to about five hundred and forty (540) dollars. The Station is in possession of furniture which cost one hundred and thirty seven (137) dollars, and of apparatus, laboratory stock and office appurtenances, not classed as furniture, estimated to be worth about one thousand (1,000) dollars.

WILLIAM H. BREWER,

Treasurer.

NEW HAVEN, Jan. 19th, 1880.

T. S. GOLD,
EDWIN HOYT,

Auditing Committee.

REPORT OF THE DIRECTOR.

In presenting his Report for 1879, the Director would remark that since the Station and its work are still imperfectly known to the citizens of Connecticut, it is desirable and even necessary to repeat here various statements and explanations which have appeared in one or both his former Reports. Accordingly the reader will find in the following pages such extracts or repetitions from the previous Reports as will be serviceable for those who have not had opportunity to see the former publications of the Station, which, from having been issued in small editions, cannot now be supplied.

The present (3d) Report covers the doings of the Station for the twelve-month ending Dec. 31st, 1879.

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 1879, 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.

Summary of Station Work.—As in former years the analysis of *Fertilizers* has been the leading feature in our operations. One hundred and seventeen (117) samples including nearly all the varieties of purchased fertilizers used by our farmers, have come under the scrutiny of the Station.

Of *Feeding Stuffs* thirty-three (33) specimens have been analyzed, mainly with a view to increase our knowledge of the two most important standard field crops of the State, viz., maize and hay.

Eight (8) samples of *Seeds* have been examined as to their purity and vegetative power.

Thirteen (13) samples of *River and Well Waters* have been tested in respect to their fitness for domestic use.

The study of *Methods of Chemical Analysis* used in the examinations of fertilizers and feeding-stuffs, has received much attention and on subsequent pages some of the processes employed or investigated in the Station Laboratory are described for the benefit of chemists who are occupied with similar work.

In connection with an investigation of the various processes that have been proposed for finding the quantities of nitrogenous principles in feeding-stuffs, Dr. Armsby has, at my request, prepared a critical account of the work recently done elsewhere in respect to the *Nutritive Value of the so-called Amides.*

Dr. Jenkins has collected and arranged in systematic tabular form the results of, I believe, all the trustworthy analyses of feeding-stuffs which have been hitherto made and published in America, with references to the original sources.

This undertaking grew out of the necessity of bringing these analyses together for the use of the Station in prosecuting its work, and the tables of analyses are printed in this Report for the benefit of the many agriculturists in this State who are making use of the information which chemistry is able to supply to the keeper of live stock. Not only are the analyses given as originally published, or in some instances with typographical errors corrected, but in the many cases where it was needful, they have been recalculated to a water-free basis, in order to make comparisons possible.

Readers who may know of trustworthy analyses not here included, will do a great favor by communicating them or reference to them, to the Station.

The important study of the *Relations of the soil to Water* which occupied a considerable space in former Reports, has not been continued experimentally, during 1879, for the reason that the Station is quite destitute of the means of prosecuting further work in that line to advantage. The results already reached and published in the two former Reports have prepared us to continue the investigation with the prospect of developing facts and laws that may be highly useful in agricultural practice. But to continue the study of the subject requires a small piece of inclosed land with an exposure unshaded by trees or buildings, and also a small plant house. The want of these appurtenances effectually bars the station from undertaking any observations or experiments on soils or plants under conditions at all resembling those which occur in agriculture.

Station Bulletins.—During the season of 1879, from March to November, the Station has issued 15 printed bulletins which were simultaneously sent to 83 daily and weekly newspapers published in Connecticut, and to the Secretaries of 26 Farmers Clubs, and 31 Agricultural Societies belonging to the State. These Bulletins were also sent in exchange to a number of the Agricultural Journals in adjoining States. They have been extensively reprinted and thus brought under the eyes of a very large number of agricultural readers. The Bulletins of the Station have been occupied with analyses of fertilizers and feeding stuffs and have served to put before the public, in a very compact form, a good share of the most immediately "practical" results of our year's work and this at times when they would best serve a practical purpose.

Correspondence.—As in former years a large number of letters have been written in answer to inquiries from farmers and gardeners, with reference to the use and value of fertilizers and feeding stuffs, and other subjects of agricultural practice. A number of these inquiries and answers, having general interest, have been printed in the "Connecticut Farmer," and are reproduced in this Report.

Means of Publication.—In my first Report I expressed regret that our State had no "Agricultural paper of its own which could serve as the organ of the Experiment Station, and the means of weekly communication between it and the farmers." I wrote further that "while the Annual Report serves to publish the detailed results of the work of the Station, and while, by means of bulletins and communications to the newspapers the more important results of investigations may be diffused, yet the Connecticut Experiment Station cannot reach its full efficiency until every farmer in the State is able to find in some one publication a ready means of learning promptly what is doing in the way of testing fertilizers, seeds, etc., and of asking and having answered in its columns questions which would not be appropriate nor timely in an annual volume."

In February began the weekly issue of the "Connecticut Farmer," an agricultural and family newspaper published at Hartford, which has supplied this want. The "Connecticut Farmer" from the outset has accorded to the Station, every desired facility for publishing our results, and I have accordingly sent to that paper the manuscript bulletins and in return have been supplied with printed copies for distribution. It has thus been possible to make our bulletins more detailed and complete and to publish them more frequently and more accurately than hitherto.

I must take this opportunity to express the hope that the "Connecticut Farmer" may meet with generous support both from the purses and the pens of all our citizens who are interested in farming or gardening. If the Experiment Station is indispensable as a source of important information to the land-owners of Connecticut, the agricultural paper of the State will be equally needed as a right hand to distribute that information to our citizens, and to convey a knowledge of their wishes and necessities to the Station.

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 1879, one hundred and seventeen (117) samples of fertilizers have been analyzed. Of these, thirty-seven (37) were examined for private parties, and the remainder, eighty (80), for the general use of the citizens of the State.

The samples analyzed for the public benefit have been sent in from all quarters of the State, in most instances by actual purchasers and consumers. In some instances, dealers or agents have sent in samples, and in a few cases, the Officers of the Station have sampled fertilizers in the stores at New Haven.

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 percentages 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 mode 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 his stock of boughten fertilizers, reasons 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, &c., 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 *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.

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, means strictly, 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 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 readily available as plant food. This is true of the 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 recently found in the Connecticut and New York markets, and employed by the Station during 1879 and which it is proposed to use in 1880, are as follows:

TRADE-VALUES FOR 1879 and 1880.—*See page* 55.

	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 fractions, 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 accurate enough to serve the object of the consumer.

To Estimate the Value of a Fertilizer we multiply the per cent. of Nitrogen, &c., 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 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.

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, &c., 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, &c., 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.

Further remarks upon Valuation will be found in subsequent pages, where the actual cost of various fertilizing elements during 1879, is compared with the trade values that were proposed a twelve-month ago.

ANALYSES AND VALUATION OF FERTILIZERS.

The fertilizers analyzed in the Station Laboratory during the year 1879 are as follows, viz:

22 superphosphates.
4 guanos.
12 ground bone.
13 dried fish scrap.
12 dried blood.
3 hair and horn.
3 G. W. Baker's animal manures.
2 damaged cotton and linseed meal.
1 hen dung.
5 sulphate of ammonia.
5 potash salts.
3 oyster shell lime.
2 paper mill waste.
1 shell marl.
3 leached wood ashes.
3 unleached wood ashes.

1 Jersey green-sand marl.
1 marine mud and seaweed.
3 fresh water sediments.
3 peats or swamp mucks.
2 catch basin sediments.
1 native phosphate.
12 "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.

Of the twenty-two samples of this kind of fertilizer that have been examined, five were analyzed for the private use of manufacturers. The analyses of the remaining seventeen samples are here tabulated on page 22. Here follow the names or brands which designate the Superphosphates, together with the address of the parties by whom they were sampled and sent. The numbers, in full-faced type, are those by which the samples are entered on the Station Record.

Superphosphates.

No.	Name or Brand	Sampled by
228	Lebanon Fertilizer.	C. P. Augur, Whitneyville.
229	" "	" "
248	Dissolved Bone, Booth & Edgar's.	W. E. Wheeler, Stratford.
249	Staggs' Superphosphate.	" "
251	Ammoniated Superphosphate, N. H. Chemical Co's.	J. J. Webb, Hamden.
271	Ammoniated Superphosphate, N. H. Chemical Co.'s	T. N. Bishop, Plainville.
256	Upton's Superphosphate of Lime.	George Maxwell, Rockville.
272	E. Frank Coe's Phosphate	Buck & Durkee, Willimantic.
277	" " "	Experiment Station.
273	Russell Coe's Phosphate.	Buck & Durkee, Willimantic.
275	Lombard & Matthewson's Superphosphate.	John D. Gaylord, Ashford.
295	Lombard & Matthewson's Superphosphate.	Buck & Durkee, Willimantic.
291	English Phosphate.	P. M. Augur, Middlefield.
298	Superphosphate of Lime.	M. S. Baldwin, Naugatuck.
306	Decomposed Fish and Beef Bones.	R. S. Hinman, Birmingham.
312	Americus Ammoniated Superphosphate.	D. H. Van Hoosear, E. Wilton.
313	Universal Superphosphate of Lime.	" "

Analyses, Cost and Estimated Values of Superphosphates.*

Station No.	Manufacturer or Importer.	Nitrogen.	Soluble Phos. Acid.	Revert. Phos. Acid.	Insol. Phos. Acid.	Potash.	Estim. Value per ton.	Cost per ton.	Dealer.
228	The Farmers' Fruit Preserving Co.,	1.68	1.98	3.66	4.77	....	$24.94	$24.00	The Farmers' Fruit Preserving Co.,
229	Lebanon, Delaware,	1.93	2.22	5.49	3.09	....	27.48	29.00	Lebanon, Del.
248	Booth & Edgar, N. Y.,	.32	1.10	2.12	2.29	....	11.06	20.00	Booth & Edgar, New York.
249	John J. Park, Stratford,	1.67	3.83	5.99	6.01	....	35.45	45.00	John J. Park, Stratford.
251	New Haven Chemical Co.,	2.59	4.57	1.70	3.77	....	36.70	38.00	New Haven Chemical Co.
271	" " "	3.01	6.32	1.37	1.57	7.31	35.37	38.00	E. W. Pierce, Plainville.
256	George Upton, Boston, Mass.,	3.08	5.49	4.58	1.13	3.18	35.87	30.00	C. B. Farley, assignee, Boston.
272	E. Frank Coe, Brooklyn, L. I.,	2.48	9.79	.51	1.55	....	37.49	40.00	Buck & Durkee Willimantic.
277	" " "	2.56	8.76	2.16	1.45	....	38.06	40.00	R. B. Bradley & Co., New Haven.
273	Russell Coe, Linden, N. J.,	1.99	8.02	1.74	3.46	....	35.98	40.00	Buck and Durkee, Willimantic.
275	Lombard & Matthewson, Warrenville,	3.15	2.62	9.52	4.46	....	42.53	38.00	Lombard & Matthewson, Warrenville.
295	" " "	3.08	2.11	10.22	5.24	....	43.33	38.00	Buck & Durkee, Willimantic.
291	H. J. Baker & Bro., New York,	....	15.19	.38	1.20	....	39.50	33.00	Wilson & Burr, Middletown.
298	" " "	....	13.69	1.10	1.58	....	38.42	30.00†	H. J. Baker & Bro, New York.
306	The Earle Phosphate Co., Providence,	3.92	6.03	4.96	1.70	.60	43.97	60.00	The Earle Phosphate Co, Providence, R. I.
312	Rafferty & Williams, New York,	2.33	7.52	0.95	2.29	2.09	35.02	33.00†	Rafferty & Williams, New York.
313	" " "	2.41	5.63	.98	2.17	1.84	30.18	28.00†	" " "
—	Average excluding **248, 306, 291,** and **298**	2.46	5.30	3.76	3.15	1.11	$35.26	$35.46	

* See page 18 and 19

† Price in New York.

The superphosphates are of three classes. Of the above samples, two, viz: **291** and **298**, are superphosphates in the original and strictly correct use of the word, i. e., they contain *soluble phosphoric acid* as their single costly ingredient.

The others are nitrogenous or ammoniated superphosphates containing, besides soluble phosphoric acid, substances of which *nitrogen* is the active element and which may yield ammonia by their decay in the soil. Of the latter, five contain a quarter or less proportion of *potash.*

The question is often asked, what are the other ingredients of a superphosphate besides those upon which its valuation is based?

This question is answered by the nearly complete analysis of **251** which follows.

NEW HAVEN CHEMICAL CO.'S AMMONIATED SUPERPHOSPHATE.

	Per cent.
Moisture,	8.05
Organic (animal) matter and combined water,	30.23
Phosphoric Acid, soluble,	4.57
Phosphoric Acid, reverted,	1.70
Phosphoric Acid, insoluble,	3.77
Sulphuric Acid,	14.12
Chlorine,	7.50
Potash,	7.31
Lime,	14.82
Magnesia,	1.37
Soda, oxide of iron and alumina by difference,	1.28
Sand and insoluble earthy matters,	5.28
	100.00
Nitrogen in organic matters,	2.59
Ammonia equivalent to nitrogen,	3.14

As to the state of the ingredients, the acids are united to the bases, lime, potash, magnesia, soda and oxide of iron, so far as the latter suffice. The soluble phosphoric acid exists as an acid salt, or, perhaps, to some extent, as free phosphoric acid. The sulphuric acid is present mainly as sulphate of lime (gypsum), the potash as muriate (potassium chloride). The reverted and insoluble phosphoric acid exist as phosphates of lime, magnesia and iron.

It is seen that a superphosphate like this, contains all those elements of plant food which are derived by vegetation from the soil, and in that sense is a "complete fertilizer."

The question might be asked, do not the lime, magnesia, sulphuric acid, etc., present in this fertilizer add to its fertilizing power and influence its agricultural value? The answer must be, yes! It then may be asked—should not the substances, which are unnamed in the usual analyses, but which are admitted to have an agricultural value, be recognized in computing the commercial value?

The answer is—the three elements which serve as the basis of the valuation, viz: nitrogen, phosphoric acid and potash, cannot be had separate from organic matters, sulphuric acid, lime, etc., and therefore the commercial value of the latter is included in that of the former. It is true that in different fertilizers, nitrogen phosphoric acid and potash are associated with different quantities, and to some extent with different kinds of other elements, but the latter are of very subordinate commercial value, and their variations do not sensibly affect the valuation of the fertilizer.

Another question often put is—why must the farmer buy so many pounds of water, organic matter, sulphate of lime, or even sand, in order to get the few pounds of valuable fertilizing matter? The answer is that the raw materials from which the manufacturer must obtain nitrogen, phosphoric acid and potash, in most cases, cannot be made to yield those valuable elements in a more concentrated state, without increased cost to the purchaser.

		Estimated Value per ton.	Cost per ton.	Value Exceeds Cost.
298	Superphosphate of Lime, Baker & Bro.,	$38.42	$30.00*	$8.42
291	English Phosphate, Baker & Bro.,	39.50	33.00	6.50
256	Upton's Superphosphate of Lime, ...	35.87	30.00	5.87
295	Lombard & Matthewson's Superphosphate,	43.33	38.00	5.33
275	Lombard & Matthewson's Superphosphate,	42.53	38.00	4.53
313	Universal Superphosphate of Lime, Rafferty & Williams,	30.18	28.00*	2.18
312	AmericusAmm'niat'd Superphosphate, Rafferty & Williams,	35.02	33.00*	2.02
228	Lebanon Fertilizer,	24.94	24.00	.94
				Cost Exceeds Value.
251	New Haven Chem. Co.'s Ammoniated Superphosphate,	36.70	38.00	$1.30
229	Lebanon Fertilizer,	27.48	29.00	1.52
277	E. Frank Coe's Superphosphate,	38.06	40.00	1.94
272	" " "	37.49	40.00	2.51
271	New Haven Chem. Co.'s Ammoniated Superphosphate,	35.37	38.00	2.63
273	Russell Coe's Superphosphate,	35.98	40.00	4.02
248	Booth & Edgar's Dissolved Bone,	11.06	20.00	8.94
249	Stagg's Superphosphate,	35.45	45.00	9.55
306	Earle Phosphate Co's Decomposed Fish and Beef Bones,	43.97	60.00	16.03

* In New York.

The table on page 24 will serve to facilitate comparison of the various samples in respect to their relative commercial value, as they are arranged in the order in which estimated value exceeds cost, or the reverse.

291 and **298** are superphosphates without nitrogen, and are believed to be of English manufacture. In them the cost of soluble phosphoric acid is $10\frac{9}{10}$ cts. per pound, making no allowance for the reverted and insoluble phosphoric acid.

The average cost of superphosphates, excluding **248, 291, 298** and **306**, which are exceptional is $35.46. The average estimated value is $35.26. That the ingredients of these fertilizers have been purchased during 1879 in other materials at less cost, will be shown on subsequent pages.

Guanos.

Of the four articles bearing the special trade name Guano, that have been analysed, three are here reported, viz:

292 Standard Guano, Imported by Hobson, Hurtado & Co., N. Y. Sold by Wilson & Burr, Middletown. Sent by P. M. Augur, Middlefield.

283 Pine Island Guano, Manufacturers, Quinnipiac Fertilizer Co., New Haven. Dealers, G. Osborn & Tolles, Naugatuck. Sent by M. S. Baldwin, Naugatuck.

319 Manhattan Blood Guano, made by Manhattan Fertilizer Co., Bridgeport. Sold by Platt & Merwin, Milford. Sent by Jos. W. Nettleton, Milford.

Station No.	292	283	319
Nitrogen as Ammonia,	5.76		
Organic Nitrogen,	2.14	3.77	2.53
Soluble Phos. Acid,	5.49	1.76	5.59
Reverted Phos Acid,	3.85	2.76	3.16
Insoluble Phos. Acid,	6 33	2.25	3.37
Potash,	2.97	6.63	.96
Chlorine,		4.94	
Total Estimated value,	$66.67	$33.57	$35.67
Cost,	$53.50	$38.00	$40.00

As usual, the Peruvian Standard Guano is one of the cheapest sources of its ingredients. The Pine Island and Manhattan Guanos are manufactured articles whose mechanical condition is excellent, and they enjoy, I believe, a high reputation. Nevertheless their cost exceeds their estimated value by more than $4 per ton.

Bone Manures.

Of the 12 fertilizers properly belonging to this class all but one are here reported. "Rotted Bone," **246,** "Dissolved Bone," **248** are elsewhere noticed, the former on p. 33, the latter on p. 21.

It is noticeable that, with two exceptions the Bone Manures cost less than the valuations. These exceptions are **279** and **305,** both of Lister Bros. manufacture. Sample **279** contained 21.6 per cent of matter soluble in cold water, probably salt cake or sulphate of soda. Sample **305** was not examined as to the quantity of salt cake present, but it is perhaps not improbable that the failure to get any good from it, which Mr. Lyman Hotchkiss states he experienced, may have been in good part owing to the salt cake which if used in large quantity or without even distribution through the soil, would easily injure vegetation, especially if applied in dry weather.

BONE MANURES.

Station Number.	Manufacturer.	Dealer.	Sent by
252	Thompson & Edwards, Chicago, Ill.	John S. Welles, Hebron.	John S. Welles, Hebron.
269	J. O. & E. Smith, Canterbury.	Charles Backus, Andover.	John S. Welles, Hebron.
279	Lister Bros., Newark, N. J.	R. B. Bradley & Co., New Haven.	Experiment Station.
305	" " "	R. B. Bradley & Co., New Haven	Lyman Hotchkiss, East Haven.
285	F. S. Johnson, Plainville.	F. S. Johnson, Plainville.	Jacob W. Hemingway, Plainville.
288	....	Royal Jennings, Agt., Trumbull.	F. G. Heublein & G. Goessinger, H'nt'gt'n
290	The Rogers & Hubbard Co., Middletown.	The Rogers & Hubbard Co., Middlet'n.	P. M. Augur, Middlefield.
293	Lombard & Matthewson, Warrenville.	Buck & Durkee, Willimantic.	Buck & Durkee, Willimantic.
294	Lombard & Matthewson, Warrenville.	Buck & Durkee, Willimantic	Buck & Durkee, Willimantic.
296	Lewis M. Wakely, Long Hill.	Lewis M. Wakely, Long Hill.	J. R. Brinsmade, Long Hill.
299	H. J. Baker & Bro., New York.	....	S. B. Wakeman, Saugatuck.

ANALYSES AND VALUATION.

Station No.	Name or Brand.	Phos. Acid.	Nitrogen.	Finer than $\frac{1}{50}$ in.	$\frac{1}{25}$ in	$\frac{1}{12}$ in.	$\frac{1}{6}$ in.	Coarser than 1-6 in.	Estimated Value.	Cost per ton.
252	Chicago Bone Dust........	26.0[illegible]	1.77	73	14	9	4	0	$41.45	$35.00†
269	Raw Bone, ...	20.40	4.07	10	19	21	24	26	36.94	30.00
279	Lister's Ground Bone......	10.63	2.80	45	18	15	14	8	23.10	30.00
305	" " " No. 1.	9.51	2.81	43	18	16	13	10	21.69	30.00
285	Ivory Dust.	24.65	5 26	76	24	0	0	0	52.67	30.00
288	Ground Bone............	19.46	3.85	28	25	27	19	1	37.57	32.00
290	"A" Ground Bone........	23.74	4.30	23	21	35	21	0	44.07	33.00
293	Lombard & Matthewson's Bone, No. 1.	25 13	3.77	20	43	34	3	0	45.02	36.00
294	Lombard & Matthewson's Bone, No. 2..	20.08	4.05	11	17	22	26	2	36.56	31.00
296	Pure Bone Meal, ...	21.43	4.10	32	35	28	5	0	41.84	32.00
299	Pure Ground Bone,.......	21.63	3.91	22	33	29	16	0	40 5	33.00‡

† $30 at Wholesale. ‡ $33.00 in Saugatuck, $31.50 in New York.

In my report for 1878 I proposed some changes in the mode of fixing the valuation of Bone Manures. Those changes and the reasons for them are explained in the following paragraphs quoted from that Report:

"The proper valuation of Bone Manures has, however, some difficulties. The prices customarily allowed for nitrogen are 15 cents per pound in coarse and 18 cents per pound in fine bone; the prices for phosphoric acid are 5 cents in coarse and 7 cents in fine bone. These prices are certainly not far from correct in the gross, as the agreement between average valuation ($35.50), and average cost ($33.00) demonstrates. In many individual cases, however, they are not satisfactory. The fact whether bone is fine or coarse is determined by sifting through sieves of appropriate mesh. When 50 per cent. of the bone passes holes of $\frac{1}{25}$ inch, we call the sample fine; when fifty per cent. is larger than $\frac{1}{25}$ inch, we call the sample coarse. It may thus happen that two samples, which differ but two or three per cent. in the proportion of fine bone which they contain, are valued, one at 5 and 15 cents per pound for phosphoric acid and nitrogen respectively, and the other at 7 and 18 cents. This difference in allowed price may make a difference of from $5 to $10 in the valuation, according to the quantities and proportions of phosphoric acid and nitrogen. I have, therefore, latterly adopted for medium bone the medium prices of

6 and 16½ cents for these two elements. This leaves the valuation hardly exact enough, especially since difficulty may often arise in deciding from the results of sifting to which of the three grades a sample should belong.

I therefore propose in the future (1879) to distinguish for the purposes of valuation five grades of ground bone, each with the dimensions and price below specified, viz:

Grade.	Dimensions	1879. Estimated value per pound. Nitrogen.	Phos. Acid.
Fine,	smaller than $\frac{1}{50}$ inch,	18 cts.	7 cts.
Fine-medium,	between $\frac{1}{50}$ and $\frac{1}{25}$ inch,	17¼ "	6½ "
Medium,	" $\frac{1}{25}$ and $\frac{1}{12}$ inch,	16½ "	6 "
Coarse medium,	" $\frac{1}{12}$ and $\frac{1}{6}$ inch,	15¾ "	5½ "
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, contains 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.

$72.6 \times 26 \div 100 \times 18 = \$3.40$
$72.6 \times 23 \div 100 \times 17\frac{1}{4} = 2.88$
$72.6 \times 27 \div 100 \times 16\frac{1}{2} = 3.23$
$72.6 \times 24 \div 100 \times 15\frac{3}{4} = 2.74$

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

This result is $1.32 higher than the valuation ($36.65) given in the table on p. 24,* and agrees within $2.00 with 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 yields to water 14 per cent. of salt cake, which mostly passes 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 might 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."

It is plain from the analyses made in 1879, that the estimated values for the nitrogen and phosphoric acid in bone above given and justified by the averages of 1878, are now considerably too high for the really good articles, and unless the state of the market changes, might be considerably reduced.

This fact is brought out by the following table, wherein the

* Of report for 1878.

bone manures are arranged in the order in which their estimated value exceeds cost, or the cost exceeds estimated value.

Station No.	Brand.	Estimated Value.	Cost.	Value Exceeds Cost.	Worth reckoned from average cost of 8 samples.*
285	Ivory Dust, F. S. Johnson..............	$52 67	$30.00	$12.67	$42,05
290	"A" Ground Bone, Rogers & Hubbard Co.	44 07	33.00	11 07	36.41
296	Pure Bone Meal, L. M. Wakely,........	41.84	32.00	9 84	34.64
293	Bone, No 1, Lombard & Matthewson, ..	45.02	36.00	9.02	37 55
299	Pure Ground Bone, H. J. Baker & Bro.,	40 52	33 00	7.52	33 81
269	Raw Bone, J. O. & E. Smith,...........	36.94	30.00	6.94	29 87
252	Chicago Bone Dust, Thompson & Edwards,	41.45	35.00	6.45	35.25
288	Ground Bone, R. Jennings, Agt.,........	37 57	32.00	5.57	31 15
294	Bone, No. 2, Lombard & Matthewson,...	36 56	31.00	5.56	29.64
	Average of 8 samples,*................	40.50	32.75	7.75	33.54
				Cost Exc'ds Value.	
279	Lister's Ground Bone,.....	23 10	30 00	6 90	19.18
305	" " " No. 1,............	21.69	35 00	8 31	17 80

* Exclusive of **285**, **279** and **305**.

Excluding the two samples of Lister's Ground Bone, and the Ivory Dust as exceptional, the average *cost per ton* of the other eight *bone manures* here reported is $32.75. Their average calculated value derived from the trade values adopted for 1879, p. 18, is $40.50. The average excess of estimated value over cost is therefore $7.75 per ton, or 19 per cent. of the former.

In the subjoined statement the reader may find a comparison between the estimated values adopted in 1879, for the *nitrogen and phosphoric acid* in the various grades of bone, and the actual *cost per pound* of the same in the eight samples of genuine bone analyzed at the Station during that year, the latter being, as near as may be, 18 to 20 per cent. of the former:

Grade.	Dimensions.	Estimated value per pound.		Cost per pound.	
		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,	$17\frac{1}{4}$ "	$6\frac{1}{2}$ "	14 "	$5\frac{1}{2}$ "
Medium,	" $\frac{1}{25}$ and $\frac{1}{12}$ inch,	$16\frac{1}{2}$ "	6 "	13 "	5 "
Coarse-Medium,	" $\frac{1}{12}$ and $\frac{1}{6}$ inch,	$15\frac{3}{4}$ "	$5\frac{1}{2}$ "	12 "	$4\frac{1}{2}$ "
Coarse,	Larger than $\frac{1}{6}$ inch,	15 "	5 "	11 "	4 "

The values given in the last column of the table on p. 30, are reckoned from these cost-figures, which are thus seen to be very nearly the real trade values of the fertilizing elements of genuine bone for the past season. The agreement between cost and the value calculated from these figures is as perfect as could be anticipated, the average value thus calculated exceeding the average cost by $0.79 per ton. As to the adoption of these reduced values in calculating the value of bone manures in the future, see further remarks on p. 55, etc.

Of the three samples which have been thrown out from this reckoning as exceptional, two, viz: **275** and **305**, have a calculated value much below their cost price. In them the bone is largely diluted with moisture and salt cake. It must be conceded, however, that the bone in these samples, having probably been boiled, might act more promptly than raw bone of equal fineness, and should therefore, perhaps, be valued at a higher rate. But this brand of Bone is very variable in composition, and must be bought at a venture, unless purchased on guarantee both as to quantity and quality of its fertilizing elements.

The other exceptional sample, ivory dust, **285**, from its extreme dryness and fineness gives a very high valuation and undoubtedly is the cheapest article among the bone manures, but it is probably not to be had in such quantity as to influence the price of ordinary bone, and from its dense texture is perhaps less active as a fertilizer than the latter.

Fish Scrap or Fish Guano.

Station No.		Water.	Nitrogen.	Ammonia Equiv. to Nitrogen.	Nitrogen in water-free fish.
226	Dry Guano,..............	18.90	7.63	9.26	9.41
234	Dry Fish Guano,..........	17.64	8.13	9.87	9.87
276	Dry Ground Fish,.........	....	8.18	9.93	....
310	Coarse Dry Guano,...	17.64	7.96	9.67	9.66
311	Fine Dry Guano,..........	16.01	8.11	9.85	9.65
315	Fine Dry Guano,..........	22.81	7.41	8.99	9.60
317	Fine Dry Fish,...........	22.62	7.35	8.93	9.49
320	Dry Fish Scrap,..........	13.70	8.19	9.95	9.47
321	Dry Fish Scrap,..........	16.14	7.95	9.65	9.47
323	Fish,....................	22.71	7.12	8.65	9.22
331	Dry Guano,...............	22.71	7.34	8.91	9.48
332	Dry Guano,...............	20.49	7.28	8 84	9.15
333	Dry Guano,...............	18.24	7.39	8.98	9.04
	Average for 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

The thirteen samples reported were with one exception analyzed for manufacturers or private parties.

276, manufactured by the Quinnipiac Fertilizer Co., was taken by the Station from stock on sale by R. B. Bradley & Co., New Haven. It contained 6.4 per cent. of phosphoric acid. Its cost was $40 per ton. Its calculated value (nitrogen reckoned at 20 cts., phosphoric acid at 7 cts. per lb.) $41.68. The cost of phosphoric acid being reckoned at 7 cts., that of nitrogen would be 19 cts. per lb.

The names given are those furnished to the Station, and signify the same thing in various states of dryness and pulverization.

Dried Blood.

Station No.		Water.	Nitrogen.	Ammonia Equiv. to Nitrogen.	Phos. Acid.
235	Dried Blood,	21.97	10.62	12.90	....
240	" "	....	11.78	14.30	..
250	" "	....	8.10	9.84	3.02
266	" "	....	10.71	13.00	....
267	" "	....	7.14	8.67	....
268	" "	....	7.84	9.52	....
278	" "	....	7.21	8.75	8.88
325	" "	9.93	10.83	13.15	....
336	" "	12.32	9.97	12.10	....
338	" "	15.76	10.05	12.21	....
339	" "	15.39	10.94	13.28	....
340	" "	14.16	7.90	9.59	....

With a single exception the samples of dried blood were analyzed for manufacturers.

278 is the only sample analyzed from the retail trade. It was taken by the Station from stock of R. B. Bradley & Co., New Haven, and was manufactured by S. E. Merwin & Son, New Haven. Its cost was $35 per ton. The value estimated on the basis of 20 cts. per lb. for nitrogen and 7 cts. for phosphoric acid is $41.68.

Reckoning its nitrogen at 16½ cts., and its phosphoric acid at 6½ cts., would give $35.33, or very nearly its cost price.

Hair and Horn.

Two samples of Hair Felt and one of Buffalo Horn Dust, all manufacturing waste, have been examined.

261 and **262** Hair Felt, sent by T. H. Ryland, Bridgeport, said to "have no market value."

286 Buffalo Horn Dust, manufactured by F. S. Johnson, Plainville. Sent by J. W. Hemingway.

Analyses.

	261	262	286
Nitrogen,	9.27	9.34	14.44
Cost of Fertilizer per ton,	?	?	$30.00
" Nitrogen per lb.,	?	?	.10½
Estimated value per ton (Nitrogen, at 15 cts.),	$27.81	$28.02	$43.32
Estimated value per ton (Nitrogen, at 11 cts.).	$20.38	$20.55	$31.77

The nitrogen of hair and of horn dust is reckoned equal in value to that of coarse bone. The value for nitrogen, hitherto adopted, viz: 15 cts. gives the horn dust a money-worth greater than its selling price by $13.32, while the cost of nitrogen in this material is 10½ cts., or nearly that of nitrogen in the coarse part of the samples of genuine bone reported on p. 26.

These articles are rich in nitrogen and contain no noticeable proportion of phosphoric acid. In use they very often prove disappointing, for the reason that their nitrogen can only become of avail to vegetation by their decay. But under ordinary circumstances they decay very slowly, and therefore remain in dry soils for a long time undecomposed. One of the simplest modes of using them is to dig them in about the roots of fruit trees, grape or hop vines, and small fruits, or to top-dress moist grass-lands. Thus applied, in considerable quantity, they make a cheap and durable source of nitrogen. To quicken their action and adapt them for general garden or farm use they should be composted with alkaline substances, such as wood ashes, "lime and salt mixture" or rich fermenting manure, the compost to be kept moist until they are thoroughly softened and impregnated with the germs of decay.

G. W. Baker's Cheap Animal Manures.

244. Animal scrap manure.
245. Corena settlings.
246. Rotted bone manure.
} Made by G. W. Baker, Williamsburgh, L. I.; sent March 14th, by W. J. Jennings, president Green's Farms Farmers Club.

	244	245	246
Water,	44.0	29.0	39.0
Nitrogen,	1.9	4.1	4.2
Phosphoric acid,	1.0	trace	2.8
Estimated value per ton (nitrogen at 18c., phosphoric acid at 7c.)	$6.25	$14.69	$12.41
Cost,	7.50	14.00	17.00

The above are made from materials which can scarcely furnish products of uniform quality and since the transportation in them, of a little fertilizing material, involves the carriage and handling of a large amount of water and worthless matters, they are not to be recommended for purchase unless on guarantee of composition and very favorable terms.

Damaged Cotton and Linseed Meal.

289. Ground cotton seed, damaged. } Sampled by L. S. Wells & Son, New Britain.
297. Cotton and Linseed Pomace. Sampled by M. S. Baldwin, Naugatuck.

Both samples were sent in June and were obtained of H. J. Baker & Brother, 215 Pearl St., New York. They were apparently the same, as they agreed exactly in composition and cost.

	289	297
Nitrogen,	6.92	6.87
Phosphoric acid,	3.09	3.00
Potash,	2.06	2.10
Estimated value per ton (nitrogen at 20c, phosphoric acid at 9c. potash, 4½c.)	$35.09	$34.77
Cost per ton in New York,	18.50	18.50
" " New Britain,	22.00	
Cost per pound of Nitrogen in New Britain,	12½c.	
" " Phosphoric acid in New Britain,	6c.	
" " Potash in New Britain,	3c.	

The elements in cotton seed and linseed are shown by abundant experience to be in excellent condition for fertilizing effect, and in the above articles they were procured for some 37 per cent. less than the trade values adopted for 1879 by the Station.

Hen Dung.

A sample received April 15th from Mr. L. H. Gager, of Quarryville, had the following composition:

	257
Moisture,	71.40
Organic matter,*	14.40
Sand and soil,	10.45
Phosphoric acid,	.45
Potash,	.49
Lime and other mineral matters,	2.81
	100.00
*With nitrogen,	.82
Estimated value per ton (nitrogen at 22c.; phosphoric acid at 9c.; potash at 6c.)	$5.01

This result of the analysis of hen manure is perhaps disappointing. We are accustomed to hear it said that the excrement of fowls is very rich, being, in fact, a domestic guano almost comparable to the guano of Peru. The poverty of this sample in fertilizing matters, stands in direct relation to the abundance of moisture and soil which it contains, amounting together to almost 82 per cent., and leaving but 18 per cent. to include all the fertilizing elements. The dry and pure dung would contain over 4 per cent. nitrogen, 2¼ per cent. phosphoric acid and 2½ per cent. potash. But these percentages are, with the exception of potash, far inferior to those of good guano, and for two reasons: 1st, the moist state of the manure has permitted a decomposition whereby nitrogen has escaped in the form of carbonate of ammonia. 2d, the food of hens, at the best, is much less rich in nitrogen and phosphates than that of the guano birds, which feed almost exclusively on fish.

The sample when it reached the Station was quite moist and exhaled ammonia decidedly, but it is not probable that decomposition had gone on far enough to cause any considerable deterioration.

Sulphate of Ammonia.

The five analyses of this fertilizer were all made for manufacturers. The results are given to show the quality of the commercial article.

	227	239	241	326	327
Nitrogen,	20.09	16.35	17.39	20.26	20.22
Equivalent to Ammonia,	24.40	19.85	21.11	24.60	24.88
" " Sulphate of ammonia,	94.71	77.12	82.03	95.51	95.31

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 and entirely convenient to handle, and permanent under transport, it is eagerly bought by compounders of fertilizers. As this substance is now manufactured in the large towns of Connecticut, consumers have the opportunity to bid for the purchase of it at first hand.

Potash Salts.

Five samples of this class of fertilizers have been analyzed.

Analyses.

	263	264	265	287	302
Potash,	37.21	27.44	48.20	59.68	32.98
Sulphuric acid,	9.77	7.21			
Chlorine,	36.07	37.24			
Soda,		12.05			
Lime,		1.44			
Magnesia,		4.79			
Insoluble in water,		3.85			
Water, by difference,		14.37			11.97
		108.39			
Deduct oxygen equivalent to chlorine,		8.39			
		100.00			
Potash guaranteed or implied in brand,	41.00	27.75	50.54		
Cost per ton,	$35.00	$29.00	$35.00	$37.50	$51.20
Cost per 100 pounds of potash,	4.70	5.28	3.63	3.14	7.77

The above figures express the percentage of potash, sulphuric acid, etc., as found in the analyses. In case of **264** the analysis was made complete, and thus exhibits the quantities of all the ingredients present. Since, however, the metals, potassium, sodium, and magnesium are partly in combination with chlorine instead of oxygen, to state them as potash (potassium oxide) soda (sodium oxide), and magnesia (magnesium oxide), makes the footing exceed 100 by an amount of oxygen chemically equivalent to the chlorine present, which amount (8.39 per cent.), is therefore deducted. In the following statements are given the percentages of the several compounds that do or may actually exist in the samples so far as the analyses enable us to calculate them. Only in case of **264** is the analysis sufficient to make the statement complete.

	263	264	265	287	230
Sulphate of Potash,	21.27	15.90			
Muriate of Potash,	40.69	30.01	76.35	89.03	
Carbonate of Potash,					48.38
Common Salt,		26.62			
Chloride of Magnesium,		11.38			
Chloride Calcium, etc.,		1.92			
Water,		14.37			
		100.00			

Reckoning all the potash in **265** and **264** as sulphate, we would have 68.80 per cent. and 47.80 per cent. of sulphate, respectively, instead of 75 per cent. and 55 per cent.

Station No.	Brand.	Importer.	Dealer.	Sent by
263	Sulphate of Potash, $75\frac{9}{10}\%$* by Dr. Ulex's and Dr. Gilbert's Analyses.	New Haven Chemical Co.	New Haven Chemical Co.	J. J. Webb, Hamden.
264	Sulphate of Potash, 55%.	New Haven Chemical Co.	New Haven Chemical Co.	J. J. Webb, Hamden.
265	80% Muriate.†	New Haven Chemical Co.	New Haven Chemical Co.	J. J. Webb, Hamden.
287	Muriate of Potash	H. J. Baker & Co., New York City.	Wilson & Burr, Middletown.	P. M. Augur, Middlefield.
302	Salts of Potash.		H.J. Baker & Bro.	S. B. Wakeman, Saugatuck.

* Equal to 41 per cent. Potash.
† Equal to 56 per cent. Potash

Of the 37.2 per cent. of actual potash in **263** only 11.5 per cent. can exist as sulphate, while 25.7 per cent. must exist in the form of muriate. Of the 27.44 per cent. of actual potash in **264** but 8.5 per cent. can be present as sulphate and the remaining 18.95 per cent. is in the state of muriate.

We observe that the amount of potash actually existing in these samples, as received at the Station, is several per cent. (4 to 8) less than claimed by the dealer.

The dealer's guarantee is based on the analyses of the Hamburg chemists, and the deficiency may be fairly (?) attributed to absorption of moisture during or since importation.

We notice again that the samples **263** and **264**, sold as sulphate of potash, contain less than one-third of their potash as sulphate, and more than two thirds as muriate.

Sulphate of potash is therefore a trade name, and, like many other trade names, involves a fiction more to the advantage of the seller than of the purchaser. The notion is prevalent that sulphate of potash is a better fertilizer than muriate of potash. Some experiments have been published going to show that potatoes and tobacco raised with sulphate are of better quality than when raised with muriate. Whether this be the fact generally, may well be doubted. Nevertheless the idea is stoutly upheld that sulphate of potash is worth more than muriate for fertilizing purposes, and advantage is taken of the superiority, real or fancied, to sell as sulphate an article that is no better than muriate. In fact both of these samples of so-called "sulphate" contain more chlorine than enough to make a muriate of all the potash they contain! The advantage of sulphate of potash as a fertilizer lies, if anywhere, in the *absence of chlorine compounds*, which are supposed to injure the qualitity of certain crops, but as the chlorine compounds (muriate of potash and common salt) are present in these so-called sulphates, in no less quantity, than in a pure muriate, they cannot be expected to make better potatoes or a better tobacco than the latter.

We see, finally, that the cost of potash in the high grade muriate is considerably less than in the so-called "sulphates," evidently, therefore, muriate of potash is the cheapest source of potash. The common salt, chloride of magnesium and water which makes up more than half of **264**, and more than one-third of **263**, have no commercial or agricultural value corresponding to their cost.

Genuine high grade sulphate of potash can be had, but its cost is considerably greater than that of these more than half spurious sulphates. Sulphate of 80 per cent. containing 43 per cent. actual potash, has been recently reported to cost $75 per ton, or 8¾cts. per pound of actual potash.

302 is an impure carbonate of potash containing some prussiate—evidently a manufacturing bye-product. The sample was kept for some weeks in an imperfectly closed tin can and had gathered some moisture from the air. Some allowance should be made for that fact in considering the cost of its potash, but how much cannot be stated. Carbonate of potash is corrosive and would be likely to injure vegetation if incautiously used. It is easily distinguished from sulphate and muriate by its effervescence when drenched with vinegar or other acid. Carbonate of potash shares with sulphate of potash any advantage which the latter may have over muriate as a tobacco fertilizer.

Oyster Shell Lime.

The three accompanying analyses exhibit the composition of samples of oyster shell lime and screenings made by H. A. Barnes & Co., Fair Haven. The samples were taken on Nov. 24th, 1879, by Dr. Armsby, with the assistance of Mr. Barnes, who has also supplied the following data descriptive of the samples.

328 is unscreened oyster shell lime, slacked the day the sample was drawn.

329 is unscreened oyster shell lime, slacked, and about six months old.

330 is oyster shell lime screenings.

The two samples of slacked lime are fine and in good condition to apply to land, **328** being quite dry in handling, **329** damp and coherent.

The slacked and unscreened lime which these two samples represent is sold by measure and not by weight. The price, in November, 1879, was 8 cts. per bushel at the works, and 9¼ cts. per car load, shipped in bulk at R. R. Depot. The average weight of the screened slacked lime used for building purposes is stated to be 47 pounds per bushel. As the screenings amount to 3 to 5 per cent. of the total, it is not far from the truth to assume that the unscreened will weigh 50 pounds per bushel. The cost of this lime would be accordingly 16 cents per 100 pounds, at the kilns, or $3.20 per ton. Shipped in casks holding 16 to 25 bushels, the lime costs about 1½ cents more per bushel and the casks cost $1.00 each, which would bring the cost of a ton up to about $6.40, two casks included.

The screenings, **330**, consist largely of imperfectly burned shells, entire or in fragments. They are not shipped but are sold at the kilns for 4 to 6 cents per bushel.

The unslacked lime, of which we have no analysis, is stated to weigh on the average 70 pounds per bushel, and is sold in bulk at the R. R. Depot, for 17 cents per bushel or about 24 cents per 100 pounds, or $4.80 per ton. Shipped in casks, its price is 19 cents per bushel, the casks costing $1.00 each, which would make the ton cost $7.70.

Analyses of Oyster Shell Lime and Screenings.

	328	329	330
Lime,	64.47	53.60	53 82
Magnesia,	.41	.32	.24
Oxide of Iron and Alumina,	1.50	1.43	1.14
Soda,	.16	.27	.15
Potash,	.04	.06	.03
Carbonic acid,	7.79	8.89	22.34
Sulphuric acid,	.52	.69	.23
Chlorine	.04	.02	.01
Phosphoric acid,	.17	.19	.15
Silica,	2.24	2.41	6.12
Sand,	5.08	2.85	
Coal,	.65	.94	2.60
Water (by difference)	16.93	28.33	13.17
	100.00	100.00	100.00

In the subjoined statement are given the proportions of the various chemical compounds that probably exist in the samples.

	328	329	330
Carbonate of lime,	17.45	19.73	50.52
Hydrate of lime,	68.74	52.34	33.29
Sulphate of lime,	1.12	1.48	.49
Phosphate of lime,	.37	.41	.33
Silicate of lime,*	4.33	4.66	—
Magnesia,	.41	.32	.24
Carbonate of potash,	.06	.09	.04
Carbonate of soda,	.22	.43	.24
Sodium chloride (common salt),	.07	.03	.02
Oxide of iron, and alumina,	1.50	1.43	1.14
Silica,	—	— }	6.12
Sand,	5.08	2.85 }	
Coal,	.65	.94	2.60
Water,	.00	15.29	4.97
	100.00	100.00	100.00

*Soluble silica is calculated as silicate of lime, $CaSiO_3$. In **330** silica was not separately determined and the lime, possibly existing as silicate in it is reckoned as hydrate.

On referring to the results of these analyses we notice that the two samples of lime contain about 9 per cent. of sand and coal or of substances mostly derived from them, viz: oxide of iron, alumina, and silica. We have small quantities of potash, soda, magnesia, phosphoric and sulphuric acids, altogether amounting to 1.5 per cent. Both samples contain also nearly equal quantities of carbonic acid, viz: 8.3 per cent. Lime, the chief ingredient, varies from 64.5 to 53.6, or nearly 11 per cent., and water from 17 to over 28, also 11 per cent.

Looking now to the statement of the proportions of the compounds probably existing in the samples, we see that in the two samples of slacked lime the chief ingredient is hydrate of lime (or calcium hydroxide), next to this in quantity comes carbonate of lime (or calcium carbonate), followed by silicate of lime 4.05 per cent., sulphate 1.03 per cent., and phosphate 0.4 per cent.

A brief review of the chemistry of the lime manufacture may be serviceable. Clean oyster shells consist chiefly of carbonate of lime. As they are used in lime manufacture they contain probably about 7 per cent. moisture and organic matter, about 6 of soil and sand, and 87 per cent. of carbonate of lime. In passing through the kiln the carbonic acid is mostly expelled. If completely expelled the loss would be 38 pounds of carbonic acid for 100 pounds of shells, leaving 49 pounds of quick lime (calcium

oxide). With this would of course remain the sand, mud, etc., that originally adhered to the shells, together with the ashes of the coal used in burning. The lime thus obtained is slacked by throwing on water, in order to reduce it to a powder. In this process of slacking, water and lime enter into chemical combination, the 49 parts of lime becoming 64 parts of hydrate of lime. In practice some carbonate of lime remains undecomposed by the burning, and in the slacking process, the use of insufficient water may leave some quick lime unconverted into hydrate, or excess of water may remain as moisture, as is the case with sample **329.**

When applied to land, oyster-shell lime may act as a *fertilizer* strictly speaking, or as an *amendment*. Commonly, both kinds of action are exerted, and the distinction between fertilizer and amendment is not generally recognized in practice although very important in considering the effects of this substance. Lime is used as an amendment on heavy clay soils, 2 to 3 or more tons being sometimes applied per acre. On loams or light lands 1,000 pounds or 20 bushels of oyster shell lime, applied once in two or three years, is a usual application, equivalent to the addition of 300 to 500 pounds to the acre, annually. It is evident that the small quantities of potash, magnesia and phosphoric acid contained in such doses of oyster shell lime can have no sensible effect upon crops. It is the lime, alone therefore, to which any benefit must be ascribed. A consideration of the modes of action of hydrate of lime, when applied as a fertilizer, will make evident that it is one of the most valuable aids to the farmer and deserves more attention from Connecticut land owners than it has received.

Our cultivated crops contain on the average as much lime as potash. The necessity for the application of potash salts is fully recognized, but probably the lack of lime is as common a cause of unfruitfulness; for while potash seldom wastes from the soil to any serious extent, and is found in spring, well, and river waters in extremely small quantities, lime freely dissolves in water and rapidly wastes from the soil, so that other things being equal there is more need for its restoration.

Paper Mill Waste, Charter Oak Fertilizer.

243. Paper mill waste. Sent March, 7th, by R. E. Pinney, Suffield.

270. Charter Oak fertilizer. Made by Charter Oak Paper Co., Parkville. Sampled and sent, April, 29th, by Paul Thomson, West Hartford.

Since the basis of the Charter Oak fertilizer is evidently the refuse lime of a paper mill to which small quantities of phosphoric acid and nitrogen have been added, its analysis is placed here in comparison with that of **243.** In Bulletin 21 a partial analysis of the latter was reported, which differs somewhat from the more complete and correct analysis here given. The difference is due in part to the difficulty of getting an average of the pasty mass, and in part to the absorption of carbonic acid from the air during the slow drying of the sample, which led to overstating the carbonate and understating the hydrate of lime.

Analyses.

	243	270
Lime,	30.15	30.91
Magnesia,	.28	11.76
Oxide of iron, and alumina,	.61	——
Soda,	2.87	.24
Potash,	——	.30
Sulphuric acid,	.61	.95
Carbonic acid,	13.52	10.47
Phosphoric acid,	trace	1.02
Chlorine.	.24	.13
Moisture,	43.09	24.34
Insoluble residue and silica,	1.68	3.49
Combined water and organic matter,*	6.95	16.39
	100.00	100.00
*Containing nitrogen,	none	.47

Reckoning the acids and bases into the chemical compounds likely to exist in these fertilizers we have the following statement:

	243	270
Carbonate of lime,	26.43	23.80
Hydrate of lime,	19.70	20.76
Sulphate of lime (hydrated),	1.31	2.04
Phosphate of lime,	——	2.23
Hydrate of magnesia,	.41	17.05
Carbonate of potash,	——	.44
Carbonate of soda,	4.56	.22
Sodium chloride,	.39	.21
Sand and silica,	1.68	3.49
Moisture,	42.50	23.00
Oxide of iron, and alumina	.61 }	6.76
Organic matter,	2.41 }	
	100.00	100.00

It thus appears that this paper-mill refuse consists essentially

of a mixture of carbonate and hydrate of lime. It contains also carbonate of soda and carbonate of potash in varying quantity and **270** contains 17 per cent. of hydrate of magnesia, evidently derived from the magnesian limestone used in the kilns of North-Western Connecticut. As a fertilizer the simple paper mill waste in its wet state is equal in commercial and fertilizing value to about half its weight of dry slaked oyster shell lime, or $3.20 per ton.*

The Charter Oak fertilizer, **270,** is worth for its lime and magnesia, not more than $3.50 per ton. Its phosphoric acid, potash and nitrogen at the most liberal estimate are worth $4.00 per ton, making its total commercial value about $7.50 per ton or one half the selling price.

Shell Marl.

324. Received from Mr. Nathan Hart, West Cornwall, Oct. 22d.

Moisture,	23.72
Silica, sand and insoluble matter,	16.88
Oxide of iron and alumina,	1.55
Lime,	27.99
Magnesia,	.97
Soda,	.59
Potash,	trace.
Sulphuric acid,	.46
Phosphoric acid,	trace.
Carbonic acid,	21.77
Organic matter,* by difference,	5.87
	100.00
*Containing organic nitrogen,	0.44

This shell marl consists of *carbonate of lime* to the extent of 40 per cent. and contains 2 per cent. of *carbonate of magnesia*, also 0.9 per cent. of sulphate of soda, and 0.25 per cent. of carbonate of soda. The organic matter includes nearly 0.5 per cent. of nitrogen, in organic combination.

Mr. Hart informed the Station, that parties, whose names were not given, proposed to put this marl on the market as a fertilizer at the price of $15 per ton.

There can be no doubt that its employment, in liberal quantities, viz: one or more tons per acre, especially upon grass lands,

* Compared with the slacked oyster shell lime, *shipped in casks*, or $1.60 compared with lime in bulk at kilns.

would often be attended with decided and long-continued benefit but, in most cases, its action upon grain crops would not appear at once in so decided a manner as is very commonly the case with good superphosphates or guanos.

The fertilizing effects of this shell marl as well as its commercial value may be safely measured by the per centage of lime which it contains. Its effects on crops would be in general quite similar to those of oyster shell lime although somewhat less pronounced since carbonate is a less energetic agent than hydrate of lime. Its content of lime, 28 per cent., is less than one-half as much as that of the two samples of slacked unscreened oyster shell lime described on a previous page, whose average is 59 per cent. As 1,000 pounds of the latter costs at New Haven, shipped in casks, $3.20, it is evident that the proposed price of the marl, $15 per ton, is much too large, even after making the most liberal allowance for cost of handling.

Leached Wood Ashes.

	307	308	309
Sent by	Moses Sherwood, Greens Farms,	Moses Sherwood, Greens Farms,	Henry Baldwin, Canterbury.
Dealer,	N. Alvord, Greens Farms,	D. Thorp, Greens Farms,	James A. Bill, Lyme.
Weight per bush.,	56 lbs.	54 lbs.	58 lbs.
Cost " "	$12\frac{1}{2}$ cts.	14 cts.	$16\frac{1}{2}$ cts.
Cost per 100 lbs.,	22 "	26 "	28 "

Analyses.

	307	308	309
Potash,	1.00	1.29	1.04
Soda,	.61	.53	.62
Lime,	29.83	33.59	28.71
Magnesia,	3.22	3.07	2.61
Iron oxide,	1.43	2.60	1.46
Phosphoric Acid,	1.30	2.02	1.55
Sulphuric Acid,	.13	.13	.13
Chlorine,	trace.	trace.	trace.
Silica and Insoluble,	9.82	5.76	7.65
Char,	1.96	3.06	1.48
Water	26.88	24.05	33.99
Carbonic Acid and Loss,	23.82	23.90	20.76
	100.00	100.00	100.00
Carbonate of Lime equivalent to Lime,	53.2	60.0	51.2

These samples agree closely in composition with those reported last year. They are somewhat drier and contain rather more potash and phosphoric acid.

These ashes applied at the rate of a ton (36 bushels) per acre,

furnish, besides a large dose of carbonate of lime (1100 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. In my Report for 1878 I gave suggestions for preparing a substitute for leached ashes. With help of the analyses of oyster-shell lime, previously given, we can calculate still more closely the composition and cost of a mixture which would be equal in all respects, or even superior to these leached ashes here reported. The fertilizing matters of 100 lbs. of the leached ashes would be contained in

Slacked Oyster-Shell Lime,	54 lbs.	costing*,	9 cts.
Muriate of Potash,	2 "	"	7 "
Ground Bone,	8 "	"	12 "
Total,			28 cts.

* At kiln.

100 lbs. of leached ashes cost on the average 25 cts. Our mixture, however, would contain, in its bone, about four cents worth of nitrogen which is absent from leached ashes, so that the cost of the materials of this mixture is not greater 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.

Unleached Wood Ashes.

The following analyses were made on samples of house ashes prepared in a stove, and kindly supplied by G. H Glover, Esq., North Branford. They illustrate the variability of wood ashes in respect to potash, &c. The quantity of sand is unusually large.

	Chestnut 253	Oak. 254	Hickory. 255
Potash,	3.07	9.37	4.56
Soda,	.42	1.92	.53
Lime,	29.15	29.65	36.29
Magnesia,	9.63	3.65	5.71
Iron Oxide,	5.21	3.73	2.79
Phosphoric Acid,	2.51	2.42	1.63
Sulphuric Acid,	2.46	1.88	.99
Chlorine,	.17	1.49	.19
Carbonic Acid,	12.80	16.57	23.22
Sand and Silica,	26.70	22.07	18.09
Char,	3.26	1.97	1.51
Water and Loss,	4.62	5.28	4.49
	100.0	100.0	100.0

New Jersey Green Marl.

316, shipped by the Kirkwood Marl and Fertilizing Co., Kirkwood, N. J. Dealer, Paul Thomson, West Hartford. Sample received from Paul Thomson, Aug. 25. Price at Hartford $4.00 per ton.

Analyses.

	316	By N. J. geologist.
Moisture,		
Combined water,	16.70	
Sand (insoluble silica),	3.26	9.66
Silica, soluble,	18.33	
Oxides of Iron,	26.65	50.80
Alumina,		
Lime,	23.00	17.63
Magnesia,	.43	8.77
Potash,	3.12	2.13
Soda,	5.69	3.54
Phosphoric acid,	.60	5.18
Sulphuric acid,	.90	....
Other matters, undetermined,	.42	2.24
		.39
		....
	100.00	100.34

The Green Sand Marl has long been a staple fertilizer and amendment in the State of New Jersey, where it occurs as a geological deposit or rather as three distinct deposits, (upper, middle and lower marl beds) which stretch across the State from the Highlands of Navesink near Sandy Hook to the Delaware river below Wilmington, and in many localities admits of easy excavation. In composition it is somewhat variable as shown by the analyses above given, made on separate samples which were obtained quite near each other. If the value of the potash and phosphoric acid in the above analysis is reckoned, for the former, at its lowest price, viz., 4½ cts. per lb., and for the latter at 9 cts. per lb., the value of the reverted phos. acid, we have in 2,000 lbs. of **316,** no less than 114 lbs. of potash worth $5.13 and 18 lbs. of phos. acid worth $1.62, the total being $6.75. The same reckoning applied to the other analysis, which is published by Prof. Cook in the Annual Report of the State Geologist of New Jersey for 1878, p. 45, gives 103.6 lbs. potash worth $4.66 and 45 lbs. phos. acid worth $4.03, the total being $8.69 as the worth of a ton.

It must be conceded, however, that the green marl contains its potash not in the freely soluble state of muriate or sulphate, but as a less soluble silicate, not worth commercially so much as the potash of potash-salts. Experience shows, nevertheless, that

vegetation makes ready use of the plant-food contained in the marl, its application having a speedy effect on clover and grass.

The silicate of alumina, iron and potash which constitutes the green sand (or *glauconite*, as the pure green mineral is termed by geologists), in fact readily suffers decomposition with liberation of its potash, and at the same time furnishes in the residual silicate, the substance which confers on good soils their remarkable quality of retaining the soluble fertilizing elements which would otherwise go to waste. No doubt it is this silicate which largely accounts for the striking improvement of the light sandy soils of Eastern New Jersey, large tracts of which have been transformed from a desert to a garden, mainly as a consequence of the use of this marl.

At the price charged, the green sand marl will be found, to judge from the results of its use in New Jersey, a cheap means of improving not only our very light soils, but also the better loams which require constant manuring to maintain their fertility.

This marl must usually be applied in large quantities, several tons to the acre, in order to get good results. It then forms a valuable amendment and a durable source of potash.

Marine Mud and Sea Weed.

A sample of black mud containing some seaweed from saltwater at Saybrook, was sent to the the Station by Geo. M. Denison, Esq., who states that it is exposed at low tide, and can be got upon the land for about 25 cents per load.

	327
Water,	71.32
*Organic and Volatile matters,	2.79
Sand, Clay and substances insoluble in acid,	20.82
†Oxide of Iron and Alumina,	2.62
Lime,	.26
Magnesia,	.51
Soda,	.60
Potash,	.17
Chlorine,	.51
Sulphuric Acid,	.39
Phosphoric Acid,	trace.

* Contains Nitrogen, 0.14 per cent.
† Most of the Iron exists as protoxide.

This mud contains, in fertilizing elements, the small amount of *nitrogen*, *lime*, *magnesia*, *soda*, *potash*, *chlorine*, and *sulphuric acid* given in the analysis, altogether amounting to about 2½ per cent of the total. But stable manure—the standard fertilizer—contains but about the same amount of plant-food, and of the same kinds, except that it has less sulphuric and more phosphoric acid, less soda and more potash.

The mud, when used judiciously, will prove an excellent fertilizer. Doubtless other samples might contain more phosphates. In any case, the mud, used copiously, together with fish, which are rich in nitrogen and phosphates, and with seaweed, which contains abundant potash, will supply all the plant-food that crops require, and serve to maintain or increase fertility of the soil to the fullest degree.

The only drawback to the use of the marine mud lies in the considerable proportion of soluble salts, mostly common salt, which it contains, being nearly one per cent. If thrown out in heaps and exposed to the rain this salt will be mostly removed. The mud may also be applied directly to root crops or grass in moderate quantities without damage, if well distributed.

As an *amendment* the fine mud must have an excellent effect on coarse-textured soils.

FRESH WATER SEDIMENTS.

	314 East Wilton.	322 Essex.	334 Woodstock.
Moisture,	34.44	5.75	4.77
*Organic and Volatile matters,	2.78	8.11*	7.31*
Oxides of Iron and Alumina,	3.58 (Oxides of Iron and Alumina to Sulphuric Acid)	5.69	3.10
Lime,		.67	trace
Magnesia,		.88	trace
Potash,		.18	none
Soda,		.06	.05
Phosphoric Acid,		.16	trace
Sulphuric Acid,		.46	.06
Sand, Silica, &c., insoluble in acid,	59.20	78.04	84.71
	100.00	100.00	100.00
*Containing Nitrogen,		0.29	0.15

314 was sent by D. H. Van Hoosear, Secretary East Wilton Farmers Club, in August last, described as "deposit from the bottom of a pond hole." The partial analysis showed such large proportions of water and insoluble matters as to lead to the conclusion that the deposit would have little more value as a fertilizer than a good soil.

The sample **322** whose analysis is next given was sent, labeled dried mud, by Mr. J. I. Stevens, of Essex, who states that "its

effect as a top dressing for lawns and also on mowing land has proved greater for good than anything I have ever seen. On many crops it has given me better results than $45 crop foods I have purchased. This mud is under water the year round."

The analysis agrees remarkably with that of pond mud from North Woodstock, mentioned in the Report for 1877. It contains, however, a little more phosphates and sulphates. In reply to Mr. Stevens' inquiries, was written as follows:

"The dried mud contains every element of plant food in about the proportions that are usually present in stable manure, or in good composts. Like the fertilizers just named it contains but about 3 per cent. of immediately available plant food; the other 97 per cent. being water, sand, or clay, vegetable matters, oxides of iron and alumina, not differing in character or fertilizing value so far as is known from the same substances as they make up the bulk of ordinary soils. Unlike stable manure and ordinary composts the mud contains a considerable amount of sulphuric acid in the form of sulphate of lime. The mud contains 0.46 per cent. of sulphuric acid, while stable manure has but 0.10 per cent. or less. It is quite likely that this fact may have made the mud so useful in your experience."

Doubtless a pretty liberal application of the mud would be required to produce the striking results Mr. Stevens observed.

In a recent note Mr. Stevens states that the mud sent by him was from a cove or pocket from the Connecticut River; the sediment is brought down in the spring freshets by the Connecticut, the cove being connected with the river by a narrow channel. There is no current in it and suspended matters are deposited at such a rate as to have reduced the depth of the water three feet since the remembrance of elderly people. There is but little matter washed in from the surrounding hills. The river at this point contains salt from the setting back of the tide during only from 4 to 6 weeks annually. Some entire years there is no salt at all in the river at this point. The quality of the sample sent was not up to the average. It should have been taken from the middle of the cove.

Mr. Stevens also remarks: "Our mill ponds a few miles back from the river, contain a rich, black mud, quite deep and with a very strong smell. It has been tried on various crops but kills everything. After being hauled and dried it turns from black to white, and puckers the mouth like alum."

The astringency here referred to is due to soluble salts of iron or alumina. Composting with a small proportion of slacked lime will decompose these salts and render the black mud a safe and serviceable application.

Sample **334** received from S. Palmer, Woodstock, consists almost entirely of sand and silica with the merest traces of fertilizing elements. Much of the silica exists in the form of the skeletons or shields of microscopic infusorial plants which are common in the water of swamps and bogs. From its light gray color it might be mistaken for marl such as sample **324**, but on mixing with acids, like vinegar, it effervesces very slightly, containing but a trace of carbonate of lime.

Peat or Swamp Muck.

Three samples sent by G. M. Dennison, Esq., of New London, are from the town of Old Saybrook.

335 and **341** from the farm of Mr. Dennison, **342** is traversed by the Connecticut Valley Railroad, near Mr. Dennison's land.

	335	341	342
Moisture,	85.25	81.40	87.22
*Organic and volatile matter,	12.52	12.49	10.42
Ash,	2.23	6.11	2.36
	100.00	100.00	100.00
Containing nitrogen,	.43	.42	.27

Reckoned in the dry state the composition is as follows:

	335	341	342
Organic and volatile,	84.87	67.08	81.53
Ash,	15.13	32.92	18.47
	100.00	100.00	100.00
Nitrogen,	2.91	2.24	2.11

The dry swamp muck is thus seen to contain 2 to 3 per cent. of nitrogen which under the action of an alkali like lime, or ammonia may become available as plant food. The organic matter itself under favorable conditions serves to liberate lime, potash, &c., from the mineral matters of the soil.

There can be no doubt that the application of this swamp muck, especially to poor, light soils, would be very serviceable. Evidently, however, the large proportion of water which the fresh muck contains makes it a nice point to decide how much can be spent upon its handling without consuming the profit of its application. The proper mode of using swamp muck is to

throw it out where it will drain and dry for some months, during frosty weather, and to employ the weathered muck as an absorbent in the stables or barn yard, or to compost it with lime, fish or animal matters yielding ammonia by their decomposition.

Catch Basin Sediments.

Two samples from the New Haven sewers sent by Prof. W. H. Brewer, after becoming air dry, or nearly so, were submitted to partial analysis with the following results:

	230	231
Moisture,	.64	7.04
*Organic and Volatile Matters,	9.29	34.52
Sand and soil,	90.07	58.44
	100.00	10.000
Containing Nitrogen,		0.42

Special Manures or Formulas for Particular Crops.

The idea that a fertilizer can be compounded which will ensure or be specially adapted to each particular crop which the farmer has occasion to produce, is a very taking one, and it is not surprising that the farmer should seek refuge from the uncertainties which environ him, by the use of fertilizers which claim to be so scientifically compounded that the chance of failure in getting a crop is reduced to the very lowest possible limit.

In the Report for 1878, some account of the history of special fertilizers and the principles on which they are compounded has been given. It is claimed, for instance, that the onion fertilizer contains the elements which must be added to the soil in order to produce a good crop of onions, and that the proportions in which they are mixed are those which the onion crop specially requires. When we have three distinct onion fertilizers, all of which make the same claim, and which differ widely from each other in the forms in which their fertilizing ingredients are present, as well as in the proportion of those ingredients, we have reason to believe that neither science nor practice has reached such a stage of intelligence as to be able to compound a fertilizer which deserves to be called an "onion fertilizer" because it is particularly adapted for onions rather than for any other crop. Such is, indeed, the fact, and the so-called "special fertilizers" may or may not be adapted to the crop whose name they bear, in general or in any particular case; may or may not be good fertilizers for common purposes; may or may not be worth commercially the money they cost.

Special Fertilizers.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Sent by
258	Stockbridge Onion Fertilizer, ...	W. H. Bowker & Co.	Hubbell & Wakeman, Saugatuck.	T. B. Wakeman, Greens Farms.
259	Mapes Onion "	The Mapes Formula and Peruvian Guano Co., New York.	Manufacturers,	" "
301	Forrester's Onion "	H. J. Baker & Bro., N. Y.	"	S. B. Wakeman, Saugatuck.
260	Stockbridge Potato "	W. H. Bowker & Co.	Hubbell & Wakeman, Saugatuck.	T. B. Wakeman, Greens Farms.
282	Forrester's Potato "	H. J. Baker & Bro.	Manufacturers.	M. S. Baldwin, Naugatuck.
304	" Potato "	H. J. Baker & Bro., N. Y.	"	S. B. Wakeman, Saugatuck.
281	" Cabbage "	H. J. Baker & Bro., N. Y.	"	M. S. Baldwin, Naugatuck.
284	" Strawberry "	H. J. Baker & Bro., N. Y.	"	" "
300	" Corn "	H. J. Baker & Bro., N. Y.	"	S. B. Wakeman, Saugatuck.
303	" Turnip "	H. J. Baker & Bro., N. Y.	"	" "
274	Stockbridge Tobacco "	W. H. Bowker & Co.	"	Chas. Sanford, Roxbury.
280	" Grass Top Dressing, ..	" "	R. B. Bradley & Co., New Haven.	Experiment Station.

Special Fertilizers.

Analyses.

Station No.	Nitrogen as Ammonia.	Nitrogen as Nitrates.	Organic Nitrogen.	Total Nitrogen.	Soluble Phos. Acid.	Reverted Phos. Acid.	Insol. Phos. Acid.	Potash.	Chlorine.	Estim. Value per ton.	Cost per ton.
258	....	....	3.91	3.91	5.73	.63	.13	8.32	13.99	$38.77	$50.00
259	3.19	....	2.51	5.70	2.05	4.15	2.53	7.47	8.44	47.26	50.00
301	5.45	....	1.91	7.36	1.73	2.76	.35	7.39	1.76	53.05	50.00
260	....	....	3.82	3.82	6.10	.92	.19	8.84	7.49	40.42	50.00
282	3.90	....	.72	4.62	.37	5.09	1.63	9.06	2.66	46.39	47.50
304	3.89	....	.88	4.77	.24	5.08	1.79	10.31	2.82	54.15	50.00
281	5.99	....	.28	6.27	3.85	2.21	.45	7.44	2.03	53.44	50.00
284	2.41	....	.60	3.01	8.22	2.12	.85	5.91	2.10	47.60	42.50
304	5.52	....	....	5.52	.44	4.86	1.46	13.09	3.53	56.37	50.00
303	6.73	....	1.18	7.91	.67	3.53	.29	8.30	2.60	59.54	53.50
274	2.85	....	2.85	5.70	.72	.71	.27	7.36	1.34	38.73	50.00
280	2.14	2.79	1.17	6.10	3.79	.30	.36	7.52	7.51	46.10	50.00
									Average, ...	48.40	49.46

The designations they bear must, therefore, be regarded as simply trade names. The full records of the results of their use would demonstrate that they fail as often as they succeed upon the crops for which they are specially designed, and that the tobacco fertilizer can be used upon the potato crop, and the corn fertilizer upon onions with as good results, in the average of a thousand cases, as if applied to the crops whose names they carry.

We observe that the three onion fertilizers in the accompanying table of analyses contain respectively 3.9, 5.7, 7.4 per cent. of nitrogen; 6.5, 8.7, 4.8 per cent. of phosphoric acid, and 8.3, 7.5, 7.4, per cent. of potash. Their estimated values are $38.77, $47.26, and $53.05 per ton. Their cost, however, is alike, namely $50 per ton in each case. Contrast with these differences the resemblance between the Stockbridge onion and the Stockbridge potato fertilizer. They contain respectively, of nitrogen 3.9 and 3.8 per cent., of phosphoric acid 6.5 and 7.2 per cent., of potash 8.3 and 8.8 per cent. If we compare the analyses above given with those reported last year, we shall see that the manufacturers do not confine themselves very strictly to their formulas, which is a significant indication of the value they attach to them.

As to the commercial value of these fertilizers we find their average cost exceeds their valuation but $1.00 per ton. We notice, however, that the value of some of them falls considerably below their cost. The following table will be useful for comparison:

		Valuation.	Cost.	Cost Exceeds Valuation.
274	Stockbridge Tobacco,	$38.73	$50.00	$11.27
258	" Onion,	38.77	50.00	11.23
260	" Potato,	40.42	50.00	9.58
280	" Grass Top Dressing,	46.10	50.00	3.90
259	Mapes Onion,	47.26	50.00	2.74
282	Forrester's Potato,	46.39	47.50	1.11
				Valuation Exceeds Cost.
301	Forrester's Onion,	53.05	50.00	$3.05
281	" Cabbage,	53.44	50.00	3.44
304	" Potato,	54.15	50.00	4.15
284	" Strawberry,	47.60	42.50	5.10
303	" Turnip,	59.54	53.50	6.04
300	" Corn,	56.37	50.00	6.37

Cost of Active Ingredients of Fertilizers during 1879.

*Organic Nitrogen.**—Fish scrap, dried blood, dried meat and tankings (the latter sometimes termed azotine) are produced in immense quantities and consumed for fertilizing purposes. They do not, however, pass to any considerable extent directly into the hands of farmers, and are not largely applied to the land in the state in which they are first produced, but they are mostly sold from the Menhaden works and slaughter houses to the compounders of superphosphates and other artificial fertilizers, where they are used to supply nitrogen to these articles, being mixed with various phosphates treated with oil of vitriol, with potash salts, etc.

The first wholesale cost of organic nitrogen is but a little more than one-half what the Station valuation allows as the fair retail price. Fish scraps, dried blood, meat and tankings are sold at wholesale at so much per "unit of ammonia," without regard to the phosphoric acid, which in dried fish amounts to 6–7 per cent. and in blood, meat, etc., ranges from less than 1 up to 10 per cent., according as more or less bone happens to be included. During the past summer the unit of ammonia† in fish, blood, etc., has been worth in New York but from $2.30 to $2.60. At $2.50 per unit of ammonia, the wholesale price of nitrogen would be 10½ cts. per pound, with, in general, several per cent. of phosphoric acid thrown in.

Now what justifies the Station in valuing this same nitrogen when it comes into our retail markets at 20 cents per pound and at the same time allowing several cents per pound for the accompanying phosphoric acid?

The Station only can answer that the retail market justifies the trade values it employs, and would, so far as many of the superphosphates and all the guanos, other than Peruvian, are concerned, justify trade values higher than it has employed.

The difference between the wholesale and retail cost of organic nitrogen is made up by various items of expense, viz: transportation; grinding and mixing with the phosphates or potash salts; bagging or barreling, storage and transportation of the superphosphate; commission to agents and dealers; losses due to sales on long credit, interest on investment, and finally profits.

* Or "potential ammonia."

† That is 20 pounds per ton for the nitrogen reckoned as ammonia, 14 pounds of nitrogen being equal to 17 pounds of ammonia.

A large expense is incurred by the makers of superphosphates in the fact that from the date their raw materials are purchased up to the time of getting pay for the finished article, six, nine or even twelve months elapse and, of necessity, the capital thus employed must draw interest from the final purchasers for whose benefit it is employed.

It is worthy the attention of consumers of fertilizers to carefully consider whether a part of these expenses may not be saved with advantage to themselves and to the manufacturers.

Many forehanded farmers are in the habit of getting their fertilizers at much less than the usual retail prices. This is done simply by making use of their knowledge of the details involved in the business of manufacturing fertilizers, a knowledge which they neglect no opportunity of increasing. The careful buyer first informs himself as to the resources of the market, second, he pays nothing more for the reputation of a fertilizer or for the claims made as to its superiority than he can satisfy himself that they are worth, but he buys with strict reference to the quantity and quality of the ingredients, and bases his opinion of the quantity and quality on the evidence of chemical analysis. Third, he prefers, if possible, and it usually is possible, to buy sufficiently pulverized raw materials and mix them himself rather than pay a profit on grinding and manipulating. Fourth, he plans and buys ahead when the market is dull. Fifth, he clubs with his neighbors to purchase in large quantity and thus secures wholesale rates. Lastly, he pays cash down and saves his interest.

We have already seen (p. 30) that the nitrogen in genuine ground bone, has cost during the season of 1879, from 11 to 15 cents per pound, according to the degree of fineness of the bone, instead of from 15 to 18 cents, the rates of the Station valuation. We have seen also (p. 34) that in damaged cotton and linseed meal, nitrogen has been bought for 13 cents per pound. Probably, however, there is no considerable or steady supply of nitrogen in this form. Undamaged cotton seed meal commands in New York, according to December quotations (1879) $24.50 per ton. If we add to this cost $3.00 per ton for transportation to Connecticut markets we have the cost of nitrogen 15.8 cents, the cost in New York being 14 cents. It is a well ascertained fact of experience that the nitrogen of cotton seed is not inferior to that of meat, blood, or ammonia-salts in average fertilizing effect. The supply of cotton seed meal is large, and although its most legitimate agricultural use is as a cattle food, it is seen to stand close to pure ground bone as a cheap source of organic nitrogen for manurial purposes.

In standard Peruvian guano (p. 25) organic nitrogen has also been furnished at 16 cents per pound.

It thus appears that while the Station has rated organic nitrogen in its most active forms at 20 cents, it has been retailed in cotton seed meal and in Peruvian guano for 16 cents, in fine bone for 15 cents, and in damaged cotton seed meal for 13 cents per pound, while its wholesale price in fish and blood has been as low as $10\frac{1}{3}$ cents.

Nitrogen in the forms of Ammonia-salts and Nitrates.—Sulphate of ammonia has not figured in our retail market. It has been quoted at $80 per ton, which would make nitrogen cost $20\frac{1}{3}$ cents per pound. The sample of standard Peruvian guano **292** which contained a good share of its nitrogen in the form of ammonia supplied it for 18 cents per pound.

The Station has no trustworthy data with reference to the present cost of *nitrates*.

Soluble Phosphoric acid.—The imported superphosphates **291** and **298** p. 25, whose value lies exclusively in their phosphoric acid which is nearly all soluble in water, furnish this ingredient for 11 cents per pound. In standard guano **292**, soluble phosphoric acid costs 10 cents per pound.

Reverted phosphoric acid.—In standard Peruvian guano this ingredient costs $7\frac{1}{4}$ cents.

Insoluble phosphoric acid.—The various grades as we have seen (p. 30) have been furnished in ground bone at reduced rates.

In the following statement we give: 1. The trade values employed by the Station during 1879, and which, as we have seen, correspond with the average retail cost of superphosphates, guanos, other than Peruvian, and "special fertilizers." 2. The cost of the fertilizing elements during 1879, as supplied in bone, Peruvian guano, cotton seed, English superphosphate and potash salts.

	1 Cost in Superphosphate, Specials, &c. Cts. per lb	2 Cost in Per. Guano, Cotton Seed, &c. Cts. per lb.
Nitrogen in nitrates,	26	?
" in ammonia salts,	22½	18
" in Peruvian Guano (organic) fine steamed bone, dried and fine ground blood, meat and fish,	20	16
" in fine ground bone, horn and wool dust,	18	15
" in fine medium bone,	17¼	14
" in medium bone,	16½	13
" in coarse medium bone,	15¾	12
" in coarse bone, horn shavings and fish scrap,	15	11
Phosphoric acid, soluble in water,	12½	11
" " "reverted" and in Peruvian Guano,	9	7½
" " insoluble, in fine bone and fish guano,	7	6
" " " in fine medium bone,	6½	5½
" " " in medium bone,	6	5
" " " in coarse medium bone,	5½	4½
" " " in coarse bone, bone ash and bone black,	5	4
" " " in fine ground rock phosphate,	3½	?
Potash in high grade sulphate,	7½	
" in low grade sulphate and kainite,	6	5
" in muriate or potassium chloride,	4½	3⅝

We see that in the second class of fertilizers the fertilizing elements have cost 20 per cent. less than in the first class. Whether the elements in the first class are, on the whole, 20 per cent. better in practical effect, as a result of better pulverization uniformity of composition, safety or convenience in application, facility or favorable terms of purchase, proportions in which the element occur, or other real or supposed advantage is a question which each purchaser must answer for himself.

The Station will retain for the coming year the valuations used in 1879. The present upward tendency of prices renders it inexpedient to make any change, and they answer perfectly for the purpose of comparing one fertilizer with another.

Inquiries and Answers Concerning the Use and Management of Manures.

Application of Stable Manure.

Director of the Experiment Station: Will you please inform me which is the better practice, to deposit manure in small heaps plowing it under directly after spreading, or to spread it broad-

cast from the cart, plowing it under when convenient? Some claim that there is more loss in the latter practice from washing and evaporation. Is it best to put it on the field in winter?

B. L. Tuttle, Milldale.

Answer.

Manure from yard or stable rarely contains such an amount of volatile fertilizing matters (carbonate of ammonia) as should deter from spreading it broad-cast on the surface when most convenient. In Report of Connecticut Board of Agriculture for 1873, p. 350, you will see from the analysis of a sample of "fresh horse manure," that 10,000 pounds of it contained but 22 pounds of nitrogen in the form of ammonia salts that could be evaporated by prolonged boiling with water, while "fresh cow manure" and "old yard manure" contained but 6 pounds and 1 pound, in 10,000 pounds respectively. Unless manure is very rich, as from grain-fed animals, and is in an active stage of fermentation, hot and smoking, and exhales a distinct smell of ammonia (hartshorn) there can be no loss on exposure, and in any case the loss will be less by spreading out thinly, than by dropping in small heaps, because spreading implies cooling and the stop of fermentation. The soil, if not mere sand, is an energetic absorber of ammonia and will not allow much to escape.

But manure, when properly handled, need not suffer any waste from evaporation. A moderate and regulated heating of fresh manure, results in the formation of *humic acid* which secures the ammonia from loss by evaporation. This moderate heating it should have before hauling out, or else it should be hauled out in cold weather before it heats at all.

The advantages of spreading manure from the wagon as it is drawn out are, a saving of labor and an even distribution of the soluble salts (ammonia, potash, phosphates, etc.), in the soil by rain. If the manure is heaped on the field and gets a heavy rain before spreading, the ground under the heaps receives an undue share of the best part of the manure.

Independently, however, of loss by evaporation, there may be circumstances when it is best to get the manure into the ground, before it has had a chance to become dry, for it distributes much better when moist and swollen with water than when "chippy" or "snuffy" in texture, and is ready at once to act as manure, whereas dry manure must recover moisture before it can be of any use.

As to spreading manure on the ground in winter, the practice works well where the ground is level or not subject to surface wash, and where the soil is deep and retentive (clay or good loam) or covered with grass or winter grain. On bare, light or leachy lands there is likely to be too much loss by percolation before the crops are ready to take up the fertilizing matters.

The surface application acts very beneficially as a mulch on lands that puddle in rain and cake in sun, and on them saves or reinforces tillage.

The application of manure is a matter in which circumstances alter cases, and in deciding on the course to pursue in every instance the circumstances should be carefully considered. The benefits of a mulch or the convenience of the farmer may often compensate for some loss of manure.

The question whether manure is better applied *fresh* or after *thorough fermentation*, is not touched in these remarks.

Bones, Raw and Boiled.

Director Experiment Station: I find that some of the bone-dust that is sold in the market has the oil extracted before grinding, and some of it is ground with the oil in it. One is quite dry and the other is wet and heavy. Is oil a fertilizer; if so, is it worth one and a half cents per pound or thirty dollars per ton or any part of that money, either in its raw state or combined with oil of vitriol as in a phosphate?

JOHN S. WELLES, Hebron, Ct.

Answer.

The pure oil, or fat of bones, is good for nothing as a fertilizer. In extracting the oil, however, by boiling, the bones lose some nitrogen in the form of gelatine (glue). The loss thus occasioned is usually not large, and is compensated by the greater ease of grinding and more ready decomposability of the boiled bones, if applied as bone-dust, or by the less grinding, less acid, and less time required to work into a superphosphate. The boiled bones come out of the boilers saturated with water. To dry them by artificial heat is costly, and to make them suitable to handle and prevent putrefaction they are often mixed with salt cake, or niter-cake (a refuse sulphate of soda), and sometimes

this cheap chemical is used in large proportion, 30 or more per cent. It thus happens that boiled bones are quite variable in value and composition, especially since more or less meat and "tankings" are mixed with the bones.

Composting Manure with Fish.

Director of Experiment Station: I have a large pile of barn yard manure rather coarse. I want to make a compost heap, and have been told if I would buy white-fish pomace or fish guano and mix them that it would be the best thing to do. Others say that the one counteracts the other. Please advise me what to do.

A. L. COLLINS.

West Meriden, May 28th.

Answer.

Fish pomace would help reduce your coarse manure and I cannot understand that one would counteract the other. The manure itself, if kept moderately moist, would soon become compost in this weather. Addition of fish pomace would hasten the operation. A little fresh slaked lime or wood ashes would also aid the process. A coating of earth, loamy or mucky, would prevent loss and regulate the heating. The fish or lime or ashes (or all three) should be well mixed with the manure.

Hen Manure—Loss by Heating—Mixing with Plaster.

Director of the Experiment Station: I send you by express a sample of hen manure, taken from my roost, for analysis.* I never have weighed any but judge that it weighs not far from 50 pounds per bushel as I ordinarily find it. I find that after standing in barrels for several weeks it sometimes appears mouldy. I have thought it to be caused by heating, if so is it an injury to the manure. Have usually sprinkled the tops of the barrels with plaster. Would not that prevent the loss of ammonia in case any was set free by decomposition?

L. H. GAGER.

Quarryville, April 14, 1879.

Answer.

The mouldiness is a sign of moderate heating and probably is accompanied by some loss of value, but unless there is a *strong*

* The analysis is given on p. 34.

odor of ammonia the loss will not be considerable. The sample has a slight smell of ammonia.

Dry plaster will not stop ammonia or prevent its loss. Plaster and *wetness* (not mere dampness) will check the escape of ammonia. Water alone, enough to fill the pores of the mass, especially if the manure be made compact, will prevent much loss in cool weather. Plaster, *in solution*, i. e., wet, arrests decomposition, as well as retains any ammonia that has been generated.

Mixing Nitrogenous Fertilizers with Ashes and Potash Salts.

Director of the Experiment Station: I am told that ashes, owing to the potash in them, when mixed with a nitrogenous fertilizer release the nitrogen. Is this true?

Is there any objection to mixing either muriate or sulphate of potash with a nitrogenous fertilizer, and if any, what? An early answer will greatly oblige,

L. S. Ellsworth, Simsbury, Conn.

Answer.

When ashes which contain *carbonate of potash* are mixed with a nitrogenous fertilizer, the effects differ according to circumstances. If the fertilizer contains its nitrogen as nitrates or in the form of organic compounds such as fish scraps, flesh, blood, or the similar albuminoids of vegetables, as in castor pomace and cotton seed, no nitrogen will be released, but when nitrogen exists in the form of *ammonia salts*, then carbonate of ammonia may escape, and will escape if the mass is moist and exposed to air and sun, so that evaporation of the water takes place. Fish scrap often contains a little ammonia salts, because it cannot always be dried before decomposition commences.

In most cases, mixture of ashes with stable manure, hen dung, guano and other animal fertilizers will occasion no serious loss if the mixture is shortly incorporated with the soil, or if the mixture be covered with a layer of loamy or peaty earth, because the quantity of nitrogen existing as ready formed ammonia in these fertilizers is usually very small; and the liberated carbonate of ammonia is perfectly retained by the moist earth. If ashes are mixed with *moist* hen dung or Peruvian guano, the smell of ammonia is at once perceived, but addition of loam speedily arrests the loss. It requires exceedingly little ammonia

to affect the sense of smell and the amount of loss is therefore easily over-estimated when judged of by the odor.

There is no objection to mixing sulphate or muriate of potash with any nitrogenous fertilizer.

Composition of Castor Pomace and Cotton Seed.

Director Connecticut Experiment Station: The Farmers and Tobacco Growers in this vicinity are interested to know the analysis of castor bean, cotton seed and castor pomace. Can you give me the proportion of castor bean and cotton seed in castor pomace, with their relative values as a fertilizer.

Yours, John N. King.

South Windsor, Ct., March 25.

Answer.

The composition of the castor bean and of cotton seed I am unable to give. In 1857–8 I analyzed samples of castor pomace and of decorticated cotton cake, and found their composition to be as follows:

	1858. Castor Pomace.	1857. Cotton seed Cake.
Water,	9.24	6.82
Oil,	18.02	16.47
Other vegetable matters,	66.60	68.91
Ash,	6.14	7.80
	100.00	100.00
Nitrogen in vegetable matters,	4.32	7.05
Phosphoric acid in ash,	2.09	2.36
Worth, calculated at present trade values, (N. 20c., P. A., 9c.)	\$21.04	\$32.45

Both these articles are simply what remains after the seeds have been crushed and subjected to extreme pressure to extract the oil. Their composition will vary according to the extent to which the oil is withdrawn, and according to the state of dryness of the cake. In case of cotton seed it makes a great difference whether the hulls are removed before expressing the oil. I believe decortication is now generally practiced, at least I have not seen of late any cake made from unhulled seed. In seven analyses of castor pomace before me, nitrogen ranges from 4 to 5.3, averaging 4.6 per cent., and phosphoric acid from 1.5 to 2.5, averaging 2 per cent. A sample analyzed at the Station last year contained 1.5 phosphoric acid, and 4.6 nitrogen. Its cost was \$22, and its estimated value was \$21.06 per ton.

Cotton seed meal has not fallen in my way of late years.* Dr. Wolff gives the average composition of this article as found in the German markets as follows:

	Unhulled.	Hulled.
Water,	11.5	12.2
Nitrogen,	3 9	6.2
Phosphoric acid,	2.8	——
Worth, at present trade values,	$20.64	$28 (?)

The absence of phosphoric acid in Wolff's statement respecting hulled cotton cake, makes the valuation uncertain by one or two dollars. Cotton seed cake and castor pomace also contain 1 to 2 per cent. of potash, not given in the above analyses, which would add a dollar or more to the valuation. I am not aware that castor pomace ever contains any cotton seed. If the two are mixed, the practiced eye would, I think, detect the fact, and chemical analysis will show the value of the mixture. You will see from the analysis above given that genuine castor pomace stands intermediate in value between hulled and unhulled cotton seed cake.

Gas Lime.

Director Experiment Station: I see nothing in your reports about lime that has been used at gas works. It kills all seed that comes in contact with it. My land is wet and needs nitrogen, I judge, as I have success with fish scraps. Is the gas lime worth anything for such land?

N. P. PERKINS.

Willimantic, April 11, 1879.

Answer.

Lime is used in the gas manufacture to purify the gas from sulphur, which it retains in the form of *sulphide of calcium.* This compound dissolves freely in water and acts like strong lye, upon vegetation. Hence the destructive effects of gas lime fresh from the purifiers. On exposure to the air the sulphide of calcium is gradually converted into sulphate of lime or "plaster." When this change is accomplished the gas lime loses its odor and also becomes tasteless. Then it may be applied as plaster or lime is applied, and is, in fact, a mixture of sulphate and carbonate of lime. The fresh gas lime would be an excellent material in the compost for dissolving or disintegrating bones, leather shavings, hair or similar matters which requires energetic

* After the above was written, the two samples **289** and **297** were analyzed. See p. 34.

agents to reduce them to a pulverulent state, admitting of easy and profitable use as fertilizers.

To prepare fresh gas lime for use as a fertilizer, it may be spread out on a layer of moist swamp muck, leaf mold, or other coarse vegetable matter, and exposed to rain and air until the odor and taste are gone. The underlying bed of muck, etc., would be advanced on its way to manure and the washings of the gas-lime saved.

By the use of lime, it often happens that nitrogen, which exists in the soil in large amount, but in a dormant or inert state, is made available to vegetation. This is especially the case in mucky and clayey lands, or where stable manure and other animal fertilizers have been copiously applied. The favorable result of a trial with a purely nitrogenous fertilizer, does not prove that the land needs nitrogen but only shows that it is relatively deficient in available nitrogen. Lime is one of the most effective agents in converting the fixed capital of the soil into floating capital to serve for the speedy realization of crops and while it may be applied on any crop, usually works best—so British practice goes to show—put on grass or winter grains as a top dressing, early in spring or late in fall, so that it may get a good distribution by rain.

Test for Adulteration of Leached Ashes.

Director of the Experiment Station: Is there a simple chemical test for the detection of coal-ashes in wood-ashes. With the present low price of coal it is quite risky to buy leached ashes.

HENRY BALDWIN.

South Canterbury, May 27th.

Answer.

Wood-ashes can be tested for coal ashes most simply by putting a few handfuls in a pan, wetting the whole thoroughly and stirring under a gentle stream of water. The fine ashes will float away in the overflowing water, leaving, in case of pure wood ashes or leached wood ashes, merely some charcoal and sand which are always present in wood ashes. If coal ashes are intermixed bits of half-burned coal and lumps of slag or clinker will also remain, which can easily be identified and, from their quantity, some idea of the extent of the adulteration can be formed. Suspected samples may be sent to the Station for further examination.

Silica in Plants.

Ever since Sir Humphrey Davy suggested that the silica which occurs in considerable proportion in the stems and leaves of grasses *might be* essential to the strength of these plants the notion has been gaining ground in the popular mind that this silica is indispensable to their strength; that its absence causes the "laying" or "lodging" of the cereals, and that the farmer must regard silica as an essential element of fertilizers and must provide for its supply to crops. The Pöpplein fertilizer which, as usual, bears high practical and pseudo-scientific endorsement, has "soluble silica" as the strong point of its "philosophy," and the questions are continually recurring—*is* silica one of the elements to be regarded in supplying the wants of crops, is it concerned in the stiffening of the stalks of grain, is it necessary to the growth of any plant, has it any use in the vegetable economy?

We have not space here to discuss these questions in detail, and in the present state of agricultural science there is little use in going beyond the solid experimental evidence which investigations have brought to bear upon them.

1. It has been conclusively shown that the strength of straw does not depend upon the silica in it, but upon the vegetable substance itself. Rapid growth produces, in presence of abundant silica a comparatively loose and weak cell tissue. Slow growth, on the other hand, yields in practically total absence of silica firm and close textured stems. Again, no fertilizing experiments in which soluble silica has been supplied have shown any benefit from the silica. Finally, there is no element so abundant in all soils, and none whose access to crops is so impossible to avoid.

2. Numerous most careful trials on the growth of plants under circumstances where silica has not, and could not, be supplied to them except in most minute quantities, have demonstrated beyond all question that silica is not necessary to the nutrition or complete development of agricultural plants.

It has lately been shown by Hohnel that the seeds of the stonecrop (Lithospermum arvense) which contain four times as much silica as wheat straw, being literally incased in a silicious coating, when grown under natural conditions, may be produced in absence of silica without any appearance of suffering from the lack of this substance.

It appears probable from recent investigations, that silica is of use in the plant, that its presence in the soil stands connected with the uniform ripening off of cereals and that its presence in their stems enables them to resist the attacks of fungi. But these points are not proved, and it is not unlikely that silica stands in relation to these consequences as a coincidence rather than as a cause.

The Strawberry Crop—Its Chemical Composition and Requirements.

Director Experiment Station: I am considerably interested in the cultivation of small fruits, particularly strawberries, and am anxious to know the best fertilizers to use. I would like to know if any analysis of the fruit has been made, and, if so, the results. I do not recollect of seeing any. Have seen it stated that about one-half of the ash of the fruit is potash, if so some manure rich in potash would seem to be the most desirable to use. Have used stable manure, but the result is not near as satisfactory as it used to be some years ago. Have a good growth of vines and fruit stalks but the fruit does not grow to ripen even when the blight does not injure them. I wish an analysis could be made so we could work intelligently about the treatment to be pursued. I am sure a large number of fruit growers will join in my request

Yours, P. A. Sears, Elmwood, Ct.

*Answer.**

I find two analyses of the ash of the fruit of the strawberry, which are as follows:

Composition of Ash of Strawberry Fruit.

	Richardson. 1848.	Pierre. 1863.
Potash,	21.07	40.3
Soda,	28.48	1.8
Lime,	14.20	16.7
Magnesia,	——	1.5
Oxide of iron,	5.89	7.8
Phosphoric acid,	13 82	11.1
Silica,	12.05	3.1
Sulphuric acid,	3.15	17.7 (Sulphuric acid, Chlorine, Carbonic acid)
Chlorine,	1.69	
Carbonic acid,		
Per cent. of ash in fruit,	3.40	4.38

When the first analysis was made, by Richardson, the processes used were far less exact than those we now possess and the analysis is doubtless incorrect in some particulars. Doubt-

* Rewritten and condensed from two articles printed in the Connecticut Farmer.

less nearly all of the so-called soda was really potash and a share of the so-called lime was magnesia. Probably also much of the silica was adhering sand.

The analysis by Pierre is not quite complete but it serves to exhibit the composition of the ash with sufficient accuracy for our present purpose.

Pierre gives a statement of the composition, exclusive of water, of the total yield *per hectare* of fruit, taken up to June 30, and of leaves, stems, and runners, taken up to the middle of August. These results calculated in pounds per acre are the following: The plants contained 62.3 per cent. of water and the vines 30 per cent.

Composition of the water-free Strawberry Crop (except roots), at the middle of August, in lbs. per acre, according to Pierre.	Plants.	Fruit.	Total.	*Composition of 3500 lbs. of moderately rotted stable manure.—Wolff.*
Organic matter exclusive of nitrogen,	4268.4	1053.5	5321.9	
Nitrogen,	88.5	16 0	104.5	17.5
Silica, Iron and Manganese Oxides,	43.3	1.5 3.8	48.6	58.8
Phosphoric acid,	35.3	5.4	40.7	9.1
Lime,	102.7	7.9	110.6	24.5
Magnesia,	16.1	.7	16.8	6.3
Potash,	89.1	19.7	108.8	22.1
Soda,	6.4	.9	7.3	6.7
Other matters,	120.9	8.8	129.7	——
Dry substance,	4770.7	1118.2	5888.9	

This investigation by Isidore Pierre was made in 1862 at Caen, in France, with the variety known as *Comte de Paris*, and is described in his *Agronomie*, T. 2, p. 156.

I calculate from Richardson's analysis (assuming what he called soda to be really potash), that 1,000 lbs. of dry (water-free) fruit, or 10,000 lbs. of fresh fruit, remove 18 lbs. of potash from the soil.

Pierre makes the export of potash in 1,118 lbs. of water-free fruit 19.7 lbs The important substances removed by 1,100 lbs. of the dry matter of strawberries are quite similar in amount to those contained in 1,000 lbs. of good timothy hay, which are: nitrogen, 15.5 lbs.; potash, 20; soda, 1.5; lime, 4.5; magnesia, 1.9; phosphoric acid, 7.2; sulphuric acid, 1.8.

If we regard the entire plant (roots excepted), the case is quite different. The foliage and stems contain, on the average, some five times as much of the various elements as the fruit alone.

Pierre reckons that the entire crop, in the three years which he says it usually occupies the ground, requires three times the quantities of the various elements given above in the "total," thus implying that the annual demand of the crop is fairly expressed by that total. If such be the case, the exhaustion consequent on taking off the entire crop is quite exactly equal to that caused by the removal of 2¾ tons of red clover hay (reckoned by Wolff's tables), except that the amount of phosphoric acid is somewhat larger in the strawberry than in the clover crop.

The quantity of fresh fruit in the above calculation (which Pierre considered to be rather below the actual produce upon his land), amounts, in round numbers, to 11,000 lbs. per acre.

These data make it nearly certain that your diminished crops are not the result of exhaustion of potash, nor of any or all the soil-elements which go to make the strawberry plant.

Certainly there can be no difficulty in restoring to the soil the substances removed by half a ton of timothy hay. Such a restoration is all that is needful if only the fruit be exported. There is no difficulty in practice in returning to the soil nearly all but the fruit, for the old vines, runners and roots are worth nothing except to plow under or put into compost, and the young plants used for propagation, carry to the new planting all they take from the old. So that except in first establishing the planting or in raising plants for market, the farm suffers no export but that of fruit, and 3,000–3,500 pounds of good stable manure is sufficient to make good what the fruit removes, as seen from the comparison in the foregoing table of analyses.

Nevertheless, the strawberry ranks as an "exhausting crop," because it ordinarily requires high manuring to make it successful. This high manuring is usually necessary, partly because the plants, in order to make their culture remunerative, must grow rapidly at the fruiting season and must therefore be highly fed with those substances which agricultural chemistry has of late years made so prominent in the minds of intelligent farmers, viz: nitrogen, potash, phosphoric acid, lime, etc. But all the manure commonly employed, can hardly be needed for that purpose. Much of it, I can scarcely doubt, finds its use in ensuring or regulating the water supply, and equalizing the termperature. It is certain that a skillful irrigation would take the place of a good share of the yard manure now generally regarded as indispensable. This fact, while it does not show that irrigation is, for us a cheaper mode of raising strawberries, does make plain that the production of fruit is not simply and solely a matter of the supply of nitrogen and of potash and like ash elements, but that other conditions connected with the so-called physical or mechanical qualities of the soil, are important for the welfare of vegetation and should be understood and kept in view by the cultivator.

In your case stable manure does not now prove so satisfactory as it formerly did. You "have a good growth of vines and fruit stalks, but the fruit does not grow to ripen even where the blight does not injure them."

In my opinion the difficulty does not lie in any deficiency of plant-food. I should say that whenever a highly developed plant is produced up to the point of fruiting, that fact demonstrates that the soil is wanting in nothing required for fruiting. The fruit contains nothing that is not needful for leaves, stems and root, and it can scarcely happen in agricultural practice, that a plant can grow up to the point of fruiting and then fail to perfect fruit on account of a cessation in the supplies of plant-food, except such as would happen from drought. When its conditions for growth are already highly favorable, any attempt to push to greater production by excess of plant-food, especially by excess of nitrogenous matters, often or generally results in development of foliage and stem at the expense of fruit, whereas whatever limit the supply of food, as drought or poor soil, tend to early, and relatively to the foliage, abundant fruiting. I am therefore inclined to believe that the soil and manure in case of your strawberries have not failed to nourish the plant sufficiently, but more likely have fed it too well.

A strawberry field highly manured, manured in fact to the verge of excess, may give a good crop when the weather is by its coolness and dryness just favorable to vegetation, but may fail of its crop when the heat and moisture at the flowering and fruiting time are excessive. What would be most favorable for foliage, stalk and runner, would be excessive for fruit. It is the equable climate of England which enables its farmers to get almost regularly heavy grain and grass crops, although they cannot raise Indian corn or grapes at all. So also the irrigated fields of Colorado and California produce large crops, sometimes

80 bushels of wheat per acre,—for the reason that the water supply is under the same control as the supply of soil-food.

Value of Sawdust as a Fertilizer and Absorbent.

Answer to a Question from the Connecticut Farmer.

Sawdust has very little, one may almost say no value as a direct source of plant food. The sawdust from pine, spruce and other resinous woods, may be a disadvantage to crops when applied fresh, in large quantities, the turpentine or resin acting as a poison.

As an absorbent, sawdust is excellent and far better than sand, because: 1st, it is, bulk for bulk, more absorbent; 2d, it is much lighter and therefore for equal cost of handling far more absorbent than sand; 3d, when saturated with dung liquor, it very readily decays in the soil or compost, and then acts in the same way as stable manure chiefly acts, viz: by improving the texture and water-storing capacity of soils, and—by the humic acid of its decay—acting as a solvent in the soil, renders the inert plant food more rapidly available to crops.

Sand, so strenuously advocated by some as an absorbent, appears to me to cost in its handling more than it can commonly be worth. Vegetable matter of some kind is the best absorbent, and can usually be got for less than the cost of carting sand in and out of the stables. Unlike sand, it has, after mixing with manure, a value of its own as an application to land, which can rarely be said of sand, in Connecticut, where putting it on the fields is, in the majority of cases, like carrying coal to Mauch Chunk. Even in clay lands, vegetable matter is a better ingredient of stable manure than sand. If otherwise, the farmer should mix sand with three or four per cent. of chemicals, representing the direct fertilizing value of stable manure, and discard dung and urine altogether.

FODDER AND FEEDING STUFFS.

Of this class of agricultural products, thirty-three (33) samples have been analyzed during the year 1879, viz:

19 of meadow hay.
1 of Hungarian millet.
9 of maize kernel.

1 of maize stover.
2 of hominy chops.
1 of linseed meal.

Before entering into details of these analyses, I copy here from former Reports some paragraphs that may serve to explain what is to follow.

Thanks to the laborious investigations carried on of late years in the Experiment Stations and University Laboratories of Europe and especially of Germany, the simple analysis of an article of cattle food may be usefully employed in fixing its place and nutritive value 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.

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 75), 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.

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

* 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 consist 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.

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	$4\frac{1}{3}$	cent.
1	"	"	fat	"	$4\frac{1}{3}$	"
1	"	"	carbhydrates	"	$\frac{9}{10}$	"

These figures express the present 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 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 $1.21 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 75 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

* 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.

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.

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 what science predicted, viz: that for each special case of animal nutrition a

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

	Water.	Ash.	Nitrogenous Matters, Albuminoid and Amides	Fiber.	N. fr. Extract.	Fat.	Digestible nutrients. Albuminoids.	Digestible nutrients. Carbhydrates incl. fiber.	Digestible nutrients. Fat.	*Nutritive Ratio.	Value. Dollars per 100 pounds.	Value. 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 73.

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 75) gives a comparison with good average meadow hay taken as 1.

Analyses of Hay.

LXI. Cut May 30, 1879, from dry upland, gravelly loam. Seeded with blue grass, white clover, timothy and red-top, and mown three years. Sent, June 27th, by A. J. Coe, West Meriden.

LXII. Cut June 5, 1879, from dry upland. Seeded with red clover. Sent by A. J. Coe.

XLVIII. Cut first week in July, 1877. From dry, rich upland, plowed about forty years ago. Consists of fine grasses. Large amount of Kentucky blue-grass (*poa pratensis*), and timothy (*phleum pratense*). Considerable red and white clover, a little red top (*agrostis*). Sent by T. S. Gold, West Cornwall.

LXVII. Yellow clover and timothy, with some *agrostis* and *poa compressa.* Cut July 1, 1877. Sent by S. A. Smith, Cheshire.

LII. Cut first week in August, 1877, from intervale meadow, sometimes overflowed. Mostly timothy and red top, some red clover and white weed (*chrysanthemum vulgare*).

LX. Timothy.* Cut June 23, 1879, from meadow never plowed. The growth was very rank, the stalks averaging 4–4½ feet high. Sent by A. J. Coe.

LVII. Cut July 1, 1878, when about one-fourth part was in bloom. Very heavy rank grass. Almost all timothy, a very little Kentucky blue-grass. From J. W. Sanborn, N. H.

* The grass of this sample was not named by Mr. Coe when sent, but at the Station was pronounced to be timothy, and was so designated in Bulletin 34. Mr. Coe believes it to have been some other grass, but the small sample was all pulverized for the analysis, and its kind must remain in doubt.

LVIII. Cut July 11, 1878. A half or more had ripened enough so that the seeds would scatter out a little in handling. The grass was of the same species as LVII.

LVII and LVIII, were both sent by J. W. Sanborn, Esq., Hanover, New Hampshire, from the Agricultural College farm, and were cut from the driest part of a fine heavy clay, yielding two, and under good culture, three to four tons of hay per acre.

LXIV. Timothy hay. The first cut after seeding. Yield 2¼ tons per acre. Height, five feet. Cut July 20–25, 1877. From S. A. Smith, Cheshire.

L. Cut last week in July, 1877, from rich, moist upland. Mostly timothy. Some red-top. From T. S. Gold, W. Cornwall.

LIX. Cut June 17, from dry upland. Seeded with timothy and red-top and mown three years. From A. J. Coe, W. Meriden.

LXIII. Cut June 18, from moderately dry irrigated intervale. Seeded with timothy and red-top and mown four years. From A. J. Coe, W. Meriden.

LXIX. Timothy and red-top. Second cut from new ground. Cut July 20, 1877. From S. A. Smith, Cheshire.

LI. Cut last week in July, 1877, from moist upland. Mostly red-top and timothy. From T. S. Gold, W. Cornwall.

XLIX. Cut second week in July, 1877, from rich, moist upland. Mostly timothy and Kentucky blue-grass. Some red-top. From T. S. Gold, W. Cornwall.

LXVI. From old meadow, 1½ tons per acre, poor feed, rather run out. Cut fourth week in June, 1877. From S. A. Smith, Cheshire.

LXVIII. From old meadow in grass for 10–15 years. Cut first week in July, 1877. From S. A. Smith, Cheshire.

LIII. Cut about the middle of August, 1877, from wet lowland, sometimes overflowed. Contains a good deal of sedge grass (*carex sterilis*), and some fern. Other weeds such as *brunella vulgaris.* Very little timothy. From T. S. Gold, W. Cornwall.

LXV. Swamp hay mostly, some species of sedge (*carex*), some fern, *equisetum*, etc. "Young stock eat it and do well, old cattle used to better, don't." From S. A. Smith, Cheshire.

LV. German golden millet. Grown on gravelly loam which had received no manure for two years previous. Estimated yield 1½ tons per acre. Sent by L. S. Wells, New Britain.

LIV. Maize stover. Variety, white flint. From T. S. Gold, W. Cornwall.

In the following tables of the composition and probable digestibility of these samples, the analyses have all been reduced to a uniform water-content of 14.3 per cent. in order to render them comparable with each other, and with the average of German analyses as given on p. 75.

The digestible nutrients have been calculated from the results of the many digestion experiments made elsewhere on hays of similar composition, and while making no claim to strict accuracy suffice to give an idea of the amounts of really nutritive matters which these feeding stuffs probably contain.

Mr. Gold states that the value of his samples, as judged practically, stands in about the following order: XLVIII, XLIX, L, LI, LII, LIII.

The crops were light, owing to the weather of 1877. XLVII and LIII yielded not over one ton per acre. The others yielded one and a half to two tons. All were harvested at what was regarded as the right time or stage of growth except LIII which was let stand too long. The hay was of very good quality, as compared with that of former years, but contained a less proportion of timothy.

The two samples sent by Mr. Sanborn have been employed in some interesting feeding trials, the results of which he has published.*

The six samples supplied by Mr. S. A. Smith, of Cheshire, were kindly selected by that gentleman who has had extensive experience in the purchase and sale of hay as fair representatives of the various grades of hay raised in Cheshire. The yellow clover is, however, not common.

The samples sent by Mr. Coe were intended to exhibit the effect of "the time of cutting" on the quality of hay. Mr. Coe considered them all cut in proper time except LX which was too mature.

* Farm Experiments at the New Hampshire College of Agriculture, by J. W. Sanborn, Superintendent.

ANAYSES OF HAY AND STOVER.

Station No.	Water.	Ash.	Total Nitrogenous Matters, Albuminoids and Amides.	Albuminoids.	*Amides.	Fiber.	N. fr. Extract.	Fat.	Sent by	When Cut.	Received at Station.
					Hay Containing Clover.						
LXI,	14.30	5.30	14.42	11.56	2.86	19.66	43.23	3.09	A. J. Coe,	May 30, 1879.	June 27, 1879.
LXII,	14.30	6.49	11.62	9.38	2.24	23.06	42.07	2.46	" "	June 5, "	" 1879.
XLVIII,	14.30	5.10	10.60	8.69	1.91	24.90	42.40	2.70	T. S. Gold.	July 1–8, 1877.	November 15, 1877.
LXVII,	14.30	4.74	9.06	7.50	1.56	28.19	42.21	1.50	S. A. Smith.	" 8–15, "	" 28, "
LII,	14.30	5.10	9.00	7.25	1.75	24.90	44.90	1.80	T. S. Gold.	August 1–8, 1877.	" 15, "
					Hay consisting mostly of Timothy.						
LX,	14.30	3.27	4.88	3.69	1.19	32.81	43.29	1.45	A. J. Coe.	June 23, 1879.	June 27, 1879.
LVII,	14.30	4.10	6.20	5.38	0.82	25.30	48.10	2.00	J. W. Sanborn.	July 1, 1878.	February 10, 1879.
LVIII,	14.30	3.80	5.30	4.75	0.55	27.50	47.20	1.90	" "	" 11, "	" 10, "
LXIV,	14.30	4.38	5.57	4.44	1.13	29.48	45.19	1.08	S. A. Smith.	July 20–25, 1877.	November 28, 1877.
L,	14.30	4.60	6.90	5.50	1.40	26.80	45.40	2.00	T. S. Gold.	" 21–28, "	" 15, "
					Hay consisting mostly of Timothy and Red-top.						
LIX,	14.30	5.57	7.85	6.69	1.16	24.72	45.08	2.48	A. J. Coe.	June 17, 1879.	June 27, 1879.
LXIII,	14.30	6.86	8.97	6.88	2.09	28.45	39.20	2.22	" "	" 18, "	" " "
LXIX,	14.30	4.81	6.02	5.31	0.71	26.54	46.88	1.45	S. A. Smith.	July 20, 1877.	November 28, 1877.
LI,	14.30	4.90	7.50	6.25	1.25	26.30	45.30	1.70	T. S. Gold.	" 21–28, 1877.	" 15, "
					Hay consisting mostly of Timothy and Blue Grass.						
XLIX,	14.30	4.70	7.00	5.56	1.44	26.90	45.40	1.70	T. S. Gold.	July 7–14, 1877.	November 15, 1877.
					Hay of mixed Meadow Grasses.						
LXVI,	14.30	4.23	7.02	6.38	0.64	27.82	45.00	1.63	S. A. Smith.	June 21–28, 1877.	November 28, 1877.
LXVIII,	14.30	4.56	6.50	5.69	0.81	25.89	47.33	1.43	" "	July 1–7, "	" " "

Station No.	Water.	Ash.	Total Nitrogenous Matters, Albuminoids and Amides.	Albuminoids.	*Amides.	Fiber.	N. fr. Extract.	Fat.	Sent by	When cut.	Received at Station.
Swamp Hay.											
LIII,	14.30	5.40	6.70	5.69	1.01	26.20	46.10	1.30	T. S. Gold.	August 15, 1877.	November 15, 1877.
LXV,	14.30	8.56	7.27	6.31	0.96	23.22	44.49	2.16	S. A. Smith.	August 7–14, 1877.	" 28, "
Millet.											
LV,	14.30	6.54	6.29	3.81	2.48	27.93	43.61	1.33	L. S. Wells.		October 24, 1877.
Stover.											
LIV,	14.30	4.43	6.45	3.94	2.51	28.33	45.00	1.49	T. S. Gold.		November 20, 1877.

Averages of German Analyses.

Water.	Ash.	Total Nitrogenous Matters.	Albuminoids.	Amides.	Fiber.	N. fr. Extract.	Fat.		Quality.
14.30	5.00	7.50	....	....	33.50	38.20	1.50	From Mentzel & v. Lengerke's *Landw. Kalender*, for 1880.	Poor.
14.30	5.40	9.20	....	....	29.20	39.70	2.00		Fair.
14.30	6.20	9.70	....	....	26.30	41.40	2.50		Good (Average).
15.00	7.00	11.70	....	....	21.90	41.60	2.80		Very good.
16.00	7.70	13.50	....	....	19.30	40.40	3.00		Extra.

* More properly non-albuminoid nitrogenous matter.

Digestible Nutrients of Hay and Stover.

Station No.	Albuminoids.*	N. fr. Extract.	Fat.	Nutritive Ratio.	Quality.
LXI,	9.23	41.54	1.48	1:4.9	Extra.
LXII,	7.44	42.95	1.18	1:6.2	very good.
XLVIII,	6.78	48.35	1.30	1:7.6	Average.
LXVII,	5.06	42.68	0.72	1:8.8	Fair.
LII,	5.04	42.48	0.86	1:8.8	Average.
LX,	2.54	45.11	0.70	1:18.4	Poor.
LVII,	3.47	44.72	0.96	1:13.5	Average.
LVIII,	2.96	45.40	0.91	1:16.1	Fair.
LXIV,	2.90	44 35	0.52	1:15.7	Fair.
L,	3.66	43.88	0.96	1:12.6	Average.
LIX,	4.40	42.48	1.19	1:10.3	Average.
LXIII,	5.02	40.92	1.07	1: 8.6	Fair.
LXIX,	3.39	44.59	0.70	1:13.7	Average.
LI,	4.20	43.53	0.82	1:10.8	Average.
XLIX,	3.92	43.93	0.82	1:11.4	Average.
LXVI,	3.69	43.21	0.74	1:12.2	Fair.
LXVIII,	3.67	44.49	0.60	1:12.5	Average.
LIII,	3.75	43.97	0.62	1:12.1	Average.
LXV,	4.08	41.24	1.04	1:10.7	Average.
LV,	3.27	42.52	0.64	1:13.5	[Fair.]
LIV,	3.45	43.60	0.72	1:13.1	[Fair.]
German Averages.	3.40	34.90	0.50	1:10.6	Poor.
	4.60	36.40	0.60	1: 8.3	Fair.
	5.40	41.00	1.00	1: 8.0	Good (Average).
	7.40	41.70	1.30	1: 6.1	Very good.
	9.20	42.80	1.50	1: 5.1	Extra.

*Including, probably, all the "Amides."

It is thought by some authorities, that hay deteriorates on long keeping to a degree that affects its chemical composition. Although such a fact does not appear to be fully authenticated, it is possible that Mr. Gold's samples, which were received at the Station in November, 1877, and were analyzed eighteen months after cutting, are not as rich nutritively as when new. The same possibility of deterioration applies to the samples furnished by Mr. Smith. Mr. Sanborn's samples cannot have suffered seriously in this way from keeping. It is, however, a question whether the samples fairly represent the crops. The samples were mostly quite small and as hay, in the very brittle condition which it assumes in the driest weather of New England, easily loses some of its more tender and better parts on handling, it is possible that the care taken to select an average sample may have defeated its purpose to a serious degree.

The most obvious result of the above figures is that the New England samples are of inferior quality as compared to those of Germany and Austria which have been analyzed in the European Experiment Stations.

Only three of these New England hays, viz: LXI, LXII and XLVIII, contain more nitrogenous matters than the German average and these three contain a decided admixture of clover. Eleven out of the nineteen are below the German "poor" in this respect.

It is, however, to be remarked that the proportions of fiber in most of the New England hays are less than in the German. Not one of the former contains as much fiber as the poor German hay.

It has been observed in digestion experiments that the coarser and more woody a hay or similar fodder becomes, the less digestible it is, and that the digestibility is in a much less degree affected by a deficiency of albuminoids than by an excess of fiber, and since the grading of hay adopted by Wolff has reference mainly to the relative digestibility we are justified in the following classification of these New England hays, although the percentage of nitrogenous matters in many of the samples would give them a lower place in the scale than that here assigned to them.

Extra.	Very Good.	Average.	Fair.	Poor.
LXI.	LXII.	XLVIII.	LXVII.	LX.
		LII.	LVIII.	
		LVII.	LXIV.	
		L.	LXIII.	
		LIX.	LXVI.	
		LXIX.	[LV.]	
		LI.	[LIV.]	
		XLIX.		
		LXVIII.		
		LIII.		
		LXV.		

Whether the striking difference between these hays and those of Germany lies mainly in difference of climate, of herbage or of soil, or is attributable in part to each of these causes, further inquiry must decide.

In respect to time of cutting, the early-cut samples are in general the best; of them all, however, only two, viz: LIII and LX, were specially stated by the gentlemen who supplied them to have been harvested too late.

The two samples sent by Mr. Sanborn were used by him in a short comparative trial, the object of which was to observe their relative feeding value. This experiment is noticed on a subsequent page.

The publication of the analyses of the samples from Messrs. Gold and Sanborn and the remarks upon them in Station Bulletin 23, called forth some correspondence on the subject of early *vs.* late cutting, the substance of which here follows:

West Meriden, Ct, *April* 21, '79.

Prof. S. W. Johnson—Dear Sir:—In the comments appended to your recently published "Analyses of Hay," you say: "The early cut is scarcely better than the late mowed, as shown by analyses, and the feeding records give no greater actual value to the former, while the early cutting is reckoned to diminish the crop on seventy-five acres some twenty tons.

While not doubting the correctness of the first proposition in its application to the particular samples examined by you, I think most readers will draw from it an inference in regard to the proper period of growth at which to cut hay, which will be to them a most injurious error. Therefore I feel constrained to write you a few words on the subject, in hopes to promote further discussion and investigation of a matter of great importance to New England farmers.

That portion of the above quoted remark relating to loss in weight by "early" cutting purports merely to give information as you have received it, as an "estimate," without vouching for its accuracy. It is a subject upon which accurate knowledge is very desirable, but, from obvious reasons, difficult to obtain. I know of but one attempt to test by actual experiment, by weighing the hay from portions of a field cut at different stages of growth, and the conclusion of this farmer was that he got more weight of hay from timothy cut when heading than from any cut later. But, of course, in this rough experiment, there could be no accuracy as to the relative productiveness of the different plats of ground, or degree of dryness of the cured product.

But in regard to the inference from your remarks in reference to the comparative nutritive value of early and late cut hay for animals giving milk:—speaking from an experience of many years wintering twenty to forty cows in milk, and some experience with sheep suckling lambs, I should say that every sample examined by you was cut so late as to be practically spoiled for the purpose in question. Timothy is the principal grass, and I have been long satisfied that timothy cut after July 1, in this latitude should never be fed to milch animals.

I am now feeding 20 cows in milk, and 190 ewes with lamb, besides other stock, and having insufficient hay, am buying for the stock at one barn.

I buy the earliest cut I can get, the timothy not being past bloom, but had no sooner changed from my own, cut earlier, than the cows fell off most markedly in their milk, despite full feeding with grain and roots. Clover cut just after heading and before blossoming, will make more milk than any other feed, if not dried too much in the sun.

For feeding any stock whatever, I will pay more for an acre of grass, of any kind, cut about heading time, than for the same cut at any subsequent period, but especially for feeding milch animals. Animals are excellent judges of nutritive values, and if allowed access to such hay would reject any of the samples you have examined, as decisively as you would so much sticks or brush-wood, and for the same reason. If you wish, I would like to present you, some time, samples of really good hay,* to ascertain whether as good cannot be made here as in Germany, and whether the results given by the chemical apparatus in your laboratory will compare with those given by that in the animal system.

* The samples LIX to LXII were sent by Mr. Coe subsequent to his writing the above letter.

Very respectfully yours,

A. J. Coe.

P. S.—I wish the method of curing by carting to the barn green, and heating in the mow, could be thoroughly tested. So far as I have tried it, I am pleased. Theoretically it would seem that there must be loss of albuminoids in the process of fermentation, but cows fed on it give a great deal of milk, consuming a comparatively small quantity.

Answer.

A. J. Coe, Esq., West Meriden:—In a letter from Mr. Sanborn, who sent the New Hampshire samples, dated April 25, he states that the loss of 20 tons total yield, on 75 acres, by early cutting, as compared with later, was accurately determined by weight and measure. He states further that the season, as a whole, was favorable to an average growth of hay. I quite agree with you that, in general, early cutting gives better hay pound for pound than late cutting. I also agree with you that all the samples reported in bulletin 23 (those of Messrs. Gold and Sanborn) were either late cut or no better than late cut, judged in respect to their quality (XLVIII possibly excepted). I agree with you also that an acre of grass cut about heading time is worth more than cut at any subsequent period. The gain of quantity got by letting grass stand after heading is more than compensated by loss of quality. Mr. Sanborn's results might appear, however, to show that under some circumstances a larger gain of quantity —20 tons on 75 acres—is attained without much loss of quality. Mr. Sanborn says "the yield of grass on 75 acres is two tons, and with good culture three to four tons per acre." The low quality fairly indicates a low yield, and if we assume the crop of July 1 to have been two tons (4000 lbs.) per acre, then the gain by growth between July 1 and July 11 being 20 tons for 75 acres, the crop of July 11 would have weighed $2\frac{4}{15}$ tons (4,533 lbs.) per acre. Multiplying these estimated figures by the percentages of the analyses given in the Station Bulletin 23, we obtain the following average yield of food elements.

Hay from N. H. College Farm.

	LVII. Cut July 1. lbs. per acre.	LVIII. Cut July 11. lbs. per acre.
Water,	572	648
Ash,	164	172
Albuminoids,	248	240
Fiber,	1012	1247
N. fr. Extract,	1924	2140
Fat,	80	86
	4000	4533

The actual yield, reported by Mr. Sanborn after the above was written, was, for the early cut, 3,444 lbs. at housing and in good order, for the late cut, 4,263 lbs. at housing. When fed, the early cut weighed 2,760 lbs., having shrunk 19.8 per cent., and the late cut weighed 3,538 lbs., having shrunk 17 per cent. The loss of crop per acre, by early cutting, was accordingly 819 lbs. at housing, and 778 lbs. at time of feeding.

Calculating from the weights observed at time of feeding, we find the actual difference greater than above supposed, viz:

	LVII. lbs. per acre.	LVIII. lbs. per acre.
Water,	247.57	328.68
Ash,	120.06	142.94
Albuminoids and amides,	181.06	199.19
Fiber,	743.82	1029.20
N. fr. Extract,	1409.53	1765.46
Fat,	57.96	72.53
	2760.00	3538.00

It is seen from the above figures that assuming a difference of 20 tons for 75 acres, as we may infer Mr. Sanborn found in gross, there has been no gain, but rather a loss of albuminoids between July 1st and 11th, a loss perhaps explained by the fact that in the later cut hay "a half or more had ripened so that the seeds would scatter out a little on handling."

Basing the calculation on the actual crops from the small plats there is found to be a loss of 18 lbs. or about 9 per cent. of albuminoids as the result of early cutting.

It is, doubtless, the fact that when the grass ripens to the point of dropping its seeds, that the crop contains, if the seeds do not drop, more nitrogen than it did ten days earlier, and a considerable part of that increase is in the seeds, but the seeds of grass are so small and hard as largely to escape mastication and

digestion, and most of their nitrogen is practically lost for feeding purposes unless the feed is *cooked*.

Again it is perfectly well settled that the digestibility of albuminoids decreases as the grass grows old, and is relatively less in grass containing a low percentage of them and a high percentage of fiber.

Both the samples are deficient in digestible albuminoids, and that deficiency is in no way helped out by increase in the quantity of other substances.

In the building of a wooden house there is required a certain proportion of wood, and a certain relative quantity of nails. No amount of nails will supply a deficiency of wood, and no amount of wood can *economically* take the place of nails. For milk cows, the proportion of digestible albuminoids should compare with that of other digestible food elements, as 1 to 6, and if the proportion is 1 to 12 as in Mr. Sanborn's grass, the greater quantity of food don't help to make more milk, because the due proportion is lost. When albuminoids are deficient, their quantity limits the value of the ration.

It would thus appear from these calculations that Mr. Sanborn's crop of July 11th was not as good as or a little better than the crop of July 1st, although it weighed one quarter ton more per acre, a conclusion exactly like that which you have drawn from your experience. There is of course some uncertainty attached to calculations of this kind. Their validity implies that the samples analyzed accurately represent the crops. It is however very difficult to sample the grass from a field of many acres and the above conclusions, so far as they are based on the analyses must not be accepted too literally. Carefully conducted experiments on the composition and yield of grasses made in Germany show that there may or may not be a considerable increase in the acreage amounts of albuminoids in the harvested crops during the period between heading and ripening, depending upon the weather and the supplies of plant-food in the soil, so that the quality of grass does not always stand immediately related to the time of cutting, but is affected by other conditions which we lose sight of, or usually "lump together" in the expressions "early" and "late."

Maize Kernel.

The nine samples of maize whose analyses are given below, were all raised in the towns near New Haven in 1878, were from large and well ripened ears, and represent Southern Connecticut Corn in its best development. Of these, all but two are Dent Corn, i. e., the apex of each kernel is sunken or shriveled in curing. The climate of Southern Connecticut admits of cultivating these western varieties to advantage, or rather, perhaps, developes varieties that are to a degree intermediate between the native flint and the western and southern Dent.

XXXIX. Coe's Prolific, Dent, crop of 1878. From W. W. Fowler, Guilford.

XL. Old Fashioned Yellow, Flint, crop of 1878. From Bethuel Brockett, North Haven.

XLI. Benton, Dent, crop of 1878. From G. W. Benton, Guilford.

XLII. Mammoth Sweet, crop of 1878. From S. D. Woodruff, Orange.

XLIII. Scioto, Dent, crop of 1878. From Rufus Leete, Guilford.

XLIV. White Ohio, Dent, crop of 1878. From F. Johnson, Branford.

XLV. Wisconsin, Dent, crop of 1878. From Rufus Leete, Guilford.

LXX. White Prolific, Dent, crop of 1878. From G. W. Bradley, Hamden.

LXXI. Extra Early Adams, Dent, crop of 1878. From E. B. Clark, Milford.

Analyses of Maize Kernel.

Air Dry.

	XXXIX	XL	XLI	XLII	XLIII	XLIV	XLV	LXX	LXXI
Water,........	9.55	10.58	10.70	9.48	10.43	9.70	9.72	10.14	10.94
Ash,.........	1.45	1.43	1.57	1.93	1.53	1.79	1.56	1.67	1.75
Albuminoids,..	10.13	9.81	9.97	12.32	9.25	11.28	11.60	9.19	10.81
Fiber, ...	2.19	1.39	1.36	2.75	1.80	1.73	2.06	1.34	1.48
Carbhydrates,.	72.70	72.11	71.40	66.09	72.98	71.30	70.17	73.38	70.21
Fat..........	3.98	4.68	5.00	7.48	4.01	4.20	4.89	4.28	4.81

Weight of Corn and Cob, Cured.

Corn, weight in grams, ...	454	467	509	424	518	467	574	344	336
Cob, weight in grams, ...	98	94	84	116	78	111	103	57	89
Relation of cob to corn, ...	1:4.6	1:4.9	1:6.0	1:3.6	1:6.6	1:4.2	1:5.5	1:6.0	1:3.8
Cob express'd in per ct. of corn.	21.6	20.1	16.5	27.3	15.1	23.8	18.0	16.8	26.5

Composition of Maize Kernel.

Water-Free.

	Coe's Prolific.	Old fashioned Yellow.	Benton.	Mammoth Sweet.	Scioto.	White Ohio.	Wisconsin.	White Prolific.	Early Adams.
Ash,.......	1.60	1.60	1.76	2.13	1.71	1.88	1.73	1.86	1.97
Albuminoids,	11.21	10.99	11.18	13.60	10.31	12.50	12.85	10.23	12.14
Fiber, ...	2.42	1.55	1.52	3.04	2.01	1.92	2.28	1.49	1 66
Carbhydrates	80.36	80.63	79.94	72 97	81.49	78.95	77.72	81 66	78.83
Fat, ...	4.41	5.23	5.60	8.26	4.48	4.65	5.42	4.76	5.40
	100.00	100.00	100.00	100.00	100.00	100.00	100 00	100.00	100.00

Digestible Nutrients, Etc , of Maize Kernel, in per cent. of Air Dry Substance.

Albuminoids,	9.42	9.23	9.39	11.42	8.66	10.50	10.79	7.35	8.73
Carbhydrates	78.40	76.36	75.70	69.72	77 34	74.92	73.90	66.19	63.97
Fat, ...	3.35	3.97	4.26	6.28	3.41	3.53	4.12	3.10	3.51
Nutritive Ratio,.......	1:9.2	1:9.3	1:9.2	1:7.5	1:9.9	1:7.9	1:7.8	1:10.1	1:8.3
Calculat'd val. per 100 lb.,	$1.26	1.26	1.27	1.39	1.22	1.28	1.31	1.05	1.11

The impression prevails that there are considerable differences in the quality of different varieties of Indian corn. Some of the popular ideas are certainly erroneous as will appear from the examination of the seventeen analyses made in the laboratory of this Station, thirteen executed at the Agricultural College of Michigan, under the direction of Prof. Kedzie, seven made by Dr. Atwater of Middletown, and twenty-eight by Dr. Collier, of the U. S. Department of Agriculture—a total of 65 analyses.

These analyses lead to the following conclusions, viz:

1. From the point of view of chemical composition, there are, broadly speaking, two kinds of Indian corn, the common and the sweet.

2. The average composition of these two kinds in the water-free condition is as follows:

Average Composition of American Maize.—Water-Free.

	SWEET av. of 11 analyses.	COMMON. av. of 52 analyses.
Ash,	2.1	1.7
Albuminoids,	13.2	12.0
Fiber,	2.3	1.9
Carbhydrates (starch, sugar, gum),	73.5	78.7
Fat,	8.9	5.7
	100.0	100.0

The greater richness of sweet corn in albuminoids and fat is very decided and indicates a higher nutritive value than that of common corn.

The sweet corn contained on the average 8.6 per cent. of water and the common contained 10.8 per cent., but the samples were unequally dried, and the analyses probably do not show the proportions of water that exist in corn in bulk as found in the crib or in market.

3. The range of variation in the several ingredients is shown by the following statement of the lowest and highest percentages as found in these analyses:

Range of Composition of American Maize.

	Sweet.	Common.
Ash,	1.6 — 2.4	1.3 — 2.0
Albuminoids,	10.2 — 15.9	8.7 — 14.4
Fiber,	2.6 — 3.0	0.3 — 3.0
Carbhydrates,	69.6 — 79.5	75.2 — 82.2
Fat,	5.8 — 10.2	4.4 — 7.8

Sweet corn in all the analyses contain more ash, more fat and less carbhydrates than common corn.

4. Flint and dent corns have, in the gross average, practically the same composition as will be seen from the comparison of 31 flints and 19 dents.

Average Composition of Flint and Dent Corn.

	Flint.	Dent.
Ash,	1.7	1.7
Albuminoids,	12.1	11.8
Fiber,	1.7	2.0
Carbhydrates,	78.7	79.0
Fat,	5.8	5.5
	100.00	100.00

The average water content of flint corn was found to be 10.6 per cent., that of dent corn 11.1 per cent.

5. Western corn has also, in the gross average, about the same nutritive value of Eastern corn. Below is the average composition of 29 samples of corn raised at the East, and 15 samples of corn raised at the West.

Average Composition of Common Eastern and Western Corn.

	Eastern.	Western.
Ash,	1.7	1.6
Albuminoids,	12.0	12.1
Fiber,	1.6	2.5
Carbhydrates,	79.2	78.1
Fat,	5.5	5.7
	100.0	100.0

The Eastern corn averaged 10.7 per cent. of water, and the Western 13 per cent. To institute a strict comparison any *constant difference* in water content should be taken into the account. All the foregoing comparisons refer to the perfectly-dried, or water-free corn.

It should be said here, that the popular idea that western corn is inferior to eastern corn, is probably correct, if by "western corn" is meant the corn as it comes in bulk from the west to be ground for feed.

The samples of western corn whose average composition is given above were no doubt taken from the field or barn to the laboratory, and had been properly cured and stored. But when corn is raised on a large scale for market at the west, it cannot be as carefully cured as with us. Many times it cannot be put under cover at all, but is stacked in the field, and necessarily deteriorates, from exposure to the weather. A single analysis of such corn (No. 4 of table at end of Report) made by Dr. Atwater, of Middletown, gave the following result—calculated on a water-free basis:

Ash,	1.4
Albuminoids,	10.3
Fiber,	1.9
Carbhydrates,	81 9
Fat,	4.5
	100

It will be seen that it has one and seven-tenths per cent. less albuminoids and one per cent. less fat than the average of eastern corn, and two and seven-tenths per cent. more of carbhydrates, while ash and fiber are approximately the same. Dr. Atwater says the sample contained unsound kernels, bits of cob, fine prairie soil, and other refuse.

6. Unripe maize so far as its composition is illustrated by three analyses of the same kind of sweet corn, is richest in albuminoids—the rarest and most costly element of food.

The samples of sweet corn, harvested by Mr. Gold, Aug. 9, Aug. 25 and Sept. 25, 1877, respectively, had the subjoined composition:

	Aug. 9.	Aug. 25.	Sept. 25.
Water,	10.1	10.1	9.5
Ash,	2.2	2.1	2.1
Albuminoids,	14.5	15.3	14.4
Fiber,	2.6	2.5	1.9
Carbhydrates, starch, etc.,	62.7	61.8	63.0
Fat,	7.9	8.2	9.1
	100.0	100.0	100.0

The albuminoids found in the earliest are indeed scarcely more than those of the latest corn. But the earliest cut sample was very small and immature, and was shelled from a cob that contained 8.6 per cent. of albuminoids, while the others were from cobs of 3.0 and 2.7 per cent. albuminoids, respectively. The comparison is therefore properly between the corn of Aug. 25 and that of Sept. 25.

The mature corn contains a less percentage of albuminoids than the immature, because, in the later stages of growth, starch and sugar, as well as fat (oil) are formed in the seed at a more rapid rate than albuminoids. The percentage of fat increases from 7.9 to 9.1.

7. The ripe grain, as a crop, contains absolutely more of every ingredient than the unripe. The yield of vegetable matter per acre in the three crops just instanced is not known; but the relative yield of the two later crops is as follows per 1,000 pounds of total harvest, reckoned water-free:

	Corn.	Cob.	Fodder.	Total.
August 25,	304	88	608	1,000
September 25,	356	94	550	1,000

Doubtless 1,000 pounds of the dry matter of the standing crop on Aug. 25 would have increased to 1,250 pounds, more or less, by Sept. 25, so that the acreage yield of total vegetable substance, as well as the relative proportion of grain, would increase

to the time of full ripeness, while the cob and stover would increase absolutely, but not so rapidly as the grain, and relatively to grain would appear to diminish. In fact the grain increases at the expense of stover and cob as well as of roots, while the entire plant gains by growth as long as the leaves are green and unshriveled.

Hominy Chops.

LVI. Sent by C. P. Augur, Whitneyville.

LXXII. Sent by J. J. Webb, Hamden. Sold by D. B. Crittenden, New Haven.

	LVI.	LXXII.
Water,	13.53	11.56
Ash,	2.44	2.67
Albuminoids,	9.50	9.82
Fiber,	3.19	4.79
N. fr. Extract,	62.02	62.58
Fat,	9.32	8.58
	100.00	100.00

Digestible Nutrients.

	LVI.	LXXII.
Albuminoids,	7.58	8.25
Carbhydrates,	59.48	60.60
Fat,	7.08	6.52
Nutr. Ratio,	1:9.6	1:9.2
Estimated value per 100 lbs.,	$1.17	$1.19
Cost per 100 lbs.,	$1.00	$1 20

The above is evidently a bye-product of the hominy manufacture, a process which consists in coarsely crushing the kernels of white flint maize and separating the flinty parts from the mealy and soft portions. The former are nearly free from fat, and after drying constitute the hominy of the grocer, which may be preserved without alteration for a long time. The latter, including the chits and bran, probably make this "hominy chop." The large content of fat comes from the chit and from its presence this substance easily spoils and becomes rancid. The nutritive ratio and money value do not essentially differ from those of entire maize, but its softness and fineness are very favorable to ready and complete digestion.

Yaryan's New Process Linseed Meal.

LXXV. Sent by J. J. Webb, Hamden, Nov. 14, '79. Sold by John Kerley, New Haven.

Water,	10.76
Ash,	6.71
Albuminoids,	35.64
Fiber,	8.86
N. fr. Extract,	35.22
Fat,	2.81

Digestible Nutrients.

Albuminoids,	29.94
Carbhydrates,	31.02
Fat,	2.56
Nutr. Ratio,	1:1.2
Estimated value per 100 lb.,	$1.69
Cost per 100 lb.,	$1.50

This sample of linseed meal agrees closely in composition with the similar article that is common in foreign markets. It differs from the linseed meal formerly made, in the fact that the oil is much more completely removed, being reduced from 10 or more per cent. to less than 3. This reduction of oil is accompanied by a corresponding increase of albuminoids, &c.

Rations for Farm Animals.

The matter of the following four pages is here reprinted because the Board of Control of the Station desires to induce our farmers to experiment on the newer modes of cattle feeding, and because the previous Reports were issued in small editions.

In the following tables of Feeding Standards from Dr. Wolff are stated the quantities and proportions of the digestible food elements which, according to the extensive experience of the German Experiment Stations, are to be given in the daily rations of farm animals in order to secure the best results of feeding. By "total organic substance" is meant the organic matter of feed considered free from water and ash. The difference between total organic substance and "total nutritive substance" expresses the quantity of indigestible or undigested matters of the ration. We are told that animals will indeed often do well with a ration less rich in albuminoids, the total amount of nutritive matters being kept up to the figures given below, but when by the use of the more highly nitrogenous feeding stuffs, such as brewer's grains, beans, peas, cotton seed cake, and meat or fish scrap, the nutritive ratio can be brought up to these standards, the results will be the most satisfactory.

The practical significance of these Feeding Standards is explained by the following paragraphs, which I have freely translated, from Dr. Wolff.

A milk cow is kept in good condition and with a full flow of milk on rich pasturage, or young clover, of which 30 lbs. are on an average daily consumed per 1,000 lbs. of live weight of improved breeds. 30 lbs. of young clover or best clover hay contain:

	Digestible.		
Organic substance.	Albuminoids.	Carbhydrates.	Fat.
23 lbs.	3.21	11.28	0.63

Experiment in the stall shows that the same result can be had with the best meadow hay, obtained from rich ground and cut young, in which 30 lbs. contain

		Digestible.		
	Organic substance.	Albuminoids.	Carbhydrates.	Fat.
	23.2	2.49	12.75	0.42
Feeding standard,	24	2.5	12.5	0.4

or almost exactly the quantities of the feeding standard, and 0.7 lb. less of albuminoids than in the clover.

In the winter keep of cows the hay at disposal is usually of only average or even of inferior quality and not capable alone of suitably nourishing milk cows. It is therefore necessary to add something to it in order to get a proper feed. Where hay commands a high cash price, it is often cheaper to use straw, chaff or maize fodder in combination with richer maize meal, bran, brewer's grains, cotton seed meal, etc., than to feed hay alone. By help of the tables we can calculate the kind and quantities of these various feeding stuffs which may compose a ration that shall take the place of clover hay and correspond to the feeding standard. Suppose there is on hand and at the daily disposal of the cows, for each 1,000 lbs. of live weight, 12 lbs. of meadow hay of average quality, 6 lbs. of oat straw and 20 lbs. mangolds, while 25 lbs. brewer's grains daily can be cheaply got. By use of the tables it is easy to calculate that all these materials together will give a ration coming short of the standard by half a pound of albuminoids, while by adding to it 2 lbs. of cotton seed meal, the requirements of the ration are fully met, as shown by the following figures.

Ration for Milk Cows.

	Dry organic matter.	Digestible.		
		Albuminoids.	Carbhydrates	Fat.
12 lbs. average meadow hay,	9.5	0.65	4.92	0.12
6 lbs. oat straw,	4.9	0.08	2.40	0.04
20 lbs. mangolds,	2.2	0.22	2.00	0.02
25 lbs. brewer's grains,	5.6	0.98	2.70	0.20
2 lbs. cotton seed meal,	1.6	0.62	0.36	0.24
	23.8	2.55	12 38	0.62
Standard,	24	2.5	12.5	0.4

Feeding Standards.

A.—Per Day and per 1,000 lbs. Live Weight.

	Total organic substance.	Nutritive (digestible) substances. Albuminoids.	Carb-hydrates.	Fat.	Total nutritive substance.	Nutritive ratio.
	lbs.	lbs	lbs	lbs.	lbs.	lbs.
1. Oxen at rest in a stall,	17.5	0.7	8.0	0.15	8.85	1 : 1.2
2. Wool sheep, coarser breeds,	20.0	1.2	10.3	0.20	11 70	1 : 9.
" " finer breeds,	22.5	1.5	11.4	0.25	13.15	1 : 8.
3. Oxen moderately worked,	24.0	1.6	11.3	0.30	13.20	1 : 7.5
" heavily worked.	26 0	2.4	13.2	0.50	16.10	1 : 6.
4. Horses moderately worked,	22.5	1.8	11.2	0.60	13.60	1 : 7.
" heavily worked,	25.5	2.8	13.4	0.80	17.00	1 : 5.5
5. Milk cows,	24.0	2 5	12 5	0.40	15.40	1 : 5.4
6. Fattening oxen, 1st period,	27.0	2.5	15.0	0 50	18.00	1 : 6.5
" " 2d "	26 0	3.0	14.8	0 70	18.50	1 : 5.5
" " 3d "	25.0	2.7	14.8	0.60	18.10	1 : 6.0
7. Fattening sheep, 1st period,	26.0	3.0	15 2	0.50	18.70	1 : 5.5
" " 2d "	25.0	3 5	14 4	0.60	18.50	1 : 4.5
8. Fattening swine, 1st period,	36.0	5.0	27.2		32.50	1 : 5.5
" " 2d "	31.0	4.0	24.0		28.00	1 : 6.0
" " 3d "	23.5	2.7	17.5		20.20	1 : 6.5
9. Growing cattle:						
Age, months. — Average live weight per head.						
2—3 — 150 lbs.*	22.0	4.0	13.8	2.0	19.8	1 : 4.7
3—6 — 300 "	23 4	3.2	13.5	1.0	17.7	1 : 5.0
6—12 — 500 "	24.0	2.5	13.5	0.6	16.6	1 : 6 0
12—18 — 700 "	24.0	2.0	13.0	0.4	15 4	1 : 7.0
18—24 — 850 "	24.0	1.6	12.0	0.3	13.9	1 : 8.0
10. Growing sheep:						
5—6 — 56 lbs.	28 0	3.2	15 6	0.8	19.6	1 : 5.5
6—8 — 67 "	25 0	2 7	13.3	0.6	16 6	1 : 5.5
8—11 — 75 "	23.0	2.1	11.4	0.5	14.0	1 : 6.0
11—15 — 82 "	22.5	1.7	10.9	0.4	13.0	1 : 7.0
15—20 — 85 "	22 0	1.4	10.4	0.3	12.1	1 : 8.0
11. Growing fat pigs:						
2—3 — 50 lbs.	42.0	7.5	30.0		37.5	1 : 4.0
3—5 — 100 "	34.0	5.0	25 0		30.0	1 : 5.0
5—6 — 125 "	31 5	4.3	23.7		28.0	1 : 5.5
6—8 — 170 "	27.0	3 4	20 4		23.8	1 : 6.0
8—12 — 250 "	21 0	2 5	16.2		18.7	1 : 6.5

* The German pound is equal to 1.$\frac{1}{10}$ lb. avoirdupois. The above weights are therefore to be increased $\frac{1}{10}$ to represent our weights. For practical purposes, however, this reduction will be in most cases unnecessary as the weights are but relative and approximate.

(*Feeding Standards, continued from page* 96.)

B.—Per Day and per Head.

	Average live weight per head.	Total organic substance.	Nutritive (digestible) substances. Albuminoids.	Carb-hydrates.	Fat.	Total nutritive substance.	Nutritive ratio.
Growing cattle: Age, Months.		lbs.	lbs.	lbs.	lbs.	lbs.	
2—3	150 lbs.	3.3	0.6	2.1	0.30	3.00	1 : 4.7
3—6	300 "	7.0	1 0	4.1	0.30	5.40	1 : 5.0
6—12	500 "	12.0	1.3	6 8	0.30	8.40	1 : 6.0
12—18	700 "	16.8	1 4	9.1	0.28	10.78	1 : 7.0
18—24	850 "	20.4	1.4	10.3	0.26	11.96	1 : 8.0
Growing sheep:							
5—6	56 lbs.	1.6	0.18	0.87	0.045	1.095	1 : 5.5
6—8	67 "	1.7	0.17	0.85	0.040	1.060	1 : 5.5
8—11	75 "	1.7	0.16	0.85	0.037	1.047	1 : 6 0
11—15	82 "	1.8	0.14	0.89	0.032	1.062	1 : 7.0
15—20	85 "	1.9	0.12	0.88	0.025	1.047	1 : 8.0
Growing fat swine:							
2—3	50 lbs.	2.1	0.38	1.50		1.88	1 : 4.0
3—5	100 "	3.4	0.50	2.50		3.00	1 : 5.0
5—6	125 "	3.9	0.54	2.96		3.50	1 : 5.5
6—8	170 "	4.6	0.58	3.47		4.05	1 : 6.0
8—12	250 "	5.2	0,62	4.05		4.67	1 : 6.5

I have calculated the following rations as examples of such combinations as may be made from materials in our markets. In the first ration, bulky corn fodder such as raised by Mr. Webb in 1874 (page 75) is a large ingredient. In the other, ordinary corn stalks or "stover" enters or may enter interchangeably with rye straw, since according to Wolff their nutritive value is the same, pound for pound. The use of these rations must of course finally depend upon whether the animals can be got to relish and digest them, as well as upon their cost I have not made any computations as to the latter point, but it is easy to do so with a knowledge of the cost of the several materials used. Actual experience alone can determine whether cattle will eat these mixtures.

Rations for Milk Cows.

	Dry organic substance.	Digestible. Albuminoids.	Digestible. Carbhydrates	Digestible. Fat
20 lbs. cured corn fodder,...	13.7	0.64	8.68	0.20
5 lbs. rye straw, or stover,..	4.1	0.04	1.82	0.02
6 lbs. malt sprouts,........	5.0	1.16	2.70	0.10
2 lbs. cotton seed meal, ...	1.6	0.62	0.36	0.24
	24.4	2.46	13.56	0.56
Standard, ...	24	2.5	12.5	0.4

Or again,

	Dry organic substance.	Digestible. Albuminoids.	Digestible. Carbhydrates	Digestible. Fat.
15 lbs. stover, ...	12.1	0.16	5.55	0.04
5 lbs. bran,...	4.1	0.59	2.21	0.15
5 lbs. malt sprouts,........	4.1	0.97	2.25	0.08
3 lbs. maize meal,.........	2.5	0.22	2.05	0.07
2 lbs. cotton seed meal, ...	1.6	0.62	0.36	0.24
	24.4	2.56	12.42	0.58

As already stated, the feeding standards of the foregoing tables give the results of German experience. Doubts have sometimes been expressed regarding the applicability of these results to American farm practice, and Mr. J. W. Sanborn, in his publication already referred to (Farm Experiments at the New Hampshire College of Agriculture) makes the following statement: "German investigators have learned much of the science of feeding. Their results are not before our farmers. The analyses given in these experiments and the results of feeding, aside from abundance of other data, show that we cannot rely on them for information upon which to base accurate practice in our climate and with our soil."

If this be true, it is certainly an important fact, for nearly all the knowledge of the science of feeding which we possess we owe to those same German investigators, and it therefore seems desirable to examine somewhat in detail the experiments upon which this assertion is based.

Aside from the "abundance of other data" Mr. Sanborn's conclusions rest essentially upon the results of two series of feeding trials, viz: one with early and late cut hay and one with a variety of mixed rations.

The points on which he differs from German authorities are three: 1st. The relative value of early as compared with late cut hay. 2d. The amount of food necessary to maintain or cause a slight gain by a 1000 pound steer. 3d. The significance of the nutritive ratio as an indication of the feeding value of a ration. These points we will consider in order.

The experiments on early *vs.* late cut hay (*loc. cit.* pp. 4–8) were made on two lots of two steers each, with the two kinds of hay described on p. 76 (Station Nos. LVII and LVIII). Two experiments, each extending over fourteen days, were made on each lot as follows:

Lot 1.		Lot 2.	
a. Early Hay.		*a.* Late Hay.	
Hay consumed,	570 lbs.	Hay consumed,	569 lbs.
Gain of weight,	41 "	Gain of weight,	87 "
b. Late Hay.		*b.* Early Hay.	
Hay cousumed,	585 lbs.	Hay consumed,	706 lbs.
Gain of weight,	33 "	Gain of weight,	40 "

The effects of the feeding were judged of only from the live weight and general appearance of the animals.

In respect to these feeding trials there are several points that are of importance in interpreting results.

The European experience in cattle feeding has shown that *live weight* is a very unsafe criterion of the value of food for the following reasons:

1st. The contents of the alimentary canal require five and sometimes seven days before they pass from mouth to stable floor. Therefore the use of each ration or fodder under experiment should extend over a period of *a month* at least, and an interval of a week should be allowed after beginning a new ration before its effects are taken account of, in order to get the previous ration out of the way.

2d. Change of ration is very apt to disturb the animals and they require time in order to get accustomed to new feed, so that results of the first or second weeks feeding on a changed ration are often unlike those obtained later when the animals get habituated to the diet.

3d. The weight of the contents of the digestive and intestinal canal amounts, in case of horned cattle, to 12–18 per cent. of the live weight. Since the evacuations are not or may not be entirely regular, changes of live weight of a few pounds may depend entirely upon the excrements and the food, and not upon the actual animal. An animal of 600 lbs., fasting and purged may weigh 70–110 lbs. less than the same animal full of feed, and with intestines and bladder full also. The *lean* animal has the greatest percentage of intestinal and stomach contents.

It will appear, therefore, that the results of Mr. Sanborn's feeding trials scarcely justify concluding that one of the rations fed was better or worse than the other, if the live weights alone are the criteria for a judgment, since the greatest gain observed, 43½ lbs. per head, was less than might have been caused in the ways just spoken of, and since, moreover, the duration of the experiments was comparatively short.

In connection with these experiments Mr. Sanborn says, (p. 8) "It is worthy of note that I find the amount of hay required to maintain a thousand pound steer without growth or loss of weight is less than that reported by German experimenters."

Apparently this refers to the same hay as that used in the feeding trials just mentioned. It will therefore be interesting to compare the amounts of digestible matters furnished to the cattle in those experiments with the amounts found by German experiments to be necessary for maintenance.

The hays used in these trials, though deficient in albuminoids, show by their percentage of crude fiber that they are fairly entitled to rank as of average digestibility. See remarks on p. 82.

On this basis, assuming the hays to have had the same water content as the samples analyzed at the Station, we have calculated by Wolff's digestion coefficients, the quantities of digestible albuminoids, carbhydrates, and fat fed per day and head (live weight slightly over 1000 lbs.) to each lot in each period.

It will be seen that with the exception of Lot 2 on Early Cut Hay the amounts agree quite closely. Excluding this experiment, I have computed the average of the other three and have placed beside it for comparison the average of four accordant feeding trials made at the Weende Experiment Station, by Henneberg & Stohmann. These experiments were made in the most careful manner possible and yielded the figures given in the table as the amounts of digestible nutritive matters required per day to maintain a thousand pound steer without growth or loss of weight.

			Digestible.			Nutritive Ratio.
			Albuminoids.	Carbhydrates.	Fat.	
Early Hay.	Lot 1.	20.40 lbs.	0.75 lbs.	9.70 lbs.	0.21 lbs.	
"	" 2.	25.22 "	0.93 "	11.99 "	0.25 "	
Late Hay.	Lot 1.	20.89 "	0 65 "	10.03 "	0.20 "	
"	" 2.	20.32 "	0.64 "	9.76 "	0.20 "	
Average of above experiments.			0.68 lbs.	9.83 lbs.	0.20 lbs.	1 : 15.2
" " Weende "			0.51 "	7.03 "	0.34 "	1 : 15.5

The comparison is instructive. The nutritive ratio shows that the proportion of albuminoids to non-nitrogenous matters in the food of Mr. Sanborn's steers was essentially that of the rations used in the Weende experiments, but the total amounts of digestible matters in the two cases are in the ratio of about 10 : 7. In other words Mr. Sanborn's steers *ate more* (or more properly digested more) than those of the German experimenters, and as a natural result gained weight.

At this rate a daily ration of 14–15 lbs. of the same hay should suffice to maintain the animals, but more than that would probably be necessary on account of the low temperature to which the animals were exposed in Mr. Sanborn's experiments.

In another experiment by Mr. Sanborn, in which two steers were fed for 70 days on straw and corn meal, it is stated that the animals returned "ordinary gains with only 0.42 pounds of albuminoids per day," so that "an ordinary gain is made by less albuminoids than has been thought sufficient by German investigators" (pp. 25 and 26).

From the details (on page 20) it appears that the two animals received together during the 70 days

2423 lbs. of straw.
347 lbs. of corn meal

calculated, by the aid of Wolff's tables, to contain respectively 34 and 25 pounds of digestible albuminoids or in all 59 pounds; making per day and head the amount of 0.42 pounds mentioned above.

It would appear from the estimated digestibility that the straw was oat straw, which, according to Wolff, contains 1.4 per cent. of digestible albuminoids.

Now straw of all kinds is a feeding-stuff of very variable composition. According to the recent tables of J. Kühn, oat straw may contain from 0.19 to 3.50 per cent. of digestible albuminoids according to soil, climate, time of cutting, etc.

It is evident, then, that while such averages as those of Wolff have their value as aids in the calculation of rations, the variations of single samples may be so great as to entirely invalidate calculations made on the assumption of average composition. Suppose, for example, that the straw used by Mr. Sanborn was unusually rich in albuminoids, containing 2.3 per cent. in a digestible form. The result then would be as follows:

	Digestible Albuminoids.
2423 lbs. straw, - - - - - -	55.73 lbs.
347 " corn meal, - - - - -	25.00 "
	80.73 "
Or per day and head, - - - - -	0.58 "

This with the digestible non-nitrogenous matters gives a ration somewhat richer in albuminoids and considerably so in carbhydrates than that required for maintenance according to the Weende experiments.

It is, of course, impossible to say how much the composition of the straw used varied from the average, but it is sufficient for the present purpose to point out the fact that such conclusions as that which we are here discussing require a more certain basis than is afforded by assumptions as to the composition and digestibility of the feeding-stuffs used.

In regard to nutritive ratios, Mr. Sanborn says (p. 22), "A study of the ratio of albuminoids to carbhydrates does not seem to give any pronounced indications."

Subsequently (p. 25), he says, "This appears to be true so far as the nutritive ratio is concerned, but when the absolute amounts of albuminoids and carbhydrates consumed per day per steer are considered, the indications of the table are more pronounced; the gain of steers following more closely the increase or decrease of carbhydrates, and is apparently nearly independent of the supply of albuminoids."

The general result of German experience in feeding has been to illustrate the great importance of albuminoids in animal nutrition, and to show that a liberal supply of these substances is essential to a rapid formation of flesh, fat, milk, etc. On the other hand, however, it has shown that if too much albuminoids be fed, there is a waste of these costly bodies and also that with

a given amount of albuminoids in the daily ration the more non-nitrogenous nutrients the animal can be made to digest, the more albuminoids and fat are protected from destruction and made available for productive purposes. Obviously this implies a limitation of the nutritive ratio in both directions. If it be too narrow, there are not enough non-nitrogenous matters to protect the albuminoids from waste, while if it be too wide, the amount of food which the animal can eat will not contain albuminoids enough to supply the demands of the body. In most cases, however, and in fattening especially, the widest nutritive ratio consistent with the supply of the requisite albuminoids gives the best results.

It is quite natural, then, that the gain of weight in these experiments should appear to follow the increase or decrease of the carbhydrates to a certain extent. At the same time there are not wanting in the results, indications of the effect of the albuminoids, while the very variable amounts of total nutritive matters fed in the several experiments render a strict comparison impossible.

It may be added here in regard to ration 3, calculated to contain only 0.42 pounds of albuminoids, that it is not impossible that even this small amount of albuminoids in combination with the large amount of carbhydrates (9.07 lbs. against 7.03 lbs. in the Weende experiments) might suffice for maintenance at least.

The foregoing criticisms are offered with the single object of furthering investigation and with a full appreciation of the credit due Mr. Sanborn for his careful and laborious experiments, and for the truly scientific spirit with which he has sought to enlarge our knowledge.

In conclusion we should repeat in regard to these feeding-standards that they are not put forth as receipts which may be blindly followed with the certainty of a favorable result.

They are simply the results of experience and like all such results are subject to modification both by the exigencies of particular cases and by the results of further experience.

The German experimenters do not themselves imagine that they have by any means overcome the difficulties of the subject. Their results are simply the best they can offer after twenty-five years of arduous labor, after making thousands of analyses and hundreds of laborious feeding trials. They believe that they are using the right methods, but admit that many further experiments must be undertaken before the investigation can be closed. In fact they are experimenting to-day more industriously than ever, with the object to test and sift the theories which their past experience has led them to adopt, and to gain a nearer approach to the true science and best practice of cattle feeding. It is to be anticipated that their views will materially change as further knowledge is gained.

The Determination of Albuminoids in Feeding-Stuffs.

By Dr. H. P. Armsby.

It will be gathered from the remarks on page 73 that the albuminoids form an exceedingly important portion of the food of animals, and when we add to this the facts that they are the most costly of all the nutrients and are contained in comparatively small quantities in most feeding-stuffs we shall easily perceive how important it is to be able accurately to estimate their amount.

Unfortunately, this is a task of great difficulty. All attempts to separate the albuminoids from the other substances with which they are associated in plants and to obtain them in a weighable form have encountered two, as yet insuperable, difficulties; in the first place it has been found impossible to effect a complete separation of these bodies from the woody fiber and other substances of the plant, and in the second place all the reagents thus far employed to effect this separation have altered more or less the albuminoids themselves.

We are thus forced to make use of an indirect method.

All the albuminoids contain nitrogen as a characteristic ingredient and vary but little in composition, containing, on the average about 16 per cent. of this element. If, therefore, in a feeding-stuff containing only albuminoids and substances free from nitrogen, we estimate the amount of the latter and multiply it by $6\frac{1}{4}$ ($16 \times 6\frac{1}{4} = 100$) we shall have a close approximation to the quantity of albuminoids present.

It is in this manner that the albuminoids in feeding-stuffs have usually been determined, it being assumed that no considerable amount of nitrogenous bodies other than albuminoids was present.

It is obvious that such a method cannot give strictly accurate results, but until within a few years the error involved has been generally considered to be comparatively small. Recently, however, the correctness of the method, and consequently the reliableness of the results of feeding experiments in which it has been used and of the estimates, partly based on it, of the value of fodders, have been seriously questioned by eminent authorities, while in less informed circles the doubt has grown into a disposition to reject all analysis of feeding-stuffs as worthless.

In view of the importance of the matter, both scientifically and practically, it seems desirable to ascertain, if possible, the amount of error incident to the present mode of determining albuminoids and the extent to which it affects the important practical results which have been obtained by its aid in the department of cattle-feeding, and also to consider the character of those methods which have been proposed as a substitute for the present one.

This implies an examination of the correctness of the two assumptions on which the usual method is based, viz., that all the albuminoids contain 16 per cent. of nitrogen and that no other nitrogenous bodies are present in feeding-stuffs. In doing this, special reference will be had to the feeding of our domestic herbivorous animals and therefore only the vegetable albuminoids will be considered.

Percentage of Nitrogen in Albuminoids.—Our most reliable knowledge of the vegetable albuminoids is due to the laborious investigations of Ritthausen,* and without going further into the literature of the subject, his results suffice to show that these bodies vary not inconsiderably in composition.

For example, in the five different albuminoids prepared by him from wheat the nitrogen ranged from 16.25 per cent. to 18.31 per cent., while in all the albuminoids examined the range was 14.71 per cent. to 18.37 per cent. He also found that albuminoids apparently identical possessed a different composition according to the source from whence they were obtained.

Ritthausen's examinations cover only the cereal grains, legumes, and oil seeds; of the albuminoids of the great number of other substances used as fodder, and especially of the albuminoids of the common coarse fodders, we have little or no knowledge. While, therefore, his results show that the assumption of 16 per cent. of nitrogen in all albuminoids is far from being correct in all cases, they also show the impossibility of finding any factor for the conversion of nitrogen into albuminoids other than a purely conventional one.

* "*Die Eiweisskörper der Getreidearten, Hülsenfrüchte und Oelsamen.*" 1872.

It is possible that, in time, we may be able to assign different factors to the several classes of feeding-stuffs, according as one or the other albuminoid predominates, but, as yet, this is impossible, and until we possess more information regarding the albuminoids of many vegetable products than we have at present, the best that can be done is to use the ordinary factor, 6.25, bearing in mind that it is simply conventional and is only approximately true.

Non-albuminoid Nitrogenous Substances.—In addition to the albuminoids the following classes of nitrogenous substances have been found in plants:

1. Nitrates, nitrites, and ammonia salts.
2. Nitrogenous glucosides.
3. Peptones.
4. Alkaloids.
5. Amide-like bodies.

Of these, the first class occurs somewhat abundantly in beets and other root-crops and considerable quantities of nitrates are sometimes found in maize fodder. These bodies are, however, easily detected, if present, and their amount can be readily determined.

Of the remaining four groups, only the amide-like bodies have yet been found to any large extent in the ordinary feeding-stuffs and to them we shall devote most of our attention in this discussion.

By amides the chemist understands substances which bear a certain likeness to ammonia and contain a portion of an ammonia molecule in combination with an organic substance. They may be subdivided into three groups, viz., amines, amides, and amido-acids, but for convenience we may designate them collectively as amides.

They are generally well defined, crystalline bodies, soluble in water and easily passing through a moist membrane by the process of liquid diffusion, differing in these points from the albuminoids, most of which are but slightly or not at all soluble in water, are not crystalline, and diffuse with extreme slowness.

Functions of Amides in the Plant.—The first substance of this class which was discovered is asparagin, which was found by Vauquelin & Robinet in 1805, in young shoots of asparagus.

The investigations of Pfeffer* into the functions of this body in the plant, show that asparagin is produced from the albuminoids of certain seeds during germination. Being soluble in water and diffusible, it passes from the seed into the young plant and there is reconverted into albuminoids, and in this way the comparatively insoluble nitrogenous matters of the seed are transferred to the young plant where they are needed. Pfeffer experimented on germinating seeds of leguminous plants and showed that, while the albuminoids were transferred to the young plant in the way just described, they may also pass unchanged from seed to sprout.

Later researches have shown that the presence of carbhydrates is necessary for the reconversion of asparagin into albuminoids, while exposure to sunlight is not essential.

Finally, the recent investigations of Borodin† and E. Schulze‡ have rendered it at least very probable that nearly all the movement of albuminoids in the plant is effected by a formation of amides of one sort or another and a rebuilding of albuminoids from them.

Another function of amides, in certain cases, is that of a reserve of nitrogenous food.

Schulze & Urich,§ who were the first to make a thorough investigation of the nitrogenous constituents of fodder beets, showed that these roots contain comparatively large amounts of amides, which, in the second year's growth, are transferred to the sprout and converted into albuminoids, thus playing a part in the economy of the plant similar to that of the albuminoids stored up in the seeds.

Separation of Amides from Albuminoids.—In the analysis of feeding-stuffs it is desirable to estimate separately the albuminoid and non-albuminoid nitrogen. In this way, by multiplying the albuminoid nitrogen by $6\frac{1}{4}$ we obtain at least a closer approximation to the true amount of albuminoids than is possible by the ordinary method.

The several processes which have been proposed to effect this may be divided into two classes, viz., those which aim at an estimation of the albuminoid nitrogen and those which are

* *Jahrb. f. Wiss. Botanik*, VIII, 530.
† *Biedermann's Central-Blatt. Jarg.* 8, *p.* 357.
‡ *Landw. Jahrbücher*, VII, 411.
§ *Versuchs-Stationen*, XVIII, 296, and XX, 193 and 214.

intended to effect a determination of the amide nitrogen. Both classes assume as their starting point that all the non-albuminoid nitrogenous substances are soluble in water or acid liquids. Now, while this is true of all the bodies of this class known to exist in feeding-stuffs, and while it is very probably correct, it should be borne in mind that it is not proved. There is no reason in the nature of things why a plant should not contain an insoluble amide as well as an insoluble albuminoid.

If there be such, however, we have no means of ascertaining the fact at present and can only adopt provisionally the assumption just mentioned as a working hypothesis.

Taking this as a starting point, the methods of the first class proceed in general as follows.

The substance to be examined is first boiled with water slightly acidified with some organic acid or with water alone; this process dissolves out the non-albuminoid nitrogenous matters (with the reservation made above), while most or all of the albuminoids are either not dissolved at all or are coagulated by boiling. Some substance is then added to the liquid which will precipitate any dissolved albuminoids which it may still contain, without affecting the amides, etc., the mass is filtered, and a nitrogen determination made either in the insoluble matters or in the filtrate.

In the first case we get directly the albuminoid nitrogen, in the second case it is obtained by subtracting the nitrogen of the filtrate from the total nitrogen of the substance. The several methods differ essentially only in the precipitant employed. Church* recommends a 4 per cent. solution of carbolic acid, Sestini† uses lead acetate, Dehmel‡ has obtained concordant results by the use of copper sulphate as proposed by Ritthausen, E. Schulze§ proposes the use of ferric acetate as recommended by Hoppe-Seyler, while in some experiments on hay made in the laboratory of this Station, pure water has proved equally efficient. These experiments were made on three samples of hay (Nos. LIX, LX and LXI) whose analyses have already been reported.

Carbolic acid, lead acetate, and cupric sulphate were all used as precipitants and trials were also made with water alone.

* Laboratory Guide, 4th Ed.. p. 209.
† *Landw. Versuchs-Stationen,* XXIII, 305.
‡ Same XXIV, 214.
§ *Landw. Jahrbücher,* VI, 160.

The experiments with carbolic acid and lead acetate were made according to the directions of Church and Sestini respectively. In the experiments with cupric sulphate the substance was boiled for an hour with water, then 10 c. c. of a ten per cent. solution of cupric sulphate were added, the boiling continued for a few minutes, the mass then filtered, and the nitrogen of the insoluble residue determined.

In the trials with water the substance was simply boiled for an hour with water slightly acidified with lactic acid, filtered, and treated as in the other methods. In each trial 0.5 grammes of hay was used, and every result is the mean of two accordant determinations.

The results express nitrogen and not albuminoids.

	LIX.	LX.	LXI.
Water,	11 31 per cent.	10.75 per cent.	11.19 per cent.
Total nitrogen,	1.30 "	0.81 "	2.39 "
Albuminoid nitrogen,			
By Church's method,	1.22 "	0.68 "	1.93 "
" Sestini's "	1.18 "	0.62 "	1.88 "
" Copper sulphate method,	1.22 "	0.69 "	1.89 "
" extraction with water,	1.11 "	0.61 "	1.92 "
Average,	1.18 "	0.65 "	1.89 "
Non-Albuminoid nitrogen,	0.12 "	0.16 "	0.50 "

In all cases (except in Church's method, where it is impossible) the filtrate was tested for albuminoids by Millon's reagent and found to be free from them.

These results show:

First, that these samples of hay contained a considerable proportion of non-albuminoid nitrogen.

Second, that all four of the methods used for the determination of albuminoid nitrogen gave practically the same result, and that consequently the use of any reagent to precipitate dissolved albuminoids was unnecessary in these cases.

In addition to these experiments the albuminoid nitrogen in twenty-one samples of hay and stover has been determined by treatment with water in the manner described above and in no case could albuminoids be detected in the filtrate, so that we are justified in concluding that in the analysis of hay a separation of the albuminoid and non-albuminoid nitrogen may be effected most simply by means of boiling water. That this method is preferable to the use of precipitants is obvious, since we are largely ignorant of the nature of the amides and other bodies extracted by water and run the risk of precipitating them from the solution by means of the reagents intended to effect the removal of albuminoids.

Whether the method of extraction with boiling water is applicable to all feeding-stuffs is perhaps doubtful. Some experiments on rye-bran and malt sprouts seem to indicate that it is not. But to hay at least it is perfectly applicable and by its aid it is a very simple matter to determine the amount of albuminoid nitrogen present, and by multiplication by $6\frac{1}{4}$ to calculate approximately the amount of albuminoids.

For the determination of the nature of the non-albuminoid nitrogenous matters when present, we have as yet only one method, viz., that of Sachsse* for the determination of amides, which, with the modifications proposed by E. Schulze† is of great value.

It is based upon the behavior of the amides with nitrous acid. An extract of the substance, freed as far as possible from albuminoids, is brought in contact with fuming nitric acid (nitric acid containing nitrous acid) in a suitable apparatus. The nitrogen of the amides is set free together with an equal amount coming from the nitrous acid. This gas is collected and after being purified is measured. One half of it represents the amount of amide nitrogen present.

Our efforts to apply this method to the hays experimented upon were not, however, attended with success. Test analyses with pure amides gave tolerably satisfactory results, but on hay more nitrogen was usually obtained than was present in the extract experimented upon. This fact, which does not appear to have been observed before, indicates a reduction of the nitric acid by the organic matter of the extract, but only further experiments can decide definitely upon the cause.

Occurrence of Amides.—The statements just made respecting the functions of amides in the plant would lead us to expect to find them chiefly in those plants or parts of plants where growth was going on, while in those which had reached their full development we should anticipate finding most or all of the amides reconverted into albuminoids except in cases where, as in the beet, they act as a reserve of nitrogenous food. As a matter of

* "*Chemie und Physiologie der Farbstoffe, etc.*" 1877. p. 258.

† *Landw. Versuchs-Stationen*, XX, 117.

fact those investigations which have hitherto been made confirm, in the main, these anticipations.

Kellner* has made quite extensive investigations into the nature of the nitrogenous bodies of several kinds of grass and hay in various stages of growth, and has found that in one case as much as 38.5 per cent. of the total nitrogen of the substance investigated existed in some form other than albuminoids, and mostly as amides.

His results also show that in general the proportion of non-albuminoid nitrogen is greatest in young plants and decreases as they approach ripeness. An interesting difference was observed in this respect between the common grasses (*Gramineae*) and the legumes; in the former the decrease in the amount of amide nitrogen with approaching ripeness was very marked, while in the latter it was much less noticeable. The former are plants which, after flowering cease to assimilate to any great extent, while the latter, along with the formation of flower and fruit, continue to grow and assimilate food and thus offer the conditions for the formation of amide compounds.

The following table of a few of his results will serve to illustrate the facts last stated, and to give an idea of the extent to which these bodies occur in this class of feeding-stuffs.

	Total Nitrogen. per ct.*	Non-albuminoid Nitrogen.		Amide Nitrogen. (Sachsse's Method.) per ct.*
		per ct.*	per ct. of total Nitrogen	
Lucerne.				
1. Cut April 7, 1½ in. high,	6.922	2.133	30.5	....
2. " " 12, 3½ in. high,	5.760	2.042	35.5	...
3. 2d Cut, without flower buds,	3.570	1.183	33.1	1.025
4. Before flowering, 18½ in. high,	2.474	0.721	29.1	0.613
5. In flower, 22½ in. high,	3.008	0.729	24.2	0.687
Red Clover.				
1. Cut March 27, 1½ in. high,	5.200	1.958	37.7	....
2. Cut Apr. 27, 2½ in. high,	3.974	0.975	24.5	....
3. In full flower,	2.244	....	(16.5)	0.370
Meadow Hay, 1877.				
1. Cut May 14,	2.824	0.983	34.8	0.892
2. " June 9,	1.787	0.285	16.0	0.239
3. " " 29,	1.354	0.102	7.5	0.033

*Per cent. of water-free substance.

* *Landw. Jahrbücher*, VIII. I Supplement, p. 243.

In the twenty-one samples of coarse fodder analyzed at the station during the past year the percentage of true albuminoids and of non albuminoid nitrogenous matters has been determined by the process described on p. 109, with the following results.

Station Number.	Kind of Fodder.	Total Nitrogen.†	Albuminoid Nitrogen.†	Amide Nitrogen.†	Amide Nitrogen in per cent. of Total Nitrogen.
LXI, ...	Hay.	2.31 pr ct.	1.85 pr ct.	0.46 pr ct.	19.91 pr ct.
LXII, ...	"	1.76 "	1.50 "	0.36 "	19.35 "
XLVIII, ...	"	1.70 "	1.39 "	0.31 "	18.24 "
LXVII, ...	"	1.45 "	1.20 "	0.25 "	17.24 "
LII, ...	"	1.44 "	1.16 "	0.28 "	19.44 "
LX, ...	"	0.78 "	0.59 "	0.19 "	24.36 "
LVIII, ...	"	0.99 "	0.86‡ "	0.13 "	13.13 "
LVIII, ...	"	0.85 "	0.76‡ "	0.09 "	10.59 "
LXIV, ...	"	0 95 "	0.77 "	0.18 "	18.95 "
L.	"	1.10 "	0.88 "	0.22 "	20.00 "
LIX, ...	"	1.26 "	1.07 "	0.19 "	15.08 "
LXIII, ...	"	1.43 "	1.10 "	0.33 "	23.08 "
LXIX, ...	"	0.96 "	0.85 "	0.11 "	11.46 "
LI, ...	"	1.20 "	1.00 "	0.20 "	16.67 "
XLIX, ...	"	1.12 "	0.89 "	0.23 "	20.54 "
LXVI, ...	"	1.12 "	1.02 "	0.10 "	8 93 "
LXVIII, ...	"	1.04 "	0.91 "	0.13 "	12.50 "
LIII, ...	"	1.07 "	0.91 "	0.16 "	14.95 "
LXV, ...	"	1.16 "	1.01 "	0.15 "	12.93 "
LV, ...	Millet.	1.01 "	0.61 "	0.40 "	39.60 "
LIV, ...	Stover.	1.03 "	0.63 "	0.40 "	38.83 "

† Calculated on an average water-content of 14 3 per cent
‡ By Sestini's method.

Other kinds of coarse fodder than those enumerated above have not yet been tested for amides.

Of concentrated fodders there is but one in common use in which the foregoing considerations would lead us to expect any large amount of amides, viz., malt sprouts or "screenings." This consists of the sprouts formed in the preparation of malt, and separated from it in the subsequent drying, and has been found to be quite rich in amides. E. Schulze* states that Stein has found them very rich in soluble nitrogen compounds and that asparagin has been found in them by Lermer. A sample of malt sprouts has also been examined in the laboratory of the Station for amides. The methods of Sestini and of Church were both used; the results did not show a satisfactory agreement, but the presence of a considerable amount of amide-like bodies was proved. The results were as follows:

* *Landw. Jahrb*, VI, 171.

Total Nitrogen, - - - - -	4.53 per cent.
Albuminoid nitrogen,	
By Sestini's method, - - - -	2.60 "
" Church's " - - - - -	2.88 "
Non-albuminoid nitrogen, - - - -	1.65–1.93 per cent.

A trial by Sachsse's method showed the presence of amides, but a satisfactory determination of their quantity was not obtained.

Five samples of malt sprouts examined by Kellner* gave by Sachsse's method, the following results, on the water-free substance:

	Total Nitrogen.	Amide Nitrogen.	Albuminoid Nitrogen.
No. 1,	3.556 per cent.	0.822 per cent.	2.734 per cent.
" 2,	4.213 "	1.023 "	3.190 "
" 3,	4.479 "	1.606 "	2.873 "
" 4,	5.080 "	1 414 "	3.616 "
" 5,	5.520 "	1.418 "	4.102 "

Other concentrated fodders, especially the grains and their bye-products, have usually been assumed to contain no amides, but some recent results serve at least to show the need of further investigation. Thus Sachsse† found in the aqueous extract of peas a small quantity of nitrogen apparently belonging to amide-like compounds, and Schulze and Umlauft‡ found in the seeds of the yellow lupine 1.30 per cent. of nitrogen not in the form of albuminoids, much of which existed as amides. A sample of rye-bran examined in the Station laboratory by the same methods used on malt sprouts gave:

Total nitrogen, - - -	2.69 per cent.
Albuminoid nitrogen,	
By Sestini's method - -	2.09 "
" Church's " - - -	2.28 "
Non-albuminoid nitrogen, -	0.41–0.60 per cent.

The agreement between the two methods is not very close and the experiments were not in all respects as satisfactory as could be desired, but they plainly indicate the presence of some other nitrogenous substances than albuminoids.

A single determination on a sample of wheat bran by Sestini's method gave the following results:

Total nitrogen, - - - - -	2.82 per cent.
Albuminoid nitrogen, - - - - -	1.99 "

* *Biedermann's Central-Blatt. Jarg.* 8, p. 417.
† *Landw. Versuchs-Stationen*, XVII, 31. ‡ *Landw. Jahrbücher*, V, 836.

A sample of "hominy chops" (Station number LVI) gave by Sestini's method:

Total nitrogen,	1.52
Albuminoid nitrogen,	1.44 per cent.

a difference less than the possible errors of experiment.

Quite recently Wigner* reports having found by Church's method that a small proportion of the nitrogen of cereal grains and a large proportion of that of cocoa belongs to non-albuminoid compounds. Finally, Dehmel (*loc. cit.*) found by the copper sulphate method the following quantities of albuminoid nitrogen in lupines and beans:

	Lupines.	Beans.
Albuminoid nitrogen,	7.01 per cent.	4.10 per cent.
Non-albuminoid "	0.51 "	0.68 "

He also shows that this method when applied to potatoes gives too high results for the albuminoid nitrogen, owing probably to the formation of a difficultly soluble compound of some of the "amides" with copper.

As already stated, large quantities of amides have been found in root-crops.

Various experimenters have noticed the occurrence of amides or related bodies, as well as of nitrates and ammonia salts, in beets, but the first thorough investigation of the nitrogenous constituents of fodder beets are those of Schulze and Urich already alluded to. In their first investigation† they confirmed the fact that beets contain a relatively large but variable quantity of nitrates, and also found a very considerable quantity of amides, while only 21.6–38.9 per cent. of the total nitrogen belonged to albuminoids.

The following statement of their results on one sample will serve to give an idea of all.

	Per cent of fresh substance.	Per cent of total Nitrogen.
Total nitrogen,	0.2390	100.00
Nitrogen in soluble albuminoids	0.0358	14 98
" insoluble "	0.0158	6.61
" amides,	0.0857	35.86
" nitrates,	0.1053	44.06
" ammonia salts,	0.0050	2.09
	.2476	103 60
Error	.0086	3.60

* *Jour. Chem. Soc.*, 1879, pp. 486 and 493.

† *Landw. Versuchs-Stationen*, XVIII, 296.

The amide nitrogen was determined by treating the juice, after having freed it from albuminoids, directly with nitrous acid, one half of the resulting nitrogen being considered as coming from the material under investigation. No asparagin could be detected.

In their second paper* the same authors show that among the amide-like bodies contained in beets was glutamine and a trifling amount of asparagin. They also investigated the functions of the amides, with the results already stated.

A considerable amount of non-albuminoid nitrogen has also been found in the potato by Schulze and Mercker† and by Kreusler,‡ and more recently Schulze and Barbieri § have published more extended investigations of five sorts of potatoes which showed that the nitrogen of the fresh substance was distributed as follows:

	Nitrogen of Insoluble Albuminoids.	Nitrogen of Soluble Albuminoids.	Nitrogen of Amides.
I.	0.069 per cent.	0.143 per cent.	0.125 per cent.
II.	0.046 "	0.157 "	0.118 "
III.	0.058 "	0.080 "	0.143 "
IV.	0.047 "	0.155 "	0.150 "
V.	0.087 "	0.147 "	0.100 "

The distribution of the nitrogen between albuminoids and non-albuminoids was, therefore:

	Albuminoids.	Non-Albuminoids.
I.	60.7 per cent.	39.3 per cent.
II,	59.7 "	40.3 "
III,	47.4 "	52.6 "
IV,	48.2 "	51.8 "
V,	65.2 "	34.8 "

Beets and potatoes appear to be the only root-crops whose nitrogenous constituents have been investigated, but it is highly probable that other roots and tubers also contain considerable amounts of amides. Naturally the bye-products such as "potato slump," beet-root molasses, etc., are also liable to contain the same or derived bodies.

Nutritive Value of Amides.—In view of the wide-spread occurrence of nitrogenous bodies not belonging to the albuminoid group the question of their nutritive value becomes an important one. Not only is it an element which must enter into

* *Landw. Versuchs-Stationen*, XX, 193.

† *Jour. f Landw.*, 1872, p. 66.

‡ See the paper by Schulze and Barbieri.

§ *Landw. Versuchs-Stationen*, XXI, 63.

our estimates of the value of feeding-stuffs but it is one which may materially modify the conclusions to be drawn from the results of feeding experiments.

Until very recently the presence of these bodies has not been considered or even recognized in the analysis of feeding-stuffs, and in many feeding experiments, from whose results important conclusions have been drawn as to the amounts of the various nutrients required in the food of farm animals, fodders have been used which have since been shown to contain considerable quantities of amide-like bodies.

Obviously, then, it is very desirable that we should know what nutritive effect, if any, these substances exerted in these experiments.

We shall confine our attention to the amides, since these are the only non-albuminoid nitrogenous matters which have been experimented with.

It may safely be assumed that these comparatively simple bodies cannot perform all the functions of the complex albuminoids, but it would seem that certain authors have allowed themselves to be carried too far by purely speculative considerations when they have pronounced them valueless for animal nutrition.

Amides are decomposed in the Body.—It has been shown by various investigators that some amides, at least, when introduced into the stomach, are resorbed and take part in the chemical changes in the body. Schultzen and Nencki* were among the first to investigate this subject. They experimented on a dog with acetamide, glycocol, leucin, and tyrosin and found that all except the first were decomposed in the body and caused an increased excretion of urea, the normal product of the destruction of nitrogenous matters in the body.

Their experiments were not adapted nor intended to show the nutritive value of amides, but it may be noted in passing that all their experiments seem to show a retention by the body of nearly 25 per cent. of the nitrogen of the amide and thus to indicate that a gain of flesh took place under its influence.† The results, however, are not decisive on this point.

* *Zeitschrift f. Biologie*, VIII, 124.

† Nitrogen is the characteristic ingredient of the albuminoids, the materials which, together with water and salts, compose flesh, and hence when the body of an animal receives more nitrogen than it excretes, we conclude that it has gained an amount of flesh corresponding to the difference.

Similar experiments, also on a dog, by v. Knieriem * with asparaginic acid and asparagin gave essentially the same result. They showed that these substances are converted into urea in the body and showed also a retention in the body of 9–10 per cent. of the amide nitrogen fed.

Further experiments by the same author † on hens with asparagin, asparaginic acid, glycocol, and leucin confirmed his previous results. In no case was there any indication of an increase of the amount of albuminoids oxydized in the body under the influence of the amides.

Indications of Nutritive Value.—All these results, while highly interesting, leave the question of the nutritive value of amides still in doubt. There are many facts, however, which indicate that they may have a certain value as food. The fact that they are decomposed in the body is one. Another is that they are formed from the albuminoids of the food to a considerable extent by the action of the trypsin of the pancreatic juice during digestion. It seems hardly probable that the amides thus formed are to be regarded as waste products.

Moreover, we have seen that in the plant these bodies may serve as a source of albuminoids, and while such synthetic processes are particularly characteristic of vegetable life, they are by no means excluded in the animal organism.

The not improbable conjecture has been advanced that amides in the food may play the same part in nutrition as gelatin has been shown to perform by Voit and others, viz., be oxydized in the place of a portion of the albuminoids, thus leaving the latter available for the formation of flesh or for other productive purposes.

This conjecture seems to be sustained by the experiments about to be described.

Asparagin a Nutrient.—The only experiments as yet executed for the purpose of determining the nutritive value of amides are those of Weiske, Schrodt, and v. Dangel ‡ at the Proskau Experiment Station with asparagin. Experiments on rabbits and on hens having shown only that albuminoids could not be entirely replaced by asparagin, but giving in other respects indecisive results, a third series was made on two merino southdown sheep.

* *Zeitschrift f. Biologie*, X, 279.

† *Zeitschrift f. Biologie*, XIII, 36.

‡ *Zeitschrift für Biologie*, XV, 261.

The plan of the investigation was as follows:

The animals were fed at first with a fodder poor in albuminoids.

Then, in three following periods, the amount of nitrogen in the daily ration was doubled by the addition respectively of albuminoids (in the form of peas), gelatin, and asparagin, while the amount of the non-nitrogenous nutrients was kept practically the same. These additions to the original fodder were made in the opposite order with the two animals, in order that the nutritive effect of the asparagin on each sheep might be compared with that of albuminoids on the other, and the influence of any individual peculiarities be thus eliminated.

In the statement of the results which follows, the numbers represent the average per day and head for five days.

Period I.

Ration. Sheep I and II, 500 grms. of hay. 200 grms. starch. 50 grms. sugar.

	Albuminoids digested.	Carbhydrates digested.	Fat digested.	Nitrogen of urine.	Flesh gained.
Sheep I,	22.21 grms.	412.37 grms	9.89 grms.	3.275 grms.	8.34 grms.
" II,	22.86 "	412.71 "	9.67 "	3.388 "	0.45 "

Period II.

Ration.

Sheep I,	500 grms. hay.	200 grms. starch.	50 grms. sugar.	42 grms. asparagin.
" II,	" " "	80 " "	20 " "	250 " peas.

	Albuminoids digested.	Carbhydrates digested.	Fat digested.	Nitrogen of urine.	Flesh gained.
Sheep I,	70.86* grms.	411.25 grms.	9.87 grams.	9.958 grms.	41.23 grms.
" II,	83.54 "	427.49 "	14.08 "	11.099 "	72.51 "

Period III.

Ration. Sheep I and II,
500 grms. hay. 200 grms. starch. 50 grms. sugar. 53 grms. gelatin.

	Albuminoids digested.	Carbhydrates digested.	Fat. digested.	Nitrogen of urine.	Flesh gained.
Sheep I,	66.68* grms.	399.71 grms.	9.23 grms.	8.69 grms.	59.15 grms.
" II,	66.38* "	401.52 "	8.86 "	9.95 "	20.32 "

Period IV.

Ration.

Sheep I,	500 grms. hay.	115 grms. starch.	15 grms. sugar.	200 grms. peas.
" II,	" " "	200 " "	50 " "	53 " asparagin.

	Albuminoids digested.	Carbhydrates digested.	Fat digested.	Nitrogen of urine.	Flesh gained.
Sheep I,	71.24 grms.	441.17 grms.	13 34 grms.	9.730 grms.	49.83 grms.
" II,	84.03* "	424.03 "	9.77 "	11.497 "	58.19 "

* To render the results better comparable the nitrogen of the asparagin and gelatin is, in all cases, multiplied by 6¼ and counted as albuminoids.

These results show plainly that asparagin, at least, is a nutrient and that when added to a fodder already containing albuminoids it may cause a gain of flesh.

It probably acts in the way already suggested, viz., by protecting a portion of the albumoids from oxydation.

That this is the case is indicated by the fact that in these experiments a gain of sulphur by the body was observed. All the albuminoids contain this element while asparagin is free from it, and we therefore must consider it highly probable that the flesh gained by the animals was formed from the albuminoids of the food.

The most important fact shown by the above results, however, is that the gain of flesh caused by the asparagin was very nearly as great as that produced by a quantity of albuminoids containing the same amount of nitrogen.

From this it would appear that, while a ration consisting of asparagin and non-nitrogenous nutrients only, cannot sustain life, the former substance is fully capable of taking the place of a considerable part of the albuminoids and is practically just as valuable as they, *so far as the formation of flesh is concerned*, for increasing the richness of a ration already containing a reasonable amount of albuminoids.

Other Amides.—Whether what Weiske has shown regarding asparagin is true of other amides as well, can of course be decided only by direct experiment; but in the mean time, while we must beware of drawing too general conclusions from a single experiment, it seems highly probable that those amides which other investigators have shown to be decomposed in the body may, like asparagin, contribute to its nourishment. These include several of the more commonly occurring bodies of this class, while only one (acetamide) has been tried with negative results.

But if what is true of asparagin applies to amides in general, then it follows that these bodies as they occur in feeding-stuffs, i. e., associated with comparatively large quantities of albuminoids, are just as valuable for the production of flesh as the latter, since, when fodders containing them are used, we have essentially the conditions of Weiske's experiments, viz: amides added to a fodder containing considerable true albuminoids, and should expect the same results.

None of the experiments yet made touch the very important question of the influence of amides on the production of fat, either as body-fat or milk-fat. It has been conclusively shown that the albuminoids serve as a source of fat in the body but it is difficult to see how fat could be formed from amides. On the other hand it is quite possible that they, like the carbhydrates, may protect the fat of the body or of the food from oxydation.

Conclusions.—We are now prepared to consider how far the results of feeding experiments already made, and the value of analyses of feeding-stuffs stand affected by the fact of the presence of amides in many of our common fodders.

Feeding experiments may be made, first, to ascertain the general laws of animal nutrition, or, second, to determine the amounts of the various nutrients demanded in the fodder of animals under various circumstances, i. e., to establish *feeding-standards.*

Regarding the first of these objects it is sufficient to say here that the general laws of nutrition, so far as they have yet been worked out experimentally, are in no essential respect invalidated by the facts which have been presented here.

As to the second object, the establishment of feeding-standards, it is to be remembered that these feeding-standards are not deduced from any theoretical considerations but are simply the combined results of more or less numerous carefully conducted feeding trials. In these experiments feeding-stuffs have been used which have subsequently been shown to contain amides and their results, when allowance is made for this fact, might be expressed somewhat as follows:

So much digestible albuminoids *and amides*, along with such and such amounts of digestible carbhydrates and fat, proved a suitable ration for the purpose intended.

Now in compounding a ration in accordance with a feeding-standard like the above the farmer would naturally use, to a considerable extent, feeding stuffs similar to those used in the original experiments, and in all probability the proportions of albuminoids and amides in the two rations would not vary very greatly.

Moreover, it would appear from our present knowledge that any difference which might exist would only affect the value of the ration as a fat producer, while as regards the formation of flesh the two rations would be on an equality.

If we add to this the fact that the feeding-standards themselves are but approximations, and are not to be blindly followed but intelligently modified to suit varying circumstances, we

shall see that, in spite of some ambiguity, a feeding-standard may yet be a valuable aid in applying the experience gained by other experimenters to our own particular case.

Still further, if we know, as we easily may, the proportion of albuminoids and of amide-like bodies in the feeding-stuffs which we use, we have, even with our present limited knowledge of the subject, the basis for forming a tolerably intelligent judgment as to whether our ration is deficient in true albuminoids or not.

It is, of course, desirable that feeding-standards should distinguish between albuminoids and amides, and doubtless this will be done to a large extent in future investigations. Meanwhile the considerations here presented seem to show that those which we possess at present are far from having lost their practical value when intelligently used. The study of the nutritive value of amides and other non-albuminoid nitrogenous constituents of feeding-stuffs is scarcely begun as yet and but few certain conclusions have been reached, but all the results hitherto brought to light warn us against hastily concluding that these substances are valueless or pronouncing the results of fodder analyses and feeding experiments to be, on this account, uncertain and misleading.

Examinations of Seeds.

Eight samples of seed have been sent to the Station for examination during the year. One of these was Hungarian grass seed, sent Oct. 6, by J. M. Hubbard, Esq., of Middletown. In a letter of the same date he says: "The sample is from a lot sown the past season which failed to germinate. Its failure involved considerable loss and I desire to know from some good authority whether the fault was in the seed or in my management."

The seed contained only 2.7 per cent. of foreign matter, which was chiefly dust and chaff with a few seeds of other plants, and was practically "pure." But out of 400 seeds which were tested only one germinated. The seed which was worthless in October could scarcely have been otherwise in April.

Seven samples of onion seeds have been sent by Messrs. S. M. & D. Wells, of Wethersfield.

43 is Wethersfield large red.		Crop of 1870.
44 " " "		" 1876.
45 " " "		" 1877.
46 " " "		" 1878.
48 " " "		" 1879.
49 is Yellow Danvers.		" 1879.
50 is White Portugal.		" 1879.

The first four were sent and examined in April, the others late in the year, so that **46**, as well as those following, represents seeds less than one year old.

The results are as follows:

	1,000 Seeds Weighed. (Grams.)	Of 100 Seeds Sprouted. (Vitality.)	Time of Germination.	
			Half Sprouted.	All Sprouted.
43	3.60	0.	—	—
44	4.16	70.	11 days.	17 days.
45	3.44	62.5	9 "	18 "
46	3 74	92.5	6 "	11 "
48	3.91	92.5	5 "	9 "
49	3.49	85.8	4 "	9 "
50	3.72	75.8	4 "	9 "

With regard to the first four samples, Messrs. Wells write: "The samples were all grown by ourselves. It is claimed by many seedsmen that the crop of 1877 is better for planting this season than the crop of 1878. We know from our own observation and experience that 'old seed' is of no value if 'new seed' can be purchased for ten dollars per lb. The old seed has so little vitality that unless the season is exceptionally favorable it will not make a crop. If dealers in seeds would purchase new seeds and not mix in their old stock there would be no trouble with their guarantee."

The Station tests show that the newest seed (1878) is decidedly the best, judged both by the per cent. that sprouted and the promptness of germination. The sample of 1877 seemed to be inferior to that of 1876. The seed of 1870 was worthless.

With regard to the crop of 1879, Messrs. Wells say: "This season at about the time the seed was 'in the milk' we suffered from a severe storm of rain and wind, which beat the seed to the ground and it did not mature as well as it would have done had the weather been favorable. The field on which the White Portugal was sown suffered more severely than the others."

The tests show that while the Wethersfield large red onion is of as good quality as the year before, the Yellow Danvers and especially the White Portugal do not have as high germinating power. Possibly this is due to damage received in the stormy weather alluded to.

Vitality of Seeds.

In his letter of October 9, giving an account of a sediment from a cove on the Connecticut River, Mr. G. I. Stevens of Essex, writes: "I put some of the mud on a worn out pasture and it came up thick with white clover. Where did the seed come from? This mud is under water the year round."

In answer was written: "Why the mud has brought in white clover I cannot say with certainty, but most probably clover seed did not come in the mud. It often happens that when white clover appears like a new growth as a result of some application such as gypsum, ashes, or lime, that the plant already is rooted in the soil but has had only a suppressed and unnoticed existence, until some favorable condition supervenes, which enables it to get the upper hand of the other vegetation and make itself manifest."

Since the above was written, facts have recurred to my recollection which show that the seeds of white clover may have come from the mud.

The investigations of Nobbe (*Handbuch der Samenkunde*, p. 112, and *Landw. Versuchs-Stationen*, XX, 71) have demonstrated that among the seeds of clover and related plants *some, usually a small proportion, are able to resist the action of water* for several months or even years, remaining hard and unswollen and retaining their vitality.

In one experiment 1000 seeds of red clover were soaked in distilled water and then placed in a sprouting apparatus, where they were kept moist and warm for 156 days. In the course of one day 919 of the seeds sprouted, while of the remaining 81, 51 became softened at various times in course of the experiment, and 30 remained entirely unaffected.

In another experiment, out of 64 seeds of white clover remaining hard after 10 days soaking, 16 (= 25 per cent.) softened in course of 282 days more and 8 (= 12½ per cent.) sprouted. Of these 2 sprouted on the 75th day, 2 on the 209th day, and 1 on the 247th day after their first immersion in water. In still another experiment with seeds of the yellow locust (*Robinia pseudacacia*) which was continued nearly two years and nine months the following results were obtained:

	Sprouted.	Rotted.	Remained hard.
Sample 1,	37.5 per cent.	33 per cent.	28 per cent.
" 2,	50 "	35 "	15 "

Of these 71 had sprouted on the 10th day after immersion, 27 more on the 29th day, 20 more on the 152d day, 8 more on the 260th day, 10 more on the 341st day, 5 more on the 462d day, 3 more on the 605th day, 1 more on the 769th day, 3 more on the 853d day, 2 more on the 1012th day.

Prof. Brewer states that according to Pouchet, some seeds of the *Medicago Americana* resisted the action of boiling water for four hours, and afterwards when planted in a suitable soil grew in from 10 to 20 days.

Nobbe has shown that the resistance of seed to the action of water which was observed in his experiments was located in the outer membrane of the seeds, which is *occasionally almost impervious to that liquid.*

On the Determination of Nitrogen.

In the Station Report for 1878* the comparative merits of the two methods employed by chemists for the quantitative determination of nitrogen in agricultural products, were discussed and full details were given of the precautions which our experience has led us to adopt in applying the soda-lime process. The notion that the so-called "absolute method" is more exact than the soda-lime process, and that the albuminoid bodies can only be analyzed by the former method, made it necessary to submit both processes to critical experimental study, and our conclusion was that the two methods, when properly worked, give results that agree within 0.05 to 0.15 per cent. We found, moreover, confirmation of the long recognized fact that the errors of the soda-lime process naturally tend to give a deficiency, and those of the absolute method an excess of nitrogen. We gave but a brief outline of our mode of working the absolute method. The circumstance that other chemists are still undecided as to the merits of the two processes, and that the absolute method must be frequently employed in the analyses of fertilizers containing both nitrates and organic nitrogen, decides us to give a detailed account of the procedure which we have adopted and which gives us so satisfactory results.

REAGENTS.

Cupric oxide.—"Copper scale," which may contain cuprous oxide, coal dust, oil, etc., is mixed in an iron pot with 10 per cent. of potassium chlorate and enough water to make a thin paste. The mass is heated and stirred till dry, the heat is then raised to the point of ignition, and continued until the mass does not glow nor sparkle when stirred.

* Also American Chemical Journal, Vol. 1, p. 74.

The potassium chloride is washed out by decantation and the cupric oxide is dried and moderately ignited.

Metallic copper.—Granular copper oxide, or fine copper gauze is suitable for its preparation. The granular copper is most convenient; copper gauze must be made into rolls adapted to the combustion tube. The copper is reduced and cooled as usual in a stream of hydrogen.

Potassium chlorate.—Commercial potassium chlorate is fused in porcelain and pulverized.

Sodium bicarbonate must contain no organic matter.

Solution of Caustic Potash.—Dissolve commercial "stick potash" in less than its weight of water, making a solution so concentrated that, on cooling, it deposits crystals of potassium hydrate.

The same clear solution may be used for a number of combustions or until the absorption of carbonic acid gas is not quite prompt.

APPARATUS.

The Combustion tube should be of the best hard Bohemian glass, about 2 feet 4 inches long. The rear end is bent and sealed as in Fig. 3.

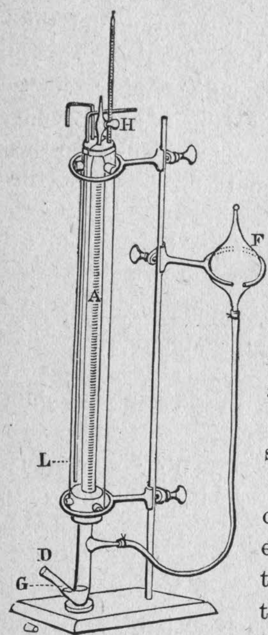
It is best to protect the horizontal part with thin copper foil. The tube is connected with the pump by a close fitting rubber cork, smeared with glycerine.

Azotometer.—This is a modification of the apparatus invented and described by Schiff, *Fres. Zeitschrift*, Bd. 7, p. 430.

It is represented in Fig. 1.

The gas is measured in an accurately calibrated cylinder (burette), A, of 120 c. c. capacity, graduated to fifths of cubic centimeters, and closed at the upper end by a glass stopcock. The lower end is connected by means of a perforated rubber stopper about 1¾ inches long and 1½ inches diameter, with another tube having two arms, one, D, to receive the delivery tube from the pump, the other connected by a rubber tube with a bulb of 200 c. c. capacity, F, through which potash solution is supplied. The graduated tube is enclosed in a water-jacket with an external diameter of about 1¾ inches. Its lower end is closed by the caoutchouc stopper that connects the two parts of the azotometer described above. The upper end of the jacket is closed by a thin rubber disc, slit radially and having four perforations: one in the center, through which the neck of the graduated tube passes, and three others near the circumference.

Fig. 1.



Through one of the latter, a glass tube, L, bent as in the figure, reaches to the bottom of the jacket, another short tube just passes through the disc, and the third hole is for supporting a thermometer. The azotometer is held upright and firm on a stand by rings fitting around the jacket and by cork wedges.

The bulb for potash solution rests in a slotted, sliding ring.

The air pump used, is the Sprengel mercury pump, modified merely so as to be easily constructed and durable. Its essential parts are sketched in Fig. 2. Some of them are exaggerated in order to show their construction more plainly. Through a rubber stopper wired into the nozzle of the mercury reservoir, A, passes a glass tube, B, 4 inches long, this connects by a caoutchouc tube with the straight tube, D, 3 feet long. The rubber tube E, 6 inches long, connects D with a straight glass tube F, of about the same length as D.

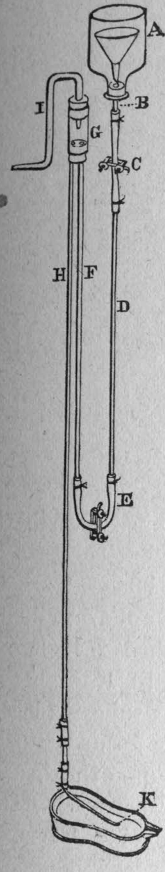
G is a piece of combustion tube 1½ inches long, closed below by a doubly perforated soft rubber stopper admitting the tubes F and H, and above by a singly perforated rubber stopper into which a tube, I, is fitted. The tube H has a length of 45 inches. At the bottom it is connected by rubber with a straight tube of 3 inches, and this again with a tube, K, of 7 inches. The tubes H K should have an internal diameter of 1½ millimeters, F may be 2 millimeters, and D still larger.

We have used for H and F slender Bohemian glass tubes of 4 millimeters exterior diameter. Their elasticity compensates for their slenderness. If heavy barometer tubes be used the stoppers and G must be of correspondingly larger dimensions.

The joints at G must be made with the greatest care.

It is best to insert the lower stopper for half its length into G, having the dimensions of the parts so related that it requires considerable effort to force the slightly greased tubes F and H to their places just through the stopper. The tube I must be of *stout glass*—a decimeter in diameter. It is drawn out at either end to a long taper, and bent as in the figure, in order to bring its free extremity to the level of the combustion furnace. The hole in the upper rubber stopper has a diameter of 5mm., just sufficient to admit the narrowed end of the tube, which, after greasing or moistening with glycerine, is "screwed down" into the stopper.

Fig. 2.



These three joints are the only ones belonging to the pump which have to resist diminished pressure, and require extreme care in making.

If not entirely secure they are to be trapped with glycerine. For this purpose it is needful to pass F and H through a stopper of half an inch greater diameter than G and correspondingly perforated, before entering the latter. Then, previous to inserting I, a tube 4 inches long is slipped over G upon this wider stopper. When I has been inserted and the tubes have been secured to their support, the space between G and the outer tube is filled with the most concentrated glycerine which is prevented from absorbing moisture by corking above.

The two rubber tubes are both provided with stout screw clamps, to admit of exactly regulating the flow of mercury. The tubes D, F, H, and I are secured to a vertical plank framed below into a heavy horizontal wooden foot on which rests the mercury trough, and having above a horizontal shelf through an aperture of which passes the neck of A.

The tubes D, F, H, and I are secured to the plank at several points by wooden or cork clamps, clasping the tubes and fastened by screws or wires.

These fastenings are made elastic by the intervention of a thick rubber tube between the glass and wood. The connections C and E should be made of stout vulcanized rubber, those at the base of H K of fine black rubber.

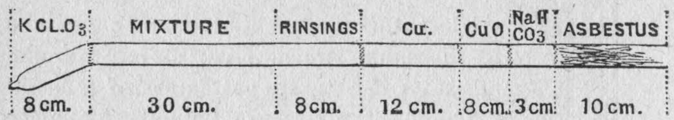
The latter should be soaked in melted tallow previous to use all excess being carefully removed from the interior. The joints should be wound with waxed silk.

A glass funnel is placed within A to prevent spattering of the mercury when it is filled.

OPERATION.

From 3 to 4 grams of potassium chlorate, according to the amount of carbon to be burned, are put into the tail of the combustion tube, Fig. 3, followed by an asbestos plug just at the bend.

FIG. 3.



The substance to be analyzed (0.6–0.8 grams) is well mixed in a mortar with enough cupric oxide that has been *freshly ignited* and allowed to cool, to make a layer 11 or 12 inches long in the tube. The mixture is introduced through a funnel and rinsed with enough cupric oxide to make a layer of 3 inches, a second asbestos plug, and upon it a layer of reduced copper of 4 or 5 inches long are put in, then a third asbestos plug, then 2 inches of cupric oxide, a fourth asbestos plug, then .8 to 1. grams of sodium bicarbonate. The remaining space in the tube is loosely filled with asbestos, to absorb the water which is formed during combustion, and prevent it from flowing back upon the heated glass. The anterior part of the tube containing the cupric oxide and reduced copper is wound with copper foil, leaving, however, a little of the copper (Cu. in fig. 3) visible at its rear. The combustion tube is placed in the furnace at the bend of the tube I, and connected with the latter by a close-fitting rubber stopper smeared with glycerine.

Care must be taken to make the joint perfectly tight. The combustion tube has its conical rubber stopper partly inserted, and is then forced and rotated upon the tapering and stout end of the tube I, the latter being supported by one hand applied at the lower bend.

PREPARATION OF THE AZOTOMETER.

Fill the bottom of the azotometer to about the level indicated by the dotted line G, with mercury. Close the arm D securely with a rubber stopper. Grease the stop-cock H and insert the plug, leaving the cock open.

Pour potash solution into F till A is nearly full, and there is still some solution in the bulb F. Raise the bulb cautiously with one hand, holding the stop-cock H in the other hand. When the solution in A has risen *very nearly* to the glass cock, close the latter, avoiding contact of the alkali with the ground glass bearings. Replace the bulb in the ring and lower it as far as may be. If the level of the solution in the azotometer does not fall in 15 or 20 minutes, it is tight. Place the delivery tube of the pump K in a mercury trough.

Supply the vessel A with at least 500 c. c. of mercury. Cautiously open the clamps C and E. If the mercury does not start at once pinch the rubber at E repeatedly. The mercury should flow nearly as fast as it can be discharged at K, without filling the cylinder G. Five to ten minutes working of the pump will generally suffice to make a complete exhaustion of the combustion tube. If most of the mercury runs out before exhaustion is complete, close the clamp C, return the mercury to A, and repeat the operation. When there is a complete exhaustion, the mercury falls with a rattling or clicking sound. After it has been distinctly heard for half a minute, close the clamp C. If the mercury column in H remains stationary for some minutes, the connections are proved to be tight.

ADJUSTING THE AZOTOMETER.

Remove the mercury trough, placing K in a capsule.

Heat the part of the tube containing sodium bicarbonate. Water vapor and carbon dioxide are evolved, which fill the vacuum in H and expel the mercury. While this is being done place the azotometer near by, remove the bulb F from the ring and support it in a box near the level of D, so that the stopper may be removed from D without greatly changing the level of the mercury G, and so that the azotometer can be moved freely without disturbing it. When the cork in D has been removed fill D half full or more with water.

As soon as the mercury has fully escaped from K insert the latter in D. Let a few bubbles escape through the water and then pass the tube K down so that the escaping gas enters the azotometer. It will much facilitate the delivery of gas if the extremity of the tube K just touches the inside of the azotometer tube, and is kept, as near as possible, to the surface of the mercury.

The carbon dioxide is absorbed in passing through the caustic potash solution. In spite of all precautions very minute bubbles of permanent gas will occasionally ascend, but, as will be seen on observing the amount of potash solution thus displaced, the error thereby occasioned is extremely small.

THE COMBUSTION.

First heat the anterior cupric oxide to full redness, and afterwards the copper. The fine gauze or pulverulent copper very completely reduces any oxides of nitrogen which might be produced in the combustion, and also retains any excess of oxygen which is evolved at the close of the process.

The anterior cupric oxide burns the traces of hydrogen which may be held by the reduced copper, even when the tube is exhausted, and also destroys the carbon monoxide which is usually formed when steam and carbon dioxide pass together over reduced copper, if iron or carbon be present. Go on with the combustion as usual bringing the heat up to a fair redness. The flow of gas may be made quite rapid, say one bubble a second, or a little faster.

When the horizontal part of the tube has all been heated, and the evolution of gas has nearly ceased, heat the potassium chlorate so that it boils vigorously from evolution of oxygen. The reoxidization of the reduced copper oxide and of any unburned carbon proceeds rapidly.

When the oxygen, whose flow admits of easy regulation, begins to attack the anterior layer of reduced copper, stop its evolution and lower the flames all along the tube, keeping the reduced copper still faint red.

After a few minutes start the pump, slowly at first, having some vessel under the tube D of the azotometer to receive the mercury. A few minutes pumping suffices to clear the tube. Remove the azotometer, close the tube D with its rubber stopper, then raise the bulb into its ring to such a height that the potash solution in it shall be at about the same level as that

in the graduated tube. Connect L at its upper end with a water supply, insert a thermometer in the top of the water jacket and let the water run until the temperature and the volume of gas are constant.

Read off the volume of gas and the temperature, after having accurately adjusted the level of the solution in the bulb to that in the azotometer.

Read the barometer and make the calculations in the usual way. When 50 per cent. potash solution is used, no correction need be made for tension of aqueous vapor, as Schiff has shown.

The calculation is somewhat shortened by the use of the table in Jour. of Chem. Soc., Vol. XVIII, (1865), p. 212.

Very fair results are got by employing, with suitable precaution, a stream of carbon dioxide to displace the air of the combustion tube, but the process is very tedious, the sources of error are more numerous, and the results are apt to be higher and not so accordant as when the mercury pump is used to evacuate the tube.

The pump above described has been in use for eighteen months without any repairs, and by its help two or even three analyses may be performed in a day.

The paper in Station Report for 1878, already referred to, gives results of analyses of a variety of substances by the method above described.

Some additional comparative analyses recently made by Dr. Jenkins, on carefully prepared, but not dry, albuminoids have given the subjoined results for nitrogen:

	By Soda Lime.	By Absolute Method.	Average Differences.
Albuminoid of Pea Nuts,	15.95	15.92	——
Legumin of Peas,	15.32–15.27	15.41	0.11
Conglution of Almonds,	16.32–16.37	16.59	0.25

ANALYSES OF NORTH AMERICAN FODDER AND FEEDING STUFFS.

See page 9.

Compiled by Dr. E. H. Jenkins.

In the following list are given references to such published analyses as have not been included in these tables. Some are partial analyses, several proximate elements being left undetermined, others were made on specially selected samples, e. g., on particularly large or small seed, and others were made by methods which prevent comparison with other analyses.

Apple. Trans. N. Y. Ag'l. Soc., 1849, p. 737.

Artichoke. " " " " 1850, p. 339.

Beet. " " " " 1852, p. 323.

Beans. U. S. Dept. Ag., 1878, p. 124.

Buckwheat. U. S. Pat. Off. Rep., 1849, p. 470.

Carrot. Trans. N. Y. Ag'l. Soc., 1852, p. 323.

Celery. " " " 1852, p. 323.

Chicory. Ohio Ag'l. Rep., 1862, p. 254.

Cucumber. Trans. N. Y. Ag'l. Soc., 1852, p. 323.

Endive. " " " 1852, p. 323.

Maize. Trans. N. Y. Ag'l. Soc., 1848, p. 678.

U. S. Pat. Off. Rep., 1849, p. 470.

" " " 1857, p. 160.

" " " 1873, p. 180.

" " " 1875, p. 144.

Muskmelon. Trans. N. Y. Ag. Soc., 1852, p. 323.

Parsnip. " " " 1850, p. 339.

Peanut. U. S. Dept. Ag., 1870, p. 92.

Peas. " " " 1878, p. 124.

Rhubarb. Trans. N. Y. Ag. Soc., 1849, p. 737.

"Tuckahoe." U. S. Dept. Ag., 1871, p. 98.

Vegetable Oyster (salsify). Trans. N. Y. Ag. Soc., 1852, p. 323.

Watermelon. Trans. N. Y. Ag. Soc., 1852, p. 323.

Wheat. Ohio Ag. Rep., 1857, p. 727.

U. S. Pat. Off. Rep., 1840, p. 64.

Yam (Chinese). U. S. Pat. Off. Rep., 1857, p. 165.

In a considerable number of cases analysts have determined sugar, gum, dextrin, wax, &c.

Such analyses have been recalculated, the wax reckoned as fat and the other ingredients collectively as N. fr. (nitrogen-free) Extract. These analyses are indicated as follows:—

† That sugar, gum, albuminoids soluble in alcohol—sometimes called "Zein"—and albuminoids insoluble in alcohol were determined.

* That wax, sugar, gum and dextrin, "amylaceous cellulose" and "alkali extract" were determined.

‡ That sugar and gum were determined.

Albuminoids in all cases signify the percentage of nitrogen multiplied by 6.25.

I. Grain and Other Seeds.

No.	Variety.	Reference.	Analyst.
	Maize (Flint Corn).		
1	Norfolk White, large, 16 rowed, N. C.,..	Rep. Ct. Ag'l. Ex St. '77, p. 57,	S. W. Johnson,
2	Vermont White Cap, 1877, Ct.,........	" " " " "	" "
3	Rowley, 1877, Ct.,..............	" " " " "	" "
4	Western Yellow, ground exclusively for feed. Raised at the West,...........	Rep.Mid.Ag.Ex.St.'77–8, p.29,	W. O. Atwater,
5	Southern White,............	" " " "	" "
6	Yellow or Canada, 8 rowed, Conn., 50 bushels shelled corn to the acre,......	" " " "	" "
7	Early Dutton, 12 rowed, kernels rather small, ...	Am.Jour.Sci.& Arts,'69, p.352,	" "
8	Common Yellow or Canada, 8 rowed, kernels good size,..................	" " " "	" "
9	King Philip or Rhode Island. Brown red, 8 rowed, kernels large,..........	" " " "	" "
10	Smut nose. Mich.,............	Rep. Mich. Bd. Ag. '78, p. 409,	R. C. Kedzie,
11	" " "	" " " "	" "
12	8 Rowed Flint. Mich.,............	" " " "	" "
13	Sanford. Mich ,..............	" " " "	" "
14	Compton's Early. Penn.,..........	Rep.U.S.Dept. Ag.,'78, p. 149,	Peter Collier,
15	Adams. N. Hampshire,..........	" " " "	" "
16	Canada. "	" " " "	" "
17	Vermont. Vermont,..........	" " " "	" "
18	Small 12 rowed. N. Hampshire,.......	" " " "	" "
19	State Fair Premium, "	" " " "	" "
20	Large Premium, "	" " " "	" "
21	Board of Agriculture, "	" " " "	" "
22	King Philip, "	" " " "	" "
23	Pop Corn, white,............	" " " "	" "
24	Improved Prolific, Tennessee,........	" " " 148,	" "
25	White Mexican, Mexico,............	" " " "	" "
26	Oregon White, Oregon,............	" " " "	" "
27	Small, 8 rowed, New Hampshire,.......	" " " "	" "
28	Miscegenation, (white and blue), New Hampshire,..................	" " " "	" "
29	Pitch Knot, New Hampshire,.........	" " " "	" "
30	Tom Thumb, Yellow, New Hampshire,..	" " " "	" "
31	Old Fashioned Yellow, 1878. Conn.,...	Rep. Ct. Ag. Ex. St.,'79, p. 88,	S. W. Johnson,
	Average Composition, (31 Analyses),		
	Maximum,..................		
	Minimum,..................		
	Maize (Dent Corn).		
32	Ohio Dent, 1877, Conn................	Rep. Ct. Ag. Ex. St.'77, p. 57,	S. W. Johnson,
33	Yellow Dent, 1877, Mich.,.......	Rep.Mich.Bd of Ag.,'78,p.408,	R. C Kedzie,
34	" " "	" " " "	" "
35	White " " "	" " " "	" "
36	Hackberry Dent, 1877, Mich.,........	" " " "	" "
37	Strawberry Roan, " "	" " " 409,	" "
38	White Oil, Indiana,..............	" " " "	" "
39	Pony Dent, Mich.,..............	" " " "	" "
40	" "	" " " "	" "

I. Grain and Other Seeds.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-free. Ash.	Water-free. Albuminoids	Water-free. Fiber.	Water-free. N. fr. Extract.	Water-free. Fat.
1	11.17	1.31	10.88	1.90	70.04	4 70	1.48	12.25	2 14	78.84	5.29
2	10.86	1.53	11.06	1.04	71.22	4.29	1.72	12.41	1.17	79.89	4 81
3	11.00	1.61	11.63	.78	70.15	4.83	1 81	13.06	.88	78.83	5.42
4	13.93	1.25	8.82	1.59	70.48	3.92	1.45	10 25	1.85	81.89	4.56
5	13.82	1.32	8.80	0.88	71.07	4.02	1.53	10.31	1.02	82.47	4.67
6	15.10	1.36	10.01	1.24	66.99	5.31	1.60	11.56	1.69	78.90	6.25
‡7	8.08	1.52	9.62	2.52	72.62	5.64	1.66	10.46	2.74	78.98	6.16
‡8	10.52	1.31	9.72	2.40	71.63	4.42	1.46	10.86	2 68	80.06	4 94
‡9	9.79	1.60	11.87	2 21	70.08	4.45	1.77	13 16	2.45	77 69	4.93
‡10	12.90	1.54	11.81	2.00	66.81	4.94	1 76	13 55	2.29	76.63	5.67
‡11	13.26	1.49	11.51	2.49	66.11	5.14	1.72	13 27	2.87	76.21	5 93
‡12	13.45	1.43	12.00	2.26	66.03	4.83	1.65	13.86	2.61	76 30	5.58
‡13	13 37	1.37	10.69	2.10	67.41	5.06	1.58	12.34	2.42	77 82	5.84
†14	6.59	1.64	9 90	2.09	74.48	5 30	1.76	10.59	2.24	79.74	5.67
†15	8.61	1 57	10.50	1.19	73.30	4.83	1.72	11.48	1.30	80 22	5.28
†16	8.27	1.72	11.36	1.26	71.79	5.60	1.87	12.36	1.37	78.29	6.11
†17	8.64	1.45	10.14	1.38	72 76	5.63	1.59	11.10	1.51	79.63	6.17
†18	11.48	1.34	10.50	1.09	69.56	6.03	1.51	11.87	1.23	78.58	6.81
†19	10 19	1 78	10.82	1.06	70.86	5.29	1.98	12 05	1.18	78.90	5.89
†20	10.00	1.46	11.36	1.09	70 57	5.52	1.62	12 63	1.21	78.40	6.14
†21	11.09	1.31	11.55	.82	70.55	4.68	1.47	12.99	.90	79.38	5.26
†22	10 23	1.84	12.08	1.01	67.79	7.05	2.04	13.47	1.13	75.50	7.86
†23	8.61	1.63	13 13	2.32	68.68	5.63	1.78	14.37	2.54	75.15	6.16
†24	7.58	1.23	9.29	2.65	74 16	5.09	1.33	10.05	2.87	80.24	5.51
†25	8.65	1.87	10.15	1.64	72.79	4.90	2.04	11.11	1.79	79 70	5.36
†26	9.25	1.46	7.88	1.26	73.07	7 08	1.61	8.68	1.39	89.52	7.80
†27	11.05	1.57	13.65	1.30	67.63	4.80	1.76	15.35	1.46	76.03	5.40
†28	9.92	1.63	11.72	1.05	70.35	5.33	1.81	13.01	1.17	78.09	5 92
†29	11.24	1 52	11 20	1.04	69.74	5.26	1.71	12.62	1.17	78.58	5.92
†30	9.05	1.60	12.60	1.33	69.53	5.89	1.76	13.85	1 46	76.46	6 47
31	10.58	1.43	9.81	1.39	72.11	4.68	1.60	10.99	1.55	80.63	5.23
	10.58	1.50	10.70	1.56	70.19	5 16	1.67	12.13	1.71	78.72	5.77
	15.10	1.87	13.65	2.67	74.48	7.08					
	6.59	1.25	7.88	.78	66.11	3.92					
32	10.78	1.37	10.06	1.35	71.30	5.14	1.54	11 27	1.51	79.92	5.76
‡33	12.74	1.41	11.75	2.49	66.98	4.63	1.62	13 47	2.85	76.75	5.31
‡34	11.66	1.51	11.48	2.48	67.80	5.07	1.71	12.99	2.81	76.75	5.74
‡35	13 73	1.60	11.52	2.26	66.26	4.63	1.85	13.35	2.62	76.81	5 37
‡36	12.47	1.47	9.88	2 30	69.11	4 77	1.68	11.29	2.74	78.84	5.45
‡37	14 05	1.39	10.31	2.03	67.63	4.59	1.62	12 00	2.36	78 68	5 34
‡38	11.29	1.28	10 50	1.90	70.16	4.87	1.44	11.83	2.14	79.10	5.49
‡39	13.42	1.40	11.25	2.16	66.94	4.83	1 62	12.99	2.49	77.32	5.58
‡40	13.29	1.31	10.63	2.21	67.53	5.03	1.51	12 26	2.55	77.88	5.80

No.	Reference and Remarks.		Name of Analyst.
	Maize (Dent Corn).—Continued.		
41	White Dent, N. Carolina,	Rep. U.S. Dept. Ag., '78, p. 148,	P. Collier,
42	Mexican White Dent, Mexico,	" " " "	"
43	White Prolific, Penn.,	" " " "	"
44	Coe's Prolific, 1878, Conn.,	Rep. Ct. Ag. Ex. St., '79, p. 88,	S. W. Johnson,
45	Benton " "	" " " "	" "
46	Scioto, 1878, Conn.,	Rep. Ct. Ag. Ex. St., '79, p. 88,	" "
47	White Ohio, 1878, Conn.,	" " " "	" "
48	Wisconsin, " "	" " " "	" "
49	White Prolific, " "	" " " "	" "
50	Extra Early Adams, 1878, Conn.,	" " " "	" "
	Average, (19 analyses),		
	Maximum,		
	Minimum		
	Maize (Sweet Corn).		
51	Immature Sweet, Conn., Harvested Aug. 9, 1877,	Rep. Ct. Ag. Ex. St., '78, p. 67,	S. W. Johnson,
52	Immature Sweet, Harvested Aug. 25, '77.	" " "	" "
53	Full grown Sweet, Harvested Sept. 25, '77,	" " "	" "
54	Stow ll's Evergreen Sweet, 12 and 16 rowed. Ears short and thick. Conn.,	Am. Jour. Sci. & Arts, '69, p. 352,	W. O. Atwater,
55	Stowell's Evergreen, N. England,	Rep. U.S. Dept. Ag., '78, p. 148,	P. Collier,
56	Egyptian, Maryland.	" " "	"
57	Red River, Minnesota,	" " "	"
58	Golden Sugar, Mass.,	" " "	"
59	Marblehead, Mammoth, Mass.,	" " "	"
60	Prolific.	" " "	"
61	Proctors, Mass.,	" " "	"
62	Mexican Blue Mexico,	" " "	"
63	Mammoth Sweet, 1878, Conn.,	Rep. Ct. Ag. Ex. St., '79, p. 88,	S. W. Johnson,
	Average, (11 analyses),*		
	Maximum,		
	Minimum,		
	Maize (Unclassified).		
64	Tuscarora, 1877, Conn.,	Rep. Ct. Ag'l Ex. St '77, p. 57,	S. W. Johnson,
65	Tuscarora, 1877, Mich.,	Rep. Mich. Bd. Ag. '78, p. 409,	R. C. Kedzie,
	Average of all varieties, (63 analyses,)		
	Maximum,		
	Minimum,		
	Winter Wheat.		
†1	Michigan White Winter. Milling extra. Detroit inspection. Cleaned for grinding,	Rep. Mid. Ag. Ex. St., '77–8, p. 25,	W. O. Atwater,
2	Missouri Red Fall. St. Louis inspection. Cleaned for grinding,	" " " "	" "
3	Diehl, Mich.,	Rep. Mich., Bd. Ag. '77, p. 350,	R. C. Kedzie,
4	" "	" " " 351,	" "
5	" "	" " " 350,	" "

* 51 and 52 excluded

† These figures differ from those given in *loc. cit.* which have been corrected by the analyst.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-free. Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.
†41	6.74	1.43	11.03	1 53	74.09	5.18	1.53	11.82	1.63	79.47	5.55
†42	11.14	1.45	10.67	1.59	68.87	6.28	1.64	11.99	1.79	77.51	7.07
†43	8.96	1 43	8.05	1.25	74.49	5 82	1.57	8.84	1.37	81.82	6.40
44	9.55	1.45	10.13	2.19	72.70	3 98	1.60	11.21	2.42	80.36	4.41
45	10.70	1.57	9.97	1.36	71.40	5.00	1.76	11.18	1.52	79.94	5.60
46	10.43	1.53	9.25	1.80	72.98	4.01	1.71	10.31	2.01	81.49	4.48
47	9.70	1.79	11.28	1.73	71.30	4.20	1.88	12 50	1.92	78.95	4.65
48	9.72	1.56	11.60	2.06	70.17	4.89	1.73	12.85	2.28	77.72	5.42
49	10.14	1.67	9.19	1.34	73.38	4.28	1.86	10.23	1.49	81.66	4.76
50	10.94	1.75	10.81	1.48	70.21	4.81	1.97	12.14	1.66	78.83	5.40
	11.13	1.48	10.49	1.86	70.20	4.84	1.67	11.81	2.10	78.96	5.46
	14.05	1.79	11 75	2.49	74.49	6 28					
	6.74	1.28	8.05	1.25	66.26	3.98					
(51)	10.12	2.19	14.50	2.57	62.70	7.92	2.44	16.14	2.86	69.75	8.81
(52)	10.09	2.08	15.31	2.52	61.78	8.22	2.31	17.02	2 80	68.73	9.14
53	9.45	2.06	14.38	1.93	63.05	9.13	2 27	15.88	2.13	69.64	10.08
‡54	10.86	1.89	11.10	2.63	65.86	7.66	2.12	12.45	2.95	73.89	8.59
†55	5.98	1.92	11.91	2.66	69 53	8.00	2.04	12.67	2 83	73.95	8.51
†56	7.54	1.92	11.55	2.02	69.17	7.80	2.07	12.58	2.19	74.73	8.53
†57	9.13	1.89	11,73	1.46	66.48	9.31	2.07	12 92	1.60	73.17	10.24
†58	6.27	1.93	14.35	1.58	66.70	9 17	2.06	15.31	1.69	71.16	9.78
†59	6.47	1.92	12.78	1.88	67.95	9.00	2 06	13.67	2.01	72 64	9.62
†60	10.38	1.87	10.33	2 04	67.73	7.65	2.07	11.49	2.26	75.68	8.50
†61	10.13	1.92	12.08	1.75	66.17	7.95	2.14	13.44	1.95	73,63	8.84
†62	8.97	1.42	10.21	1.80	72.35	5 25	1.56	11.22	1.98	79.47	5.77
63	9.43	1.93	12.32	2.75	66 09	7.48	2.13	13.60	3.04	72.97	8.26
	8 59	1.88	12.08	2 04	67.37	8.04	2.06	13.20	2.24	73.62	8.88
	10.86	2.06	14.38	2.75	72 35	9 31					
	5.98	1.42	10.21	1.46	63.05	5.25					
64	11.25	1.47	11.44	1 28	68.82	5.74	1.66	12.89	1.44	77.54	6.47
‡65	14.08	1.52	10.86	1.80	65.97	5.77	1.77	12.64	2.09	76.78	6.72
	10.47	1.56	10.96	1.73	69.69	5 59	1.74	12.22	2.00	77.80	6.24
	15.10	2.06	14.38	2.75	74.49	9.31					
	5.98	1.23	7.88	.78	63.05	3.92					
*1	12.75	1.56	11.64	1.83	70.96	1.26	1.79	13.34	2 10	81.33	1.44
2	13.52	1.55	11.79	1.72	69.95	1.47	1.79	13.63	1.99	80.89	1.70
3	9.64	1.72	12.38	.	76.26	..	1.90	13.69	..	84.41	..
4	12.18	1.82	13.78	..	72.22	..	2.07	15.63	..	82.30	..
5	12.68	1.77	11.81	..	73 74	..	2.03	13.54	..	84.43	..

I. Grain and Other Seeds.

No.	Variety.	Reference.	Analyst.
6	Diehl, Mich.,	Rep. Mich. Bd. Ag. '77, p. 350,	R. C. Kedzie,
7	Soules "	" " " "	" "
8	Soules, British Columbia,	" " " "	" "
9	" " "	" " " "	" "
10	" " "	" " " "	" "
11	Lincoln, Mich.,	" " " "	" "
12	Lincoln, "	" " " "	" "
13	Fultz, "	" " " "	" "
14	" "	" " " "	" "
15	Treadwell "	" " " "	" "
16	" "	" " " "	" "
17	" "	" " " "	" "
18	Buckeye or White Wabash,	" " " "	" "
19	Tappahannock, Mich.,	" " " "	" "
20	Lancaster, "	" " " "	" "
21	Asiatic, "	" " " "	" "
22	Gold Medal, "	" " " "	" "
23	" "	" " " "	" "
24	Egyptian Red, "	" " " "	" "
25	Clawson, "	" " " "	" "
26	" "	" " " "	" "
27	" "	" " " "	" "
28	" "	" " " "	" "
29	" "	" " " "	" "
30	" "	" " " "	" "
31	" "	" " " "	" "
32	" "	" " " "	" "
33	" "	" " " "	" "
34	" "	" " " "	" "
35	" Oregon,	" " " "	" "
36	Weeks, Mich.,	" " " 351,	" "
37	Powers, "	" " " 350,	" "
38	Armstrong, Mich.,	" " " "	" "
39	Tuscan, "	" " " "	" "
40	Post, "	" " " "	" "
41	Sonora Club, Oregon,	" " " 351,	" "
42	Yellow, Missouri,	Rep. U.S. Dept. Ag., '78, p. 147,	P. Collier,
43	Swamp, Ohio,	" " " "	"
44	Victor, Canada,	" " " "	"
45	Silver Chaff, Canada,	" " " "	"
46	Foizy, Oregon,	" " " "	"
47	Brazilian, "	" " " "	"
48	Polish, Md.,	" " " "	"
49	White, Oregon,	" " " "	"
	Average, (49 analyses),		
	Maximum,		
	Minnimum,		
	Spring Wheat.		
50	Improved Fife, Canada,	Rep. U. S. Dept. Ag. '78, p. 48,	P. Collier,
51	Champlain, N. Y.,	" " " "	"
52	Defiance, N. Y.,	" " " "	"

I. Grain and Other Seeds.

No.	Water	Ash.	Albu-minoids.	Fiber.	N. fr. Extract.	Fat.	Water-free. Ash.	Albu-minoids.	Fiber.	N. fr. Extract.	Fat
6	10.25	1.50	11.88	..	76.37	..	1.67	13.24	..	85.09	..
7	11.02	1.73	11.81	..	75.44	..	1.94	12.81	..	84.75	..
8	8.51	1.63	12.25	..	77.61	..	1.78	13.39	..	84.84	..
9	11.22	2.09	11.88	..	74.81	..	2.35	13.34	..	84.29	..
10	10.07	1.89	13.45	..	74.59	..	2.10	14.96	..	82.94	..
11	13.38	1.56	11.90	..	73.16	..	1.80	13.78	..	84.42	..
12	10.78	1.75	11.38	..	76.09	..	1.97	12.76	..	85.27	..
13	11.45	1.74	11.59	..	75.22	..	1.98	13.09	..	84.93	..
14	12.53	1.74	14.47	..	71.26	..	1.99	16.54	..	81.47	..
15	12.69	1.71	12.50	..	73.10	.	1.96	14.31	..	83.73	..
16	9.94	1.80	11.69	..	76.57	..	2.02	12.99	..	84.99	..
17	10.00	1.76	11.88	..	76.36	..	1.96	13.20	..	84.84	..
18	12.73	1.38	10.97	..	74 92	..	1.58	12 69	..	85.73	..
19	11.21	1.77	13 56	..	73.46	..	2.00	15.27	..	82.73	..
20	11.93	1.82	14.00	..	72.25	..	2.06	15.88	..	82.06	..
21	11.11	1.70	12.25	..	74.94	..	1.91	13.78	..	84.31	..
22	10.55	1.73	11.15	..	76.57	..	1.93	12.47	..	85.60	..
23	10.12	2.00	13.06	..	74.82	..	2.23	14.51	..	83.26	..
24	11.48	1.69	11.19	..	75.64	..	1.91	12.64	..	85.45	..
25	12.29	1.64	11.88	..	74.19	..	1.87	13.54	..	84.59	..
26	11.30	1.74	10.94	..	76.02	..	1.97	12.33	..	85.70	..
27	12.29	1.79	11.16	..	74.76	..	2.06	12.72	..	85.22	..
28	10.36	1.64	11.81	..	76.19	..	1.83	13.21	..	84.96	..
29	11.19	1.76	12 06	..	74.99	..	1.99	13.59	..	84.42	..
30	11.09	1.64	12.38	..	74.89	..	1.85	13.93	.	84.22	..
31	11.08	1.49	12.25	..	75.18	..	1,68	13.78	..	84.54	..
32	10.43	1.70	12.69	..	75.18	..	1.90	14.17	..	83.93	..
33	10.31	1.60	12.25	..	75.84	..	1.78	13.66	..	84.56	..
34	13.00	1.79	11.37	..	73.84	..	2.05	13.07	..	84.88	..
35	12.99	1.77	10.50	..	74.74	..	2 03	12.07	..	85.90	..
36	10.03	1.59	11.00	..	77.38	..	1.77	12.22	..	86.01	..
37	10.85	1.70	12.03	..	75.42	..	1.91	13.50	..	84.69	..
38	12.21	1.97	12.88	..	72.94	..	2.24	14.66	..	83.10	..
39	13.77	1.72	11.37	..	73.14	..	1.99	13.19	..	84.82	..
40	10.27	1.58	11.25	..	76.90	..	1.76	12.54	..	85.70	..
41	10.91	1.46	10.63	..	77.00	..	1.63	11.93	..	86 44	..
†42	7.69	1.91	11.59	1.53	75.17	2.11	2.07	12.56	1.66	81.42	2.29
†43	7.63	1.84	11.59	1.54	74.99	2.41	2.00	12.55	1.67	81.17	2.61
†44	7.49	1.39	9.45	1 69	77 71	2.27	1.50	10.22	1.83	84.01	2.44
†45	8.93	1.58	9.89	1.75	75.41	2.44	1.73	1[illegible].86	1.92	82.81	2.68
†46	8.98	1.57	8.40	1.25	77.52	2.28	1.73	9 23	1.37	85 16	2.51
†47	9.29	1.77	9.45	1.17	76.33	1.99	1.95	10.42	1.29	84.15	2.19
†48	10.08	1.67	12.43	1.56	71.59	2.67	1.86	13.82	1.73	79.62	2.97
†49	9.52	1.57	8.58	1.53	77.11	1.69	1.74	9.47	1.68	85.24	1.87
	10.93	1.70	11.71		75.66		1.91	13.13		84.96	
	13.17	2.09	14.47		81.67						
	7.49	1.38	8.40		71.26						
†50	8.50	1.47	14.70	1.62	71.15	2.56	1.61	16 07	1.77	77.75	2.80
†51	8.79	2.05	15.40	1.49	69.72	2.55	2.25	16.89	1.63	76.43	2.80
†52	8.12	1.57	14.00	2.04	71.78	2.49	1.71	15.23	2.22	78.13	2.71

I. Grain and Other Seeds.

No.	Variety.	Reference.	Analyst
53	Chili Club, Oregon, ...	Rep. U. S. Dept. Ag. '78, p. 48,	P. Collier,
54	Noah Island, Oregon, ...	" " " "	"
55	Spring Wheat, Minnesota, ...	Rep. Mich. Bd. Ag., '77, p. 350,	R. C. Kedzie,
	Average, (6 analyses), ...		
	Maximum, ...		
	Minimum, ...		
	Average of all wheats, (55 analyses), ...		
	Oats.		
*1	Probably Illinois "No. 1 White Oats." ..	Rep. Mid. Ag. Ex. St., '77–8, p. 27,	W. O. Atwater,
2	Conn., 1877, 30 bush. per acre, ...	" " " "	" "
	Average, (2 analyses), ...		
	Rye.		
1	White Winter, Penn., ...	Rep. U.S. Dept. Ag., '78, p. 148.	P. Collier,
	Barley.		
1	Nepaul, Cal., ...	" " " "	"
	Cow Pea—(Dolichos).		
1	Black Cow Pea. Taken when seeds were ripe, ...	Rep. N.C. Ag. Ex. St. '79, p. 112.	A. R. Ledoux,
2	Yellow Cow Pea. Taken when seeds were ripe, ...	" " " 113,	" "
	Average, (2 analyses), ...		

* These figures differ from those given in *loc. cit.*, which have been corrected by the analyst.

I. Grain and Other Seeds.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-free. Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.
†53	7.90	1.56	8.14	1.41	78 68	2.33	1.69	8.83	1.53	85.42	2.53
†54	9.64	2.00	9.80	1.92	74.58	2.06	2.21	10.84	2.12	82 55	2 28
55	11.13	1 95	14.00	..	72.92	..	2.20	15.75	..	82.05	..
	9.01	1.76	12.67	..	76 56	..	1.94	13.93	..	84.13	..
	11.13	2.05	15.40	..	82.42	..					
	7.90	1.47	8.14	..	72.92	..					
	10.72	1.70	11.82	..	75.76	..	1.90	13.24	..	84.86	..
1	11.23	2.91	11.54	12.18	57.08	5.06	3.28	13.00	13.72	64.30	5.70
2	12.36	3.03	8.00	12.89	59.02	4.70	3.46	9.13	14.71	67.34	5.36
	11.79	2.97	9.77	12.53	58.06	4.88	3.37	11.07	14.22	65.81	5.53
†1	8.68	1.87	12.07	1.40	73.91	2.07	2.04	13.21	1.54	80.95	2.26
†1	7.23	1.94	13.17	1.55	72.96	3.15	2.09	14.19	1.67	78.65	3.40
1	20.85	2.94	20.08	4.34	50.51	1.28	3.72	25.37	5.48	63.81	1.62
2	19.20	3.31	23.02	5.03	48.07	1.37	4.10	28.50	6.23	59.49	1.68
	20.02	3.13	21.55	4.68	49.29	1.33	3.91	26.93	5.86	61.65	1.65

No.	Variety.	Reference.	Analyst.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-free. Ash.	Water-free. Albuminoids.	Water-free. Fiber.	Water-free. N. fr. Extract.	Water-free. Fat.
	Maize Meal.													
1	From Feed Store. Conn.,	Rep. Ct. Ag. Ex. St., '77, p. 56,	S. W. Johnson,	12.91	1.17	8.69	1.79	71.93	3.51	1.34	9.97	2.06	82.60	4.03
2	New Home-Ground Yellow Flint, Conn.,	" " " "	" "	20.67	1.17	7.81	0.93	66.35	3.07	1.48	9.85	1.17	83.63	3.87
3	Western Corn, Conn.,	" " " "	" "	21.67	1.16	7.38	1 41	65.88	2.50	1.48	9.42	1.80	84.11	3.19
	Average, (3 analyses),			18.41	1.16	7.96	1.38	68.02	3.03	1.43	9.75	1.68	83.45	3.69
	Maximum,			21.67	1.17	8.69	1.79	71.93	3.51					
	Minimum,			12.91	1.16	7.38	.93	65.88	2.50					
	Wheat Flour. From Winter Wheat.													
1	Diehl, Mich.,	Rep. Mich. Bd. Ag., '77, p. 350,	R. C. Kedzie,	8.28	.62	10.94	..	80.16	..	.68	11.93	..	87.39	..
2	" "	" " " "	"	9.29	.65	9.71	..	80.35	..	.72	10.71	..	88.57	..
3	Soule's, "	" " " "	"	10.65	.62	10.00	..	78.73	..	.69	11.19	..	88.02	.
4	Fultz, "	" " " "	"	9.69	.66	8.94	..	80.71	..	.73	9.90	..	89.37	..
5	Treadwell, "	" " " "	"	10.46	.66	10.63	..	78.25	..	.73	11.87	..	87.40	..
6	Buckeye, "	" " " "	"	10.66	.63	9.69	..	79.02	..	.71	10.86	..	88.43	..
7	Asiatic, "	" " " "	"	9.66	.64	11.00	..	78.70	..	.71	12.18	..	87.11	..
8	Gold Medal, "	" " " "	"	9.56	.67	9.80	..	79.97	..	.74	10.84	..	88.42	..
9	" " "	" " " "	"	9.66	.64	11.01	..	78.69	..	.71	12.19	..	87.10	..
10	Egyptian red, "	" " " "	"	9.71	.66	10.75	..	78.88	..	.73	11.90	..	87.37	..
11	Clawson, "	" " " "	"	9.93	.63	11.25	..	78.19	..	.70	12.49	..	86.81	..
12	" "	" " " "	"	10.69	.64	9.62	..	79.05	..	.72	10.78	..	88.50	..
13	Weeks, "	" " " "	"	9.10	.65	10.50	..	79.75	..	.72	11.55	..	87.73	..
14	Powers, "	" " " "	"	10.15	.48	11.59	..	77.78	..	.53	12.91	..	86.56	..
15	Armstrong, "	" " " "	"	12.61	.63	12.25	..	74.51	..	.72	14.02	..	85.26	..
16	Tuscan, "	" " " "	"	13.43	.72	10.94	..	74.91	..	.83	12.63	..	86.54	..
	Average, (16 analyses),			10.22	.63	10.54	..	78.61	..	.70	11.74	..	87.56	..
	Maximum,			13.43	.72	12.25	..	80.71						
	Minimum,			9.10	.48	8.94	..	74.51						
	From Spring Wheat.													
17	Tea Wheat Flour, Kansas,	Rep. Mich. Bd. Ag., '77, p. 350,	R. C. Kedzie,	12.43	.59	13.56	..	73.42	..	.67	15.48	..	83.85	.
18	Grass Wheat, "	" " " "	"	11.92	.59	13.31	..	74.18	..	.67	15.06	..	84.27	..
19	Early May, "	" " " "	"	10.70	.57	11.37	..	77.36	..	.64	12.73	..	86.63	..
20	Blue Stem, "	" " " "	"	10.99	.57	11.37	..	77.07	..	.64	12.76	..	86.60	..
21	Mammoth Spring, "	" " " "	"	10.96	.69	13.31	..	75.04	..	.78	14.96	..	84.26	..
	Average, (5 analyses),			11.40	.60	12.58	..	75.42	..	.68	14.19	..	85.13	..
	Maximum,			12.43	.69	13.56	..	77.36						
	Minimum,			10.70	.57	11.37	..	73.42						
22	Minnesota Flour, Minnesota,	Rep. Mich. Bd. Ag., '77, p. 350,	R. C. Kedzie,	11.78	.49	12.25	..	75.49	..	.56	13.88	..	85.56	..
23	" " "	" " " "	" "	12.80	.55	12.50	..	74.15	..	.63	14.33	..	85.04	..
24	Patent Process Flour, Mich.,	" " " "	" "	10.31	.60	10.94	..	78.15	..	.67	12.19	..	87.14	..
*25	" New Process Flour," Conn.,	Rep. Mid. Ag. Ex. St. '77-8, p. 25,	W. O. Atwater,	13.50	0.42	10.92	none	74.04	1.12	0.49	12.63	..	85.58	1.30
*26	" No. 1 Flour,"	" " " "	" "	11.98	0.46	8.71	"	78.11	0.74	0.52	9.88	..	88.76	0.84
*27	" No 2 Flour,"	" " " "	" "	12.46	0.50	8.56	"	77.92	0.56	0.57	9.75	..	89.04	0.64
*28	" No. 3 Flour,"	" " " "	" "	10.30	0.55	9.59	"	78.52	1.04	0.61	10.69	..	87.54	1.16
	Average of all varieties, (28 analyses),			10.84	.60	10.89	..	77.67		.67	12.22		87.11	
	Maximum,			13.50	.72	13.56	..	80.71						
	Minimum,			9.10	.42	8.56	..	73.42						
1	Barley Meal,	Rep. Mid. Ag. Ex. St., '77-8, p. 27,	W. O. Atwater,	9 85	3.77	12.68	7.00	63.46	3.24	4.18	14.06	7.76	70.41	3.59
1	Rice Meal	" " " "	" "	15.11	6.03	9.25	8.12	59.88	1.61	7.10	10.94	9.56	70.50	1.90

* These figures differ from those given in *loc. cit.*, which have been corrected by the analyst.

III. By Products and Refuse.

No.	Variety.	Reference	Analyst.
1	Linseed Meal, sold in Conn., ...	Rep. Mid. Ag. Ex. St. '77–8, p. 38	W. O. Atwater,
2	" " "	Rep. Conn. Ag. Ex. St., '79, p. 93,	S. W. Johnson,
3	Ohio Round Cakes, ...		
4	Western Cake, ...		
5	Boston Cake, ...		
6	North American Cake, ...	Trans. High. and Ag. Soc., '55, July, p. 50,	
7	" " "		
8	Albany Cake, ...		Dr. Anderson,
9	Finest American Cake, ...		
10	" " "		
	Average, (10 analyses,)		
	Maximum, ...		
	Minimum, ...		
1	Cotton Seed Meal. Sold in Conn., ...	Rep. Mid. Ag. Ex. St. '77–8, p. 38,	W. O. Atwater,
2	" " " " N. Hampshire,	Rep. Dept. Ag., '78, p. 146,	P. Collier,
3	" " Cake. " Conn., ...	Trans. Ct. Ag. Soc., 1857, p. 84,	S. W. Johnson,
	Average, (2 analyses), ...		
	Maximum, ...		
	Minimum, ...		
1	Palm Nut Meal. Sold in N. Y. City, ...	Rep. Mid. Ag. Ex. St., '77, p. 38,	W. O. Atwater,
1	"Hominy Chops." Sold in Conn., ...	Rep. Ct. Ag. Ex. St., '79, p. 93,	S. W. Johnson,
2	" " " "	" " " "	" "
1	"Corn Feed." Waste product from Starch manufacture. Sold in Conn., ...	" " " '78, p 76,	" "
2	"Starch Feed,"	Rep. Mid. Ag. Ex, St. '77–8, p. 38,	W. O. Atwater,
	Maize Cob.		
1	Maize Cob Immature Sweet. Harvested Aug. 9, '77. Conn., ...	Rep. Ct. Ag. Ex St., '78, p. 72,	S. W. Johnson,
2	Immature Sweet. Harvested Aug. 25, '77. Ct.	" " " " "	" "
3	Sweet. Harvested Sept. 25, '77. Conn.,	" " " " "	" "
4	Ohio Dent. Crop, 1877. Conn., ...	" " " " "	" "
5	Norfolk White. N. Carolina.	" " " " "	" "
6	Tuscarora. Crop, 1877. Conn., ...	" " " " "	" "
7	Vt. White Cap, " "	" " " " "	" "
8	Rowley " "	" " " " "	" "
9	Canada Yellow. Conn., ...	" " " " "	" "
10*	Eight Rowed Yellow. Conn., ...	Rep. Mid. Ag. Ex St., '77–8, p. 29,	W. O. Atwater,
11	Cob Meal. Maryland, ...	U. S. Dept. Ag., '78, p. 136,	P. Collier,
	Average (9 analyses), ...		
	Maximum, ...		
	Minimum, ...		

* These figures differ from those given in *loc. cit.*, which have been corrected by the analyst.

III. By Products and Refuse.

No.	Water	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-free. Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.
1	9.13	8.16	32.43	7.26	31.45	11.57	8.98	35.69	7.99	34.61	12.73
2	10.76	6.71	35.64	8.86	35.22	2.81	7.50	39.92	9.91	39.52	3.15
3	8.70	5.17	30.94	4.48	37.54	13.17	5.66	33.89	4.91	41.12	14.42
4	9.08	5.49	28.45	5 52	35.79	15.67	6.03	31.26	6.07	39.39	17.25
5	8.80	7.22	28.32	8.37	33.82	13.47	7.91	31.05	9.18	37.10	14.76
6	9.32	7.24	26.00	7.83	38.02	11.59	7.98	28.67	8.63	41.94	12.78
7	9.76	5.73	29.50			9.57	6.32	32.70			10.61
8	8.54	6.85	27.17	..	45.44	16.15	7.49	29.70	..	50.37	17.65
9	9.96	6.48	27.82	..	41.29	10.96	7.20	30.92	..	45.16	12.17
10	9.72	5.56	28.07	15.73	29.05	13.18	6.15	31.09	17.49	32.22	14.60
				12.27	31.20				13.59	34.57	
	9.38	6.46	29.43	*8.80	*34.12	11.81	7.13	32.48	9.70	37,66	13.03
	10.76	8.16	35.64	15.73	38.02	16.15					
	8.54	5.17	26.00	4.48	29.05	2.81					
1	7.24	5.83	41.45	3.08	24.39	18.01	6.28	44.69	3.32	26.29	19.42
2	8.27	7.77	46.37	..	..	..	8.48	50.57	..	..	..
3	6.82	7.80	44.41	11.76	12.74	16.47	8.37	47.65	12.61	13.70	17.67
	7.03	6.82	42.93	7.42	18.56	17.24	7.33	46.17	7.98	19.98	18.54
	8.27	7.80	46.37	11.76	24.39	18.01					
	6.82	5.83	41.45	3.08	12.74	16.47					
1	7.90	3.99	13.53	18.75	41.05	14.78	4.33	14.69	20.36	44.57	16.05
1	13.53	2.44	9.50	3.19	62.02	9.32	2.82	10.88	3.70	71.83	10.77
2	11.56	2.67	9.82	4.79	62.58	8.58	3.01	11.10	5.43	70.78	9.68
1	62.27	.27	5.67	1.58	28.90	1.31	.70	15.03	4.19	76.62	3.46
2	72.19	.12	3.56	3.36	18.78	1.99	.43	12.88	12.05	67.49	7.15
1	(10.10	6.70	8.56	21.40	51.14	2.10)	7.45	9.52	23.80	56.89	2.34
2	(9.02	2.60	3.00	29.63	54.91	0.84)	2.86	3.30	32.56	60.36	.92
3	8.82	1.47	2.69	30.57	55.53	0.92	1.61	2.95	33.54	60.89	1.01
4	8.21	.97	2.56	30.99	56.99	.28	1.06	2.79	33.75	62.10	.30
5	7.18	1.33	1.81	29.80	59.57	.31	1.43	1.94	32.10	64.20	.33
6	8.37	1.57	2.56	30.01	57.15	.34	1.71	2.79	32.75	62.38	.37
7	8.40	.96	2.63	30.47	57.21	.33	1. 5	2.87	33.27	62.45	.36
8	8.05	.98	1.81	32.39	56.54	.23	1.07	1.97	35.21	61.50	.25
9	7.52	2.14	2.35	29.76	57.72	.51	2.31	2.54	32.1	62.43	.55
10	11.45	1.36	1.23	38.26	47.62	.08	1.52	1 38	43.21	53.80	.09
11‡	14.42	1.12	2.33	36.10	45.31	.72	1.31	2.72	42.18	52.95	.84
	9.16	1.32	2.22	32.04	54.85	.41	1·45	2.44	35.31	60.35	.45
	14.42	2.14	2.69	38.26	59.57	.92					
	7.18	.96	1.23	29.76	45.31	.08					

* Average of 8 analyses.

III. By Products and Refuse.

No.	Variety.	Reference.	Analyst.
	Wheat Bran and Middlings.		
1	"Coarse Wheat Feed," from White Wheat, Conn., ...	Rep. Ct. Ag. Ex. St., '77, p. 59,	S. W. Johnson,
2	"Coarse Wheat Feed," from Red Wheat. Conn., ...	" " " "	" "
3	Western Wheat Bran, Conn., ...	" " " "	" "
4	"Fine Feed,"—Ground Bran, Conn., ...	" " " "	" "
5	Wheat Middlings, Conn., ...	" " " "	" "
6	"Wheat Shorts," Conn., ...	Rep. Mid. Ag. Ex. St. '77–8, p. 26,	W. O. Atwater,
7	"No. 2 Middlings," "	" " " "	" "
8	"No 1 Middlings," "	" " " "	" "
9*	"Purified Middlings," Conn., ...	" " " "	" "
10	"St. Louis Shorts," 1872, ...	Bull. Bussey Inst., '74, p. 27,	F. H. Storer,
11	"Illinois Shorts,"	" " " "	" "
12	"Michigan Shorts,"	" " " "	" "
13	"St. Louis Middlings,"	" " " "	" "
14	"Illinois Middlings,"	" " " "	" "
15	"St. Louis Ship Stuff,"	" " " "	" "
16	Bran. Mich., ...	Rep. Mich. Bd. of Ag., '78, p. 410,	R. C. Kedzie,
17	"Shorts," "	" " " "	"
18	"Middlings," "	" " " "	"
19	"Mill Feed," "	" " " "	"
	Average, (18 analyses), ...		
	Maximum, ...		
	Minimum, ...		
	Rye Bran.		
1	Sold in Conn., ...	Rep. Ct. Ag. Ex. St., '78, p. 75,	S. W. Johnson,
2	" "	Rep. Mid. Ag. Ex. St., '77, p. 27,	W. O. Atwater,
	Average, (2 analyses), ...		
	Malt Sprouts.		
1	Sold in Conn., ...	Rep. Ct. Ag. Ex. St., '77, p. 50,	S. W. Johnson,
	Brewers Grains.		
1	Sold in New York, 1 bush. = 70 lbs., ...	Rep. Mid. Ag. Ex. St., '77–8, p. 38,	W. O. Atwater,
2	" " 1 " = 40 lbs., ...	Rep. Ct. Bd. Ag., '72, p. 423,	S. W. Johnson,
3	" "	Rep. Dept. Ag., '78, p. 137,	P. Collier,
	Date Stones.		
1	From Light Colored, Sugar Cured Dates,	Bull. Bussey Inst., '76, p. 375,	F. H. Storer,
2	From Dark Colored, Molasses Cured Dates	" " " "	"
1	*Peach Stones,*	" " " "	"
	Prune Stones.		
1	From French Prunes, ...	" " " "	"

* Has more nearly the composition of flour.

III. By Products and Refuse.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-Free. Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.
1	10.87	5.75	13.63	7.56	58.92	3.27	6.46	15.30	8.47	66.13	3.64
2	11.14	5.99	12.13	9.31	58.36	3.07	6.73	13.65	10.47	65.65	3.50
3	12.12	6.33	13.50	8.79	55.90	3.36	7.21	15.36	10.11	63.48	3.84
4	10.47	5.56	13.88	7.98	58.88	3.23	6.22	15.51	8.92	65.73	3.62
5	10.56	3.45	14 22	5.35	62.90	3.52	3.86	15.91	5.97	70.32	3.94
6	11.31	3.94	13.91	6.34	62.10	2.50	4.44	15.68	7.04	70.02	2.82
7	12 27	4.06	13.33	7.45	61.21	2.68	4.63	15.19	8.50	68.63	3.05
8	11.32	1.39	10.48	3.88	70.86	2.07	1.57	11.82	4.38	79.90	2.33
(9	12,35	0.50	10.40	none	75.50	1.24)	0.57	11.87	..	86.14	1.42
10	12.23	4.53	12.06	7.12	60.05	4.01	5.17	13.73	8.11	68.44	4.55
11	10 96	4.24	11.13	7.29	62.32	4.06	4.76	12.51	8.20	69.96	4.57
12	11.77	4.06	12.75	10.47	56.30	4.65	4.59	14.46	11.87	63.80	5.28
13	12.08	1.57	11.06	3.57	69.21	2.51	1.79	12.58	4.06	78.72	2.85
14	13.30	2 71	10.13	5.35	64.80	3.71	3.12	11.68	6.17	74.75	4.28
15	11.81	2.25	11.12	5.59	66.46	2.77	2.55	12.67	6.34	75.32	3.14
16	11.65	5.63	14.00	9.13	55.56	4.03	6.37	15.83	10.31	62.93	4.56
17	11.26	3.95	15.13	7.46	57.35	4.85	4.46	17.07	8.41	64.59	5.47
18	11.27	2.11	13.75	3.47	65.71	3.69	2.38	15.49	3.91	74.06	4.16
19	11.29	2.24	11.38	5.22	65.52	4.35	2.50	12.83	5.88	73.89	4.90
	11.53	3.82	12.64	6.74	61.81	3.46	4.31	14.28	7.60	69.90	3.91
	13.30	6.33	14.22	10.47	70 86	4.85					
	10.47	1.39	10.13	3.47	55.56	2.07					
1	10.30	3.54	16.81	4.07	62.68	2.60	3.95	18.74	4.54	69.87	2.90
2	12.88	2.89	12 58	2.54	66.96	2.15	3.32	14.44	2.92	76.85	2.47
	11.59	3.21	14.69	3.31	64.82	2.38	3.63	16.62	3.74	73.32	2.69
1	11.55	6.68	25.91	9.30	45.47	1.09	7.54	29.29	10.52	51.52	1.13
1	75.24	0.29	5.94	3.87	13.19	1.47	1.18	24.06	15.62	53.20	5.92
2	78.50	1.07	4.69	3.11	12.63	..	4.98	21.81	14.46	58	.72
3‡	10.24	2.70	21.66	14.88	43.86	6.66	3.01	24.11	16.57	48.89	7.42
1	7.71	1.05	5.16	24.07	53.06	8.95	1.13	5.60	26.09	57.59	9.69
2	10.83	1.02	5.75	22.06	52.29	8.05	1.14	6.45	24.73	58.65	9.03
1	5.53	0.36	0.58	70.63	22.81	0.09	.38	.61	74.73	24.18	.10
1	10.96	0.40	0.31	48.74	38.87	0.72	.45	.35	54.76	43.63	.81

IV. Hay.

No.	Variety.	Reference.	Analyst.
	Timothy Hay (Phleum pratense.)		
1	Crop 1876, Maine. Clayey loam, heavy, wet. Since '72 in grass. Well headed out,..................	Rep. Mid. Ag. Ex. St. '77–8, p. 31,	W. O. Atwater,
2	Crop 1876, Maine. Clayey loam, heavy, wet. Since '72 in grass. In full blossom,..................	" " " "	" "
3	Crop 1876, Maine Clayey loam, heavy, wet. Since '72 in grass. Past blossom,..................	" " " "	" "
4	Crop 1876, Maine. Clayey loam, heavy, wet. Since '72 in grass. Nearly ripe,	" " " "	" "
5	Crop of 1879. Conn.,..................	Rep. Ct. Ag. Ex. St., '79, p. 80,	S. W. Johnson,
6	N. Hampshire July 1, 1878, }	" " " "	" "
7	" " 11, 1878, }	" " " "	" "
8	Crop 1877. Conn.,..................	" " " "	" "
9	Crop 1877. Conn.,..................	" " " "	" "
	Average, (9 analyses),..................		
	Maximum,..................		
	Minimum,..................		
	Hay, mostly timothy and red-top.		
1	Crop 1879. Conn.,..................	Rep. Ct. Ag Ex. St., '79, p. 80,	S. W. Johnson,
2	" 1879. "	" " " "	" "
3	" 1877. "	" " " "	" "
4	" 1877. "	" " " "	" "
	Hay, mostly timothy and blue grass.		
5	Crop 1877. Conn.,..................	Rep. Ct. Ag. Ex. St., '79, p. 80,	S. W. Johnson,
	Hay, mixed meadow grasses.		
6	Crop 1877. Conn.,..................	Rep. Ct. Ag. Ex. St., '79, p. 80,	S. W. Johnson,
7	" 1877. "	" " " "	" "
	Average (7 analyses),..................		
	Maximum,..................		
	Minnimum,..................		
	Hay, containing much clover.		
1	Crop 1879. Conn.,..................	Rep. Ct. Ag. Ex. St., '79, p. 80,	S. W. Johnson,
2	" 1879. "	" " " "	" "
3	" 1877. "	" " " "	" "
4	" 1877. "	" " " "	" "
5	" 1877. "	" " " "	" "
	Average (5 analyses),..................		
	Maximum,..................		
	Minimum,..................		
	Clover Hay, (Trifolium pratense).		
1	Maine. Crop 1875. Poor loam, well manured, cut just before blossom,..................	Rep. Mid. Ag. Ex. St., '77–8, p. 32,	W. O. Atwater,
2	Maine. Crop 1876. Poor loam, well manured, cut in full blossom,..................	" " " "	" "

IV. Hay.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-Free. Ash.	Water-Free. Albuminoids.	Water-Free. Fiber.	Water-Free. N. fr. Extract.	Water-Free. Fat.
1	12.5*	4.10	8.37	28.90	44.42	1.71	4.69	9.57	33.03	50.74	1 95
2	12.5*	3.81	6.23	29.12	46.63	1.71	4.35	7.12	33.28	53.29	1.96
3	12.5*	3.53	6.18	29.56	46.70	1.53	4.15	7.06	33.78	53.26	1.75
4	12.5*	3.22	5.86	31.00	45.69	1.73	3.65	6.81	35.43	52.19	1.97
5	14.3*	3.27	4.88	32.81	43.29	1.45	3.80	5.69	38.28	50.55	1.68
6	14.3*	4.10	6.20	25.30	48.10	2.00	4.78	7.24	29.53	56.12	2.33
7	14.3*	3.80	5.30	27.50	47.20	1.90	4.43	6.19	32.09	55.07	2.22
8	14.3*	4.38	5.57	29.48	45.19	1.08	5.11	6.50	34.40	52.74	1.25
9	14.3*	4.60	6.90	26.80	45.40	2.00	5.37	8.05	31.28	52.99	2.33
	13.50	3.87	6.16	28.94	45.85	1.68	4.47	7.11	33.45	53.03	1.94
	14.30	4.60	8.37	32.81	48.10	2.00					
	12.50	3.22	4.88	25.30	43.29	1.08					
1	14.3*	5.57	7.85	24.72	45.08	2.48	6.50	9.15	28 85	52.60	2.90
2	14.3*	6.86	8.97	28.45	39.20	2.22	8.00	10.46	33.20	45.74	2.60
3	14.3*	4.81	6.02	26.54	46.88	1.45	5.61	7.02	30.98	54.71	1.68
4	14.3*	4.90	7.50	26.30	45.30	1.70	5.72	8.75	30.70	52.85	1.98
5	14.3*	4.70	7.00	26.90	45.40	1.70	5.48	8.17	31.41	52.96	1.98
6	14.3*	4.23	7.02	27.82	45.00	1.63	4.93	8.18	32.47	52.52	1.90
7	14.3*	4.56	6.50	25.89	47.33	1.43	5.31	7.57	30.24	55.23	1.65
	14.30	5.09	7.26	26.66	44.89	1.80	5.93	8.47	31.10	52.40	2.10
		6.86	8.97	28.45	47.33	2.48					
		4.23	6.02	24.72	39.20	1.43					
1	14.3*	5.30	14.42	19.66	43.23	3.09	6.19	16.82	22.95	50.54	3.60
2	14.3*	6.49	11.62	23.06	42.07	2.46	7.57	13.56	26.90	49.09	2.88
3	14.3*	5.10	10.60	24.90	42.40	2.70	5.95	12.37	29.06	49.47	3.15
4	14.3*	4.74	9.06	28.19	42.21	1.50	5.48	10.57	32.89	49.31	1.75
5	14.3*	5.10	9.00	24.90	44.90	1.80	5.95	10.51	29.06	52.38	2.10
	14.30	5.34	10.94	24.14	42.97	2.31	6.24	12.77	28.17	50.13	2.69
		6.49	14.42	28.19	44.90	3.09					
		4.74	9.00	19.66	42.07	1.50					
1	14.3*	7.15	12.23	23.79	41.06	1.47	8.34	14.27	27.75	49.93	1.71
2	14.3*	6.56	11.56	23.82	41.72	2.04	7.65	13.48	27.79	48.70	2.38

* Reckoned by the analyst to a uniform water content. No. 2 Timothy, corrected by the analyst. Figures different from those given in *loc. cit.*

IV. Hay.

No.	Variety.	Reference.	Analyst.
3	Maine. Crop 1875. Poor loam, well manured, cut when heads began to brown,	Rep. Mid. Ag. Ex. St. '77–8, p. 32,	W. O. Atwater,
4	Maine. Crop 1875. Poor loam, well manured, nearly ripe, ...	" " " "	" "
	Average, (4 analyses), ...		
	Maximum, ...		
	Minimum, ...		
	Hay from Hungarian Grass.		
1	Conn. Crop 1876. Cut July 17. Heads partly filled. Seeds but little developed,	Rep. Mid. Ag. Ex. St. '77–8, p. 33,	W. O. Atwater,
2	Conn. Crop 1876. Cut Aug. 3. Heads well filled. Seeds Soft, ...	" " " "	" "
3	Conn. Crop 1876. Cut Aug 18. Seeds falling out, ...	" " " "	" "
4	Conn. Crop 1877, ...	Rep. Ct. Ag. Ex. St., '79, p. 80,	S. W. Johnson,
	Average, (4 analyses), ...		
	Maximum, ...		
	Minimum, ...		
	Low Meadow Hay.		
1	Cut from low meadows in Ct. Chiefly Carex stricta, Lamarck. C. stellulata v. scirpoides, Gr., and Eleocharis tenuis Schultes,	Rep. Ct. Bd. Ag., '72, p 422,	S. W. Johnson,
2	Cut June 11, '73. Small sample gathered by hand. Mass. Carex stricta. Going to seed. Many seeds included, ...	Bull. Bussey Inst., '75, p. 345,	F. H. Storer,
3	Cut June 16, '73. Small sample gathered by hand. Mass Carex stricta, ...	" " " "	"
4	Cut Aug., 1874. Mass, "Bog hay," Carex stricta? No seeds or flowers, ...	" " " "	"
5	Cut 1874. Mass. "Bog hay," Carex stricta, ...	" " " "	"
6	Cut Dec. 26, 1874. Mass. "Bog hay," Carex stricta. Dead and weather beaten, ...	Bull. Bussy Inst., '75, p. 345,	F. H. Storer,
7	Swale Hay 1878. N. Hampshire, ...	Rep. U. S. Dept. Ag., '78, p. 146,	P. Collier,
8	Conn. 1877, ...	Rep. Ct. Ag. Ex. St., '79, p. 80,	S. W. Johnson,
9	" 1877, ...	" " " "	" "
	Average, (9 analyses), ...		
	Maximum, ...		
	Minimum, ...		
	Salt Marsh Hay		
1	Crop 1872. Mass. Brizopyrum spicatum, Spartina juncea and some Glyceria maritima, ...	Bull. Bussy Inst., '75, p. 341,	F. H. Storer,
2	Crop 1874. Mass. Brizopyrum spicatum, some Juncus bulbosus, ...	" " " "	"
3	Crop 1874. Mass. Mostly Brizopyrum spicatum, some Juncus bulbosus, ...	" " " "	"
4	Crop 1874. Mass. Mostly Spartina juncea,	" " " "	"

IV. Hay.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-Free. Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.
3	14.3*	6.29	11.25	25.60	41.01	1.55	7.34	13.13	29.87	47.86	1.80
4	14.3*	5.57	8.87	27.22	41.98	2.06	6.50	10.35	31.75	49.00	2.40
	14.3	6.39	10.98	25.10	41.45	1.78	7.46	12.81	29.30	48.37	2.06
	14.3	7.15	12.23	27.22	41.98	2.06					
	14.3	5.57	8.87	23.79	41.01	1.47					
1	16.7*	7.17	10.67	28.91	34.85	1.70	8.60	12.81	34.69	41.76	2.04
2	16.7*	4.28	8.03	27.55	41.91	1.53	5.13	9.63	33.06	50.35	1.83
3	16.7*	5.29	5.72	28.94	41.94	1.42	6.34	6.87	34.73	50 36	1.70
4	16.7*	6.34	6.09	27.17	42.40	1.30	7.57	7.35	32.60	50.97	1.51
	16.7	5.77	7.63	28.14	40.28	1.48	7.00	9.16	33.76	48.31	1.77
	16.7	7.17	10.67	28.94	42.40	1.70					
	16.7	4.28	5.72	27.30	34.85	1.30					
1	14.3	3.3	7.8	31.6	39.9	3.1	3.85	9.10	36.87	46.56	3.62
2	7.46	6.52	10.41	33.60	39.80	2.21	7.05	11.25	36.23	43.08	2.39
3	7.33	6.17	9.38	33.91	41.08	2.13	6.67	10.11	36.57	44.35	2.30
4	7.96	5.65	6.31	33.55	43.53	3.00	6.14	6.86	36.44	47.30	3 26
5	8.38	5.43	7.44	33.30	43.53	1.92	5.80	8.12	36.36	47.63	2.09
6	9.32	4.42	4.63	39.99	40.90	0.74	4.87	5.10	44.09	45.12	.82
7	6.41	6.33	7.07	21.39	55.17	3.63	6.76	7.55	22 85	58.96	3.88
8	14.3	5.40	6.70	26.20	46.10	1.30	6.30	7.80	30.58	53.81	1.51
9	14.3	8.56	7.27	23.22	44.49	2.16	9.97	8.47	27.10	51.94	2.52
	9.97	5.76	7.44	30.75	43.84	2.24	6.39	8.22	34.15	48.76	2.48
	14.30	6.52	10.41	39.99	55.17	3.63					
	6.41	3.30	4.63	21.39	39.80	0.74					
1	7.93	6.29	7.09	31.40	44.39	2.90	6.84	7.69	34.09	48.23	3.15
2	8.91	7.79	7.53	32.90	39.73	3.14	8.56	8.25	36.11	43.72	3.45
3	7.84	7.10	7.79	33.84	40 66	2.77	7.68	8.46	36.69	44.10	3.00
4	8.70	7.51	4.88	28.71	48.52	1.68	8.22	5.35	31.43	53.16	1.84

* Reckoned by the analyst to a uniform water content. No. 3 Timothy corrected by the analyst. Figures different from those given in *loc. cit.*

No.	Variety.	Reference.	Analyst.	No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-Free. Ash.	Water-Free. Albuminoids.	Water-Free. Fiber.	Water-Free. N. fr. Extract.	Water-Free. Fat.
5	Crop 1874. Mass. Almost all Spartina juncea,............................	Bull. Bussey Inst., '75, p. 341,	F. H. Storer,	5	8.61	5.97	4.38	37.91	41.30	1.83	6.54	4.80	41.46	45.20	2.00
6	Crop 1872. Mass. Pure Spartina stricta var. alterniflora, ...	" " " p. 342,	"	6	11.70	9.84	4.33	30.54	41.30	2.29	11.15	4.90	34.58	46.77	2.60
7	Crop 1874. Mass. Pure Spartina stricta var. alterniflora,.....................	" " " "	"	7	17.47	9.56	5.55	30.01	35.15	2.26	11.59	6.72	36.36	42.60	2.73
8	1874. Mass. Mostly spartina stricta. Sample not taken from a *crop*.........	" " " "	"	8	18.61	11.81	5.38	27.64	34.07	2.49	14.51	6.61	33.96	41.86	3.06
9	Mass. Juncus bulbosus. Upper parts of stalks and empty seed vessels. Sample not taken from a *crop*, ...	" " " "	"	9	7.17	4.90	7.39	35.90	42.55	2.09	5.28	7.96	38.69	45.82	2.25
10	Mass. Juncus bulbosus. Many seeds on the stalks,........	" " " "	"	10	10.25	5.48	6.18	30.43	45.15	2.51	6.11	6.89	33.91	50.29	2.80
	Average. (10 analyses), ...				10.72	7.62	6.05	31.93	41.29	2.39	8.53	6.78	35.76	46.25	2.68
	Maximum, ...				18.61	11.81	7.79	37.91	48.52	3.14					
	Minimum,........................				7.17	4.90	4.33	27.64	34.07	1.68					
	Hay from Various Grasses.														
1	Calamagrostis Canadensis, Blue Joint Grass, June '76. Mass. In blossom,..	Bull. Bussey Inst., '77, p. 131,	F. H. Storer,	1	9.77	4.19	6.72	40 00	37.18	2.14	4.65	7.45	44.34	41.23	2.33
2	Calamagrostis Canadensis, Blue Joint Grass, July '76. Mass. In blossom,..	" " " "	"	2	9.22	4.30	5.59	39.47	39.36	2.06	4.74	6.15	43.48	43.38	2.25
	Average, (2 analyses), ...				9.49	4.25	6.15	39.74	38.27	2.10	4.69	6.80	43.92	42.27	2.32
1	Phalaris arundinacea, Reed Canary Grass, June '76. Mass. In bud, ...	Bull. Bussey Inst., '77, p. 132,	F. H. Storer,	1	9.56	5.99	10.00	32.90	38.86	2.69	6.63	11.06	36.39	42.93	2.99
2	Phalaris arundinacea, Reed Canary Grass, June '76, Mass. In bud, ...	" " " "	"	2	10.11	8.18	11.09	33.20	34.06	3.36	9.10	12.32	36.92	37.93	3.73
	Phalaris arundinacea, Leaves. 41.29 per cent. of the whole, ...	4th Rep. Mass. Bd. Ag., '56, p.83,	E. N. Horsford,		10.98	8.85	7.06		72.96						
	Stalks 52.12 per ct., ...	" " " "	"		9.58	3.58	.50		86.33						
	Joints 6.59 per ct..................	" " " "	"		10.72	3.50	2.81		82.91						
3	Composition of the whole, ...	" " " "	"	3	10.42	5.31	3.44		80.83		5.93	3.83		90.24	
	Average, (3 analyses), ...				10.03	6.49	8.17		75.31		7.22	9.07		83.71	
1	Hierochloa borealis. Vanilla Grass. Ill.	Rep. U.S. Dept. Ag., '78, p.184	Peter Collier.	*1							8.41	14.31	23.30	49.86	4.12
1	Eleusine Indica. Wire grass. Texas, Ala., Miss., Ga.,....	" " " "		*1							9.12	13.72	31.29	43.71	2.16
2	Eleusine Indica. Wire grass. Texas, Ala., Miss., Ga., ...	" " " "		*2							6.33	13.28	22.38	55.94	2.07
3	Eleusine Indica. Wire grass. Texas, Ala., Miss., Ga., ...	" " " "		*3							7.07	12.23	21.53	56.61	2.56
1	Uniola latifolia. Fescue grass,.........	" " " "		*1							11.38	11.29	38.67	35.43	3.23
1	Cynodon dactylon. Bermuda grass. Ala., Miss.,..........................	" " " "		*1							6.16	11.15	24.55	55.92	2.22
2	Cynodon dactylon. Bermuda grass. Ala., Miss., ...	" " " "		*2							7.96	13.59	23.57	53.29	1.59
1	Sporobolus Indicus. Smut grass. Miss..	" " " "		*1							6.19	12.46	25.91	52.14	3.30
1	Andropogon Virginicus. Broom Grass. Texas, ...	Rep. U.S. Dept. Ag., '78, p. 184,	P. Collier,	*1							6.44	13.00	33.73	45.12	1.71
1	Andropogon scoparius. Ala.,..........	" " " "	"	*1							3.90	6.21	24.91	63.39	1.59
1	Poa pratensis, Ky. Blue Grass. Wis.,..	" " " "	"	*1							5.18	11.54	27.94	52.48	2.86
1	" serotina. Fowl Meadow Grass. Wis.,	" " " "	"	*1							4.74	8.91	25.62	57.25	3.48

* These analyses of grass were reduced by the analyst to a water-free basis. The original water content was not given.

IV. Hay.

No.	Variety.	Reference.	Analyst.
1	Dactyloctenium Aegyptiacum. Willd. Egyptian Grass. Ga.,	Rep. U.S.Dept. Ag.,'78,p. 184,	P. Collier,
1	Panicum sanguinale. Crab Grass. Miss., Ala.,	" " " "	"
1	Panicum jumentorum True Guinea Grass,	" " " "	"
1	" obtusum, Texas,	" " " "	"
1	" virgatum. Tall Panic Grass. Texas or Ala.,	" " " "	"
2	Panicum virgatum. Tall Panic Grass. Texas or Ala.,	" " " "	"
1	Panicum Texanum. Texas Millet. Texas,	" " " "	"
1	" crus-galli. Barn Yard Grass. Texas, Ala., Miss.,	" " " "	"
1	Panicum filiforme. Slender Crab Grass, Ala.,	" " " "	"
1	Sorghum halapense. Johnson Grass. Ala.,	" " " "	"
1	" avenaceum. Indian Grass,	" " " "	"
1	Muhlenbergia diffusa. Drop Seed. Tex.,	" " " "	"
1	Bromus unioloides. Schrader's Grass,	" " " "	"
1	Bromus carinatus. Brome Grass. Ill.,	" " " "	"
1	Agrostis exarata. Brown top. Wis.,	" " " "	"
1	Paspalum laeve. Water Grass. Texas,	" " " "	"
1	Setaria setosa. Bristly Fox Tail.—Bristle Grass, Texas,	" " " "	"
1	Leptochloa mucronata. Feather Grass. Ala.,	" " " "	"
1	Tripsacum dactyloides. Game Grass, Miss.,	" " " "	"
1	Tricuspis seslerioides. Tall Red Top. Texas,	" " " "	"

V. Various Plants and Weeds.

No.	Variety.	Reference.	Analyst.
	Air Dry.		
1	Juncus effusus. Aug., 1874, Mass.,	Bull. Bussey Inst., '75, p. 351,	F. H. Storer,
2	Ranuculus acris. June, 1873, Mass.,	" " " "	" "
3	Leucanthemum vulgare. In full flower. June, 1872, Mass.,	" " " "	" "
4	Osmunda regalis. 1874, Mass.,	" " " "	" "
5	Desmodium. Beggar Lice,	Rep. U.S. Dept. Ag.,'78, p.184,	P. Collier,
6	Lespedeza striata. Japanese Clover. Ala.,	" " " "	"
7	Lathyrus maritimus. Mass.,	Bull. Bussey Inst., '75, p. 351,	F. H. Storer,
8	" " Me.,	" " " "	" "
9	" " Mass.,	" " " "	" "
	Fresh.		
1	Leontodon taraxacum. Dandelion. May, '75, Mass.,	Bull. Bussey Inst., '77, p. 117,	" "
2	Urtica dioica. Nettle. Mass., May, '76,	" " " 119,	" "
3	Plantago major. Common Plantain. Mass. May, '76,	" " " 123,	" "
4	Portulaca oleracea. Purslane. Mass., July, '76,	" " " 126,	" "
5	Chenopodium album. Pig Weed. Mass., Aug., '76,	" " " 127,	" "
6	Equisetum arvense. Scouring rush. Fertile stems. April, '76,	" " '78, p. 167,	" "
7	Equisetum arvense. Sterile stems. May, '76,	" " " "	" "

IV. Hay.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-Free. Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.
							6.90	9.01	17.48	64.65	1.96
*1											
							10.68	9.99	32.80	43.64	2.89
*1							8.37	8.95			
*1							8.75	7.28	31.76	49.04	1.58
*1									33.32	48.38	2.27
							4.84	5.01	37.38	51.07	1.70
*1											
							3.56	4.58	28.87	60.07	1.92
*2							6.63	5.61			
*1									27.68	57.54	2.54
							10.14	4.14	32.27	51.34	2.11
*1											
							4.65	3.32	26.78	63.71	1.54
*1							4.85	13.18			
*1							5.63	3.29	25.15	53.96	2.86
*1							7.61	10.06	36.70	52.71	1.67
*1							7.78	12.45	23.37	57.14	1.82
*1							10.31	9.98	24.31	52.23	3.23
*1							5.62	10.65	26 90	50.11	2.70
*1							6.43	8.14	24.59	56 83	2.31
*1									27.72	55.95	1.76
*1							6.71	8.61	32.76	50.41	1.51
*1							8.98	7.80	32.16	48.98	2.08
*1							5.96	8.62	26.59	56.43	2.40
*1							4.55	6.32	37.86	49.22	2.50

V. Various Plants and Weeds.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-Free. Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.
1	6.88	2.63	6.75	41.48	42.26		2.83	7.25	44.44	45.	48
2	8.24	5.21	10.66	30.70	41.55	3.64	5.68	11.60	33.44	45.32	3.96
3	10.87	6.44	7.00	31.00	42.27	2.42	7.23	7.86	34.79	47.51	2.71
4	8.23	6.73	7.38	25.59	49.10	2.97	7 83	8.04	27.88	53.52	3.23
*5							7.56	22.22	25.39	43 04	2.79
*6							4.33	15.11	23.77	52.39	4.40
7	7.88	6.99	23.25	29.35	27.58	4.95	7.59	25.24	31.87	29.92	5.38
8	7.18	6.54	14.66	30.02	36.64	4.96	7.05	15.80	32 85	39.46	5.34
9	7.79	8.60	18.19	26.99	35.39	3.04	9.32	19.74	29.28	38.37	3.29
1	85.54	1.99	2.81	1.52	7.45	0.69	13.74	19.38	10.52	51.59	4.77
2	82.44	2.30	5.50	1.96	7.13	0.67	13.14	31.32	11.15	40.56	3.83
3	81.44	2.16	2.65	2.09	11.19	0.47	11.64	14.29	11.27	60.27	2.53
4	92.61	1.56	2.24	1.03	2.16	0.40	21.06	30.25	13.96	29.38	5.35
5	80.80	3.02	3.94	2.55	8.93	0.76	15.76	20.61	13.25	46.44	3.94
6	87.28	1.60	1.86	1.87	7.05	0.34	12.55	14.62	14.72	55.43	2.68
7	85.63	1.74	3.34	2.49	6.04	0.76	12.12	23.26	17.31	42.00	5.31

VI. Straw and Coarse Fodder.

No.	Variety.	Reference.	Analyst.
	Oat Straw.		
1	The Straw from Oats, No. 2. Conn., ...	Rep.Mid.Ag.Ex.St.,'77-8,p.37,	W. O. Atwater,
	Rye Straw.		
1	Conn. Raised on heavy loam. 16 bush. rye per acre, ...	Rep.Mid.Ag.Ex.St.,'77-8,p.37,	W. O. Atwater,
	Buckwheat Straw.		
1	Conn., ...	Bull. Bussey Inst., '77, p. 54.	F. H. Storer,
2	"	" " " "	" "
	Cow Pea Vines (Dolichos).		
1	Equal parts of black and yellow Cow Pea Vines, ...	Rep.N.C.Ag. Ex.St.,'79, p. 115,	A. R. Ledoux,
	Maize Fodder and Stover (Fresh).		
1	Cut July 25, before tassels appeared,. } Medium or large var. Sweet Corn plant'd June 1,'77, in good garden soil. Hills 2½ ft. apart in row. Rows 3 ft. apart.	Rep. Ct. Ag. Ex. St., '78, p. 60,	S. W. Johnson,
2	Cut Aug. 9, in full silk,.	" " " "	" "
3	Cut Aug. 25, kernels full size, ...	" " " "	" "
4	Cut Sept. 25. Nearly "dry."	" " " "	" "
5	*Southern White Fodder. Conn. Cut when tassels began to appear, ...	Rep.Mid.Ag.Ex.St.'77-8,p.35,	W. O. Atwater,
6	Southern White Fodder. Conn. Cut when tassels began to appear. Sown thicker than 5, ...	" " " "	" "
7	Southern White Fodder. Conn. Cut two weeks later than 5, ...	" " " "	" "
8	Fodder, Norfolk White. Conn. On long tilled ground with stable manure. Cut Sept. 1, Fresh, ...	Am.Jour.Sci.& Arts,'77, p 203,	S. W. Johnson,
9	Fodder, Norfolk White. Conn. Not long tilled. Cut Sept. 1, Fresh, ...	" " " "	" "
	Average (9 analyses), ...		
	Maximum, ...		
	Minnimum, ...		
	Maize Fodder and Stover (Field cured).		
1	Ohio Dent, 1877. Conn., ...	Rep. Ct. Ag. Ex. St., '78, p. 60,	S. W. Johnson,
2	Norfolk White. Conn. On land long tilled,	Am.Jour.Sci.&Arts,'77, p. 203,	" "
3	" " Conn. On land not long tilled,	" " " "	" "
4	White Flint Corn. Conn., 1877, ...	Rep. Ct. Ag. Ex. St.,'79, p. 80,	" "
	Average (3 analyses), ...		
	Maximum, ...		
	Minimum, ...		

* The statements with regard to Nos. 5, 6 and 7, differ from those given in *loc. cit.*, corrected by the analyst.

VI. Straw and Coarse Fodder.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water-Free. Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.
1	12.50*	1.81	2.30	55.96	26.42	1.00	2.07	2.63	68.96	30.19	1.15
1	12.50*	8.03	6.89	34.20	35.70	2.68	9.18	7.88	39.08	40.82	3.04
1	10.35	4.94	4.38	46.83	32.08	1.42	5.52	4.91	52.28	35.71	1.58
2	10.39	5.16	3.33	44.93	34.49	1.70	5.76	3.72	50.12	38.51	1.90
1	72.81	2.00	1.85	15.27	7.86	0.21	7.37	6.81	56.27	28.88	0.78
1	92.908	.980	.866	1.903	3.198	.145	13.82	12.22	26.84	45.08	2.04
2	88.289	1.269	1.310	3.227	5.736	.169	10.84	11.19	27.45	49.08	1.44
3	90.480	1.104	.864	2.694	4.719	.139	11.59	9.08	28.30	49.57	1.46
4	80.740	2.334	1.538	5.939	9.207	.244	12.12	7.89	30.78	47.94	1.27
5	85.70*	0.94	1.27	4.60	7.28	0.21	6.55	8.87	32.17	50.91	1.50
6	85.70*	1.23	1.20	4.95	6.73	0.18	8.62	8.44	34.66	46.98	1.30
7	85.70*	1.00	1.48	4.31	7.37	0.14	6.97	10.38	30.16	51.48	1.01
8	87.18	0.84	0.88	4.38	6.44	0.28	6.57	6.87	34.19	50.23	2.14
9	85.04	0.74	0.78	5.16	8.06	0.22	4.95	5.19	34.45	53.95	1.46
	86.86	1.16	1.13	4.13	6.53	.19	8.83	8.60	31.43	49.69	1.45
	92.91	2.33	1.54	5.94	9.21	.28					
	80.74	0.74	.78	1.90	3.20	.14					
1	36.490	2.874	4.623	19.077	35.781	1.155	4.52	7.28	30.04	56.36	1.80
2	27.590	4.760	4.97	24.76	36.37	1.55	6.57	6.86	34.19	50.24	2.14
3	26.920	3.62	3.79	25.18	39.42	1.07	4.95	5.17	34.46	53.96	1.46
4							5.13	7.57	33.06	52.49	1.75
	30.33	3.75	4.46	23.02	37.19	1.25	5.38	6.40	33.06	53.37	1.79
	36.49	4.76	4.97	25.18	39.42	1.55					
	26.92	2.87	3.79	19.08	35.78	1.07					

* Reckoned to this per cent. by the analyst for comparison.

VII. Fruits and Vegetables.

No.	Variety.	Reference.	Analyst.
1	Ruta Bagas. Me.,	Rep. Me. Ag. Coll., '78, p. 31,	A.M. Farrington
2	Yam. Conn., 1877,	Rep. Ct. Ag. Ex. St., '78, p. 16,	S. W. Johnson,
3	Sweet Potato. (Convolvulus batatas) Nansemond Improved, Va., 1876,	Am.Jour.Sci.& Arts,'77,p.197,	"
4	Sweet Potato,	Rep. U. S Dept. Ag., '69, p. 76,	T. Antisell,
5	Squash, (Flesh) Marrow Squash. Mass.,	Bull. Bussey Inst., '77, p. 88,	F. H. Storer,
6	" " Hubbard " "	" " " "	"
7	" " Crooked necked Squash. Mass.,	" " " "	"
8	Squash, (Rind) Marrow Squash. Mass.,	" " " "	"
9	" " Hubbard " "	" " " 89,	"
10	" " Crooked necked Squash. Mass.,	" " " 90,	"
11	Squash, (Seeds and stringy matters,) Marrow Squash. Mass.,	" " " 88,	"
12	Squash, (Seeds and stringy matters,) Hubbard Squash. Mass.,	" " " 89,	"
13	Squash, (Seeds and stringy matters,) Crooked necked Squash. Mass.,	" " " 90,	"
14	Pumpkin, (Flesh) common round Yellow. Mass.,	" " " 83,	"
15	Pumpkin, (Flesh), smaller round Yellow. Mass.,	" " " 83,	"
16	Pumpkin, (Rind), common round Yellow. Mass.,	" " " 84,	"
17	Pumpkin, (Rind), smaller round Yellow. Mass.,	" " " 84,	"
18	Pumpkin, (Seeds and stringy parts), common round Yellow. Mass.,	" " " 84,	"
19	Pumpkin, (Seeds and stringy parts,) smaller round Yellow. Mass.,	" " " 84,	"
20	Apples, (Stem and seeds not included,) R. I. Greening. Conn.,	Rep.Mid.Ag.Ex.St.,'77-8,p.39,	W. O. Atwater,
21	Apples, (Flesh), Baldwin, '74. Mass.,	Bull. Bussey Inst., '75, p. 365,	F. H. Storer,
22	" " Roxbury Russet, '74. Mass.,	" " " "	"
23	Apples, (Skin). Baldwin, '74. Mass.,	" " " "	"
24	" " Roxbury Russett, '74. Mass.,	" " " "	"
25	Apple Pomace, from Baldwins chiefly,	" " " "	"

VII. Miscellaneous.

No.	Variety.	Reference.	Analyst.
1	Broom Corn Seeds. 1875-6. Boston Seed Store. More plump than 19,	Bull. Bussey Inst., '77, p. 99,	F. H. Storer,
2	Broom Corn Seeds. 1876. Hartford, Ct.,	" " " "	"
3	" " " 1876. Youngest anthers not yet fallen.	" " " 100,	"
4	Broom Corn Seeds. 1876. Plants out of flower. Youngest anthers all fallen,	" " " "	"
5	Broom Corn Seeds.'76,Sept.21. Much more mature than 21. Still soft and unripe,	" " " "	"
6	Sorghum cane (free from leaves, roots and tops,)	Trans. N. Y. Ag. Soc., '61,	C.A. Goessmann,
7	Seeds of Juncus bulbosus, var. Gerardi or Bothnicus,	Bull. Bussey Inst., '75, p. 343,	F. H. Storer,
8	Pachyma Cocos. —"tuckahoe"— edible fungus,	" " " 370,	"
9	Sapindus marginatus. Soap berry,	Rep. Dept. Ag., '70, p. 107,	T. Antisell,
10	Juniperus communius. Juniper berry,	" " " "	"

VI. Fruit and Vegetables.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water Free. Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.
1	87.08	1.41	1.15	1.16	9.11	.09	10.91	8.90	8.98	70.51	.07
2	71.23	.67	2.06	.75	25.24	.25	2.31	7.11	2.59	87.13	.86
3	73.39	1.07	1.28	0.98	23 00	.28	4.02	4.81	3.68	86.44	1.05
4	65.96	1.07	.45	2 50	29.72	.30	3.14	1.32	7.35	87.31	.88
5	89.65	0.73	0.96	1.19	7.13	0.34	7.07	9.32	11.52	68.80	3.29
6	85.28	0.91	0.69	0.99	11 98	0.15	6.17	4.52	6.75	81.57	0.99
7	89.33	0.53	1.11	0.95	8.04	0.04	4.94	10.37	8 87	75.44	0.38
8	85.65	1.49	2.81	2.86	6.43	0.76	10.35	19.61	19.93	14.60	5.33
9	79.01	1.13	2.75	3.89	12.42	0.80	5.36	13.11	18.53	14.70	3.83
10	81.35	1.02	2.94	2.82	11.28	0.59	5.49	15.74	15.14	11.99	3.15
11	72.35	1.70	5.75	4.48	7.97	7.75	6.14	20.79	16.22	28.81	28.04
12	66.72	1.64	6.07	6.24	11.77	7.56	4.92	18.22	18.74	35.40	22.72
13	83.32	0.83	3.99	2.05	6.20	3.61	4.93	23.89	12.20	37.44	21.54
14	92.41	0.71	0.87	1.11	4.80	0.10	9.31	11.50	14.64	63.21	1.34
15	94.57	0.63	0.95	0.86	3.05	0.14	11.61	13.75	15.88	56.24	2.52
16	84.44	1.50	2.90	3.92	6.75	0.49	9.64	18.65	25.18	43.41	3.12
17	88.01	1.23	2.63	2.97	4.67	0.49	10.25	21.94	24.75	38.95	4.11
18	75.94	1.66	6.32	3.74	5.21	7.13	6.88	26.26	15.54	21.69	29.63
19	77.79	1.36	5.68	4.12	4.34	6.71	6.14	25.56	18.53	19.56	30.21
20	85.96	0.28	0.27	....	....	....	2.00	1.92	....	....	....
21	84.11	0 23	0.21	0.91	14.26	.28 ?	1.45	1.32	5.73	89.74	1.76
22	82.22	0.26	0.27	0.95	15.77	.53	1.46	1 52	5.34	88.70	2.98
23	71.60	0.45	1.00	5.37	19 31	2.27	1.58	3.52	18.91	68.00	7.99
24	69.93	0.53	1.08	5.02	21.73	1.71	1.76	3.59	16.70	72.26	5.69
25	77.21	0.50	0.98	3.90	15.71	1.70	2.19	4.30	17.11	68.94	7.46

VII. Miscellaneous.

No.	Water.	Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.	Water Free. Ash.	Albuminoids.	Fiber.	N. fr. Extract.	Fat.
1	11.20	2.02	6.97	6.67	69.82	3.32	2.27	7.85	7.51	78.63	3.74
2	11.93	2.55	7.56	6.57	68.14	3.25	2.89	8.58	7.46	77.39	3.68
3	5.67	4.18	6.96	26.66	55.45	1.08	4.43	7.38	28.26	58.78	1.15
4	5.97	6.14	9.07	23.90	53.61	1.31	6.53	9.65	25.42	57.01	1.39
5	7.19	4.44	9.02	15.15	62.15	2.05	4.78	9.72	16.32	66.97	2.21
6	78.94	1.24	1.40	8.20	10.22 (N. fr. Extract and Fat together)		5.89	6.65	38.94	48.53 (N. fr. Extract and Fat together)	
7	7.98	2.65	15.89	22.92	47.23	3.33	2.88	17.39	24.91	51.20	8.62
8	14.51	0.24	1.38	9.80	73.73	0.34	.28	1.61	11.45	86.25	.40
9	18.16	3.61	14.44	63.79 (Fiber, N. fr. Extract and Fat together)			4.41	17.64	77.95 (Fiber, N. fr. Extract and Fat together)		
10	14.34	3.86	5.87	75.93 (Fiber, N. fr. Extract and Fat together)			4.50	6.85	88.65 (Fiber, N. fr. Extract and Fat together)		