STATE OF CONNECTICUT.

# ANNUAL REPORT

OF

# The Connecticut Agricultural

# EXPERIMENT STATION

For 1881.

PRINTED BY ORDER OF THE LEGISLATURE.

NEW HAVEN:
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1882.

OFFICERS

OF

# The Connecticut Agricultural Experiment Station,

1881.

## STATE BOARD OF CONTROL.

| | | | |
|---|---|---|---|
| | His Exc. HOBART B. BIGELOW, *President.* | | *Ex-officio.* |
| | Hon. E. H. HYDE, Stafford, *Vice-President.* | Term expires, | 1882. |
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*Chemists.*

E. H. JENKINS, Ph.D.

H. P. ARMSBY, Ph.D., to September, 1881.

C. A. HUTCHINSON, B.S.

# ANNOUNCEMENT.

The Connecticut Agricultural Experiment Station was established in accordance with an Act of the General Assembly, approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food, seeds, soils, waters, milks, and other agricultural materials and products, to identify grasses, weeds, and useful or injurious insects, and to give information on the various subjects of Agricultural Science, for the use and advantage of the Citizens of Connecticut.

The Station makes analyses of Fertilizers, Seed-Tests, &c., &c. for the Citizens of Connecticut *without charge*, provided—

1. That the results are of use to the public and are free to publish.
2. That the samples are taken by *consumers* from stock now in the market, and in accordance with the Station instructions for sampling.
3. That the samples are fully described on the Station "Forms for Description."

All other work proper to the Experiment Station that can be used for the public benefit, will be made without charge. Work done for the use of individuals will be charged for at moderate rates. The Station will undertake no work, the results of which are not at its disposal to use or publish, if deemed advisable for the public good. See p. 17.

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

The results of each analysis or examination will be promptly communicated to the party sending the sample. Results that are of general interest will be sent simultaneously to all the newspapers of the State for publication, and will be summed up in the Annual Reports made to the Legislature.

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of the farmers is essential for the full and timely protection of their interests. Farmers' Clubs and like Associations can efficiently work with the Station for this purpose, by sending in samples early during each season of trade.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties, sent on application.

☞ Parcels by Express, to receive attention, should be prepaid, and all communications should be directed, not to individual officers but simply to the—

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

P. O. Box, 945.

LABORATORY AND OFFICE, (until June 30, 1882).

**In East Wing of Sheffield Hall, Grove Street, head of College Street.**

# CONTENTS.

# REPORT OF THE BOARD OF CONTROL.

*To the General Assembly of the State of Connecticut:*

GENTLEMEN:—The Board of Control of THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION herewith submits to your Honorable Body the Annual Reports of the Director and Treasurer made to this Board at its Annual Meeting held at the State House, in Hartford, January 17, 1882.

We beg leave to say that the work of the Station has gone on through the year without interruption. Professor Johnson, as Director, has been assisted the whole year by Dr. E. H. Jenkins and Mr. C. A. Hutchinson, and by Dr. H. P. Armsby, for eight months. Dr. Armsby left the Station September 1st, to take a position in the Storrs Agricultural School.

The Board of Control has held one meeting, and its Executive Committee eight meetings in the year.

The Sheffield Scientific School of Yale College, which has furnished accommodations free of expense, since the establishment of the Station in 1877, gave notice at the end of the fourth year of this arrangement that it would need its rooms for instruction at the end of the five years named in its original offer, which would be June 30, 1882. This necessitates that provision be made for the future accommodation of the Station, and your Honorable Body will be asked to make a special appropriation to furnish a place and facilities for its work.

The last Annual Report was bound and distributed as heretofore with the Report of the Board of Agriculture. By special resolution the Legislature called for 1250 extra copies, which were distributed in advance of the regular edition. These extra copies cost comparatively little (less than seven cents each), and the demand for them has been greater than the supply, and the Board suggests that your Honorable Body take similar action this year and order 2000 copies for separate distribution.

HOBART B. BIGELOW,
*President.*

WILLIAM H. BREWER,
*Secretary.*

# REPORT OF THE TREASURER.

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

Receipts.

| | | |
|---|---|---|
| Balance from account of 1880, | $132.56 | |
| Laboratory Receipts, | 303.15 | |
| From State Treasurer, licenses for sale of Fertilizers, | 725.00 | |
| From State Treasurer, Annual Appropriation, | 5,000.00 | |
| | | $6,160.71 |

Payments.

| | | |
|---|---|---|
| Salaries, | $3,706.50 | |
| Laboratory Expenses, | 1,217.85 | |
| Stationery, Postage and Printing, | 225.48 | |
| Furniture and Repairs, | 237.13 | |
| Gas and Fuel, | 142.16 | |
| Traveling Expenses of the Board, | 10.00 | |
| Miscellaneous, | 10.50 | |
| Cash Balance on hand, | 611.09 | |
| | | $6,160.71 |

There is due the Experiment Station fifty-three (53) dollars for Laboratory work done, and the outstanding bills, apparatus and material ordered from abroad, but not yet received, and liabilities of the Station are estimated to amount to six hundred and thirty (630) dollars.

The Station is in possession of office furniture, apparatus, appliances, laboratory stock, seed and plant collections, and other material estimated to be worth sixteen hundred (1600) dollars, that is, it would take fully that sum to replace them or procure their equivalent.

WM. H. BREWER,
*Treasurer.*

Audited, Hartford, Jan. 17, 1882.

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

# REPORT OF THE DIRECTOR.

The year 1881 has given this Station abundant employment in the analysis of Fertilizers, of which 170 samples have been examined, including, so far as could be learned, nearly every brand of fertilizer sold in the State.

Of Feeding Stuffs 37 samples have been analyzed and most of this work has been done incidental to an investigation of the winter feed in use on some of our Dairy farms, made for the purpose of comparing the rations there employed with the German Standard.

The Station has analyzed 56 samples of milk, partly in the interest of one of our large creameries, partly as a contribution to a knowledge of Guernsey milk, and partly in reference to the quality of the milk supplied to cities.

Since the issue of the last Report, 15 samples of seeds have been tested. Other seed-examinations now in progress are not ready for publication.

Five examinations for poisons have been made. Of these three, viz., one on a well-water and two on parts of dead animals, gave negative results. An account of the other two cases is given further on.

A large amount of work has been done in the Station Laboratory with reference to the determination of "reverted" phosphoric acid, but the results are not ready to publish.

The other subjects that have been under investigation may be learned from subsequent pages or referred to by help of the preceding Table of Contents and the Index at the close of this Report.

*Seventeen Station Bulletins* have been issued during the year and sent to all the newspapers and to all the Farmers' Clubs and of one or several acres in extent, with unobstructed exposure to sun, and so enclosed as effectually to exclude all intrusion.

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

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

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

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

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



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

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

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

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

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

It is, I believe, universally believed by all who are capable of intelligent judgment, that the Experiment Station as now carried on has been of great service to our agriculture, and has saved many times its cost to the State of Connecticut in the single item of Commercial Fertilizers.

It is evident that a continuance of Station work is indispensable in order that our farmers may have the means of knowing with reasonable accuracy, what is offered in the fertilizer market, and what are fair prices for a costly class of goods whose commercial value can only be ascertained by chemical analysis.

But in fact the Experiment Station, if suitably equipped, can do a grander and vastly more profitable work for the State than by the analysis of Commercial Fertilizers.

The virgin soils of the Western Prairies are brought into pressing competition with our rugged and "exhausted" fields by the increasing facilities for cheap transportation, and by the eager industry of the army of immigrants which continually invades our country. During the last twelve months Europe has poured upon us nearly 700,000 men, women and children, mostly reared to habits of assiduous labor, and many of them accustomed to such desperate economies that they are easily able to live on what we commonly throw away.

To maintain our position as a State preëminent in all that has made New England civilization so powerful and beneficent in shaping the destinies of this Republic, it is of the first importance that our farms be developed and worked to their full capacity. This is essential to our manufacturing and commercial interests, for all forms of honest industry reach their highest successes when they are most intimately associated, and to the greatest degree mutually helpful.

That our farms can hold their own against those of the great West, and can in fact derive immense advantage from Western competition is not a matter for doubt.

To do this, however, intelligence must both hold and drive the plow. We must learn and use all the best methods of planting and harvesting, the best modes of making, saving, and applying home manu es, the best systems of farm management, of tillage, rotation of crops, cattle feeding, handling of milk, that exist, or that can be devised which suit our circumstances.

In almost every direction in which the farmer prosecutes his search for more light, he is confronted by a darkness which for thousands of years has resisted the utmost efforts of those who have gone before him, and now equally resist his attempts to dispel. He has but one resource left, and that is science, and to judge from the brilliant successes which for the last twenty-five years have fairly crowded each other in our recollection, this resource is equal to the emergency. In fact, now that all other industries have recognized the potency of this means of advancement, the Eastern farmer must either make use of it in self-defence or be driven to the wall.

Science is from its nature peculiarly adapted to flourish among, and to make flourish a free and aspiring people. Science is not necessarily an aristocracy of intellect that condescends to dole out the crumbs of knowledge to the common herd, but is an organization of all available forces for the pursuit of knowledge.

The citizens of Connecticut are, separately, as mere individuals, nearly powerless to maintain peace, order, decency, education, justice, rights to property, or any of the fruits of civilization. But the citizens of Connecticut, organized by the machinery of town, county, State, and Federal Government, and by the institutions of education and religion, not only are able to possess their individual property, rights and enjoyments, but are able through legislation, yearly to attain a fuller measure of prosperity and happiness, as well as a higher capacity for enjoying these blessings; are able also to exercise a magnificent hospitality to the



emigrating thousands of other countries, and to defend their firesides and their institutions against the armies of the world.

Just as each citizen of our State and Union, working in our governmental organization, is according to his talent and energy, a potent agent in civil progress, so each farmer and gardener, whether he labors with his own hands for daily bread or directs the labor of others by the toil of his brain, becomes a discoverer when he works under efficient scientific organization, and may have the satisfaction of finding his good ideas and his accurate observations recognized at their true value and usefully incorporated into the common fund of agricultural knowledge.

Science is ready to do for our farming industries, what it has done for our intellectual enjoyments. It is as able to trace the kinds, the sources, and to control the movements of plant-food, to investigate the workings of manure, the effects of tillage or rainfall, the traction of the plough, the rising of cream or any agricultural question, as to guide the ship at sea by magnet and sextant, to transmit messages from town to town or from continent to continent by telegraph or telephone.

But here again the results obtained must be proportioned to the efforts used. Before we can control the production of a crop we must learn in detail what are the exact conditions which, in the plan of nature, invariably work together, and are essential to vegetable growth. To prosecute such studies successfully, is now a comparatively simple matter, but it cannot be done without certain apparatus, and it cannot be done advantageously without various conveniences which are to be had by paying for them, but which cannot be realized by wishing for them. Out of nothing comes nothing.

The splendid successes of gas lighting, of the steam engine, the telegraph, the electric light, of the arts of spinning, weaving and dyeing, of glass and metal manufacture, and, in our own field, of the mowing and reaping machine, have cost long and anxious experimenting and heavy outlay for labor and materials. It cannot be otherwise in respect to most of the unsolved questions that we desire cleared up. In any direction where the investigator can see before him the reasonable possibility of reaching a result that will ensure large pecuniary reward, there is, generally speaking, no difficulty in securing from capitalists any requisite amount of funds for prosecuting investigations. Many of our rich corporations, whose money has been made by scientific investigations, are constantly assisting numberless projects which point with more or less promise to improvement in the processes they employ and to corresponding increase of their gains.

They are able to secure to themselves by patent or by secrecy, the fruit of their outlay. In agriculture, however, we want improvements in a multitude of details which can offer no considerable pecuniary reward to the inventor or discoverer; improvements, many of which in their nature are not patentable and which ought to be made of universal avail to every landholder without restriction or royalty. We know that these improvements and discoveries may be made or their impracticability demonstrated, and we earnestly wish somebody would do it and thus give us relief. But they are not realized, because for the most part they do not offer sufficient inducements to stimulate investigators to work them out. Men who have a genius for discovery labor for some more or less tangible reward, at least the means of comfortable living and enough besides to command books, apparatus, learned society, and the power of gratifying in all ways their passion for seeing, knowing and experimenting. Unless Agriculture can offer some of these inducements, she cannot expect the results to which they lead. Occasionally a man of wealth and scientific tastes like Boussingault in France, Lawes in England, and Valentine in New York, will work or aid work in this direction for the pleasure and the fame of it. Occasionally a College Professor may have energy enough to do something in this line besides carrying the burden of academic duty. But the Experiment Station is the institution that must ultimately be depended upon. The Farmers of Connecticut have wanted it and at their word the State has given it to them. If they want it enlarged, put upon a broader and more practical basis, enabled to do more work and a greater variety of work, they have but to decide upon a plan and submit it to the General Assembly, where it will be passed upon according to its merits.

The initiative taken in this matter by Connecticut has found response in other States. The New Jersey Agricultural Experiment Station was established by Act of Legislature in March, 1880, with an appropriation of $5,000. The Station was located at New Brunswick in connection with the State Agricultural College. On the College Farm provided for that institution some years ago at the expense of the State, the Experiment Station carried out several series of practical feeding trials to test the value of the German



Standard Rations, and to study the nutritive value of ensilage. These investigations* so completely demonstrated the utility of the Experiment Station, that the Legislature of 1881 voted to increase the Station income to $8,000. North Carolina lately has furnished her station with excellent accommodations at public expense. New York is just organizing a station at an outlay of $20,000 per annum.

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## FERTILIZERS.†

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

During 1881, one hundred and seventy (170) samples of fertilizers have been analyzed. Of these, 44 were examined for private parties, and the remainder, 126, for the general use of the citizens of the State.

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

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.

* For the account of them see subsequent pages of this Report.

† The matter of this and of several subsequent pages, explanatory of the sampling and valuation of fertilizers, is copied with a few appropriate alterations from the Report for 1880.

## THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

### INSTRUCTIONS FOR SAMPLING COMMERCIAL FERTILIZERS.

The *Commercial Value* of a high priced Fertilizer can be estimated, if the amounts *per cent.* of its principal fertilizing elements are known. Chemical analysis of a small sample, so taken as to fairly represent a large lot, will show the composition of the lot. The subjoined instructions, if faithfully followed, will insure a fair sample. Especial care should be observed that the sample neither gains or 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 cupfulls 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.*

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



In case of a fine, uniform and moist or coherent article, a butter-tryer or a tin tube, like a dipper handle, put well down into the packages in a good number of places will give a fair sample with great ease. With dry, coarse articles, such as ground bone, there is likely to be a separation of coarse and fine parts on handling. Moist articles put up in bags or common barrels may become dry on the outside. It is in these cases absolutely necessary to mix thoroughly the coarse and fine, the dry and the moist portions before sampling. Otherwise the analysis will certainly misrepresent the article whose value it is intended to fix.

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

It is also important that samples for analysis should be taken at the time when the fertilizer is purchased, and if they cannot be at once dispatched to the Station, they should be so preserved as to suffer no change. Moist fish, blood or cotton seed will soon decompose and lose ammonia, if bottled and kept in a warm place. Superphosphates containing much nitrogen will suffer reversion of their soluble phosphoric acid under similar circumstances. Most of the moist fertilizers will lose water unless tightly bottled, but some of the grades of potash salts will gather moisture from the air and become a slumpy mass if not thoroughly protected.

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

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

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

THE CONNECTICUT

AGRICULTURAL EXPERIMENT STATION,

NEW HAVEN, CONN.

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FORM FOR DESCRIPTION OF SAMPLE.

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

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

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

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

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

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

-----------------------------------------------------------

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

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

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

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

Actual weight of packages opened, --------------------------

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

-----------------------------------------------------------

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

-----------------------------------------------------------



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

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

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

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

A copy of the analysis is also immediately reported to the party that furnished the sample, the report being entered on one page of another printed form and facing a second printed page of "Explanations" intended to embody the principles and data upon which the valuation of fertilizers is based.

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

## EXPLANATIONS OF FERTILIZER-ANALYSIS AND VALUATION.

*Nitrogen* is commercially the most valuable fertilizing element. It occurs in various forms or states. *Organic nitrogen* is the nitrogen of animal and vegetable matters generally, existing in the albumen 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, or 66 parts of pure sulphate of ammonia, contain 14 parts of nitrogen.

85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

*Soluble Phosphoric acid* implies phosphoric acid or phosphates that are freely soluble in water. It is the characteristic ingredient of Superphosphates, in which it is produced by acting on "insoluble" or "reverted" phosphates with oil of vitriol. It is not only readily taken up by plants, but is distributed through the soil by rains. Once well incorporated with soil it shortly becomes reverted phosphoric acid.

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

*Insoluble Phosphoric acid* implies various phosphates not freely soluble in water or ammonium citrate. In some cases the phosphoric acid is too insoluble to be rapidly available as plant food. This is true of South Carolina rock phosphate, of Navassa phosphate, and especially of Canada apatite. The phosphate of coarse raw bones is at first nearly insoluble in this sense, because of the animal matter of the bone which envelopes it, but when the latter decays in the soil, the phosphate remains in essentially the "reverted" form.



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

*The Valuation of a Fertilizer* signifies estimating its worth in money, or its trade-value; a value which, it should be remembered, is not *necessarily* proportional to its fertilizing effects in any special case.

Plaster, lime, stable manure and nearly all the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and other fertilizers, for which $30 to $80 per ton are paid, depend chiefly for their trade-value on the three substances, *nitrogen*, *phosphoric acid* and *potash*, which are comparatively costly and steady in price. The money-value per pound of these ingredients is easily estimated from the market prices of the standard articles which furnish them to commerce.

*The average Trade-values*, or cost in market per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash, as found in the Connecticut and New York markets, and employed by the Station during 1881, have been as follows:

TRADE-VALUES FOR 1881.

| | Cents per pound. |
|---|---|
| Nitrogen in nitrates, | 26 |
| " in ammonia salts, | 22½ |
| " in Peruvian Guano, fine steamed bone, dried and fine ground blood, meat and fish, superphosphates and special manures, | 20 |
| " in coarse or moist blood, meat or tankage, in cotton seed, linseed, and Castor Pomace, | 16 |
| " in fine ground bone, horn and wool dust, | 15 |
| " in fine medium bone, | 14 |
| " in medium bone, | 13 |
| " in coarse medium bone, | 12 |
| " in coarse bone, horn shavings, hair and fish scraps, | 11 |
| Phosphoric acid soluble in water, | 12½ |
| " " "reverted" and in Peruvian Guano, | 9 |
| " " insoluble, in fine bone and fish guano, | 6 |
| " " " in fine medium bone, | 5½ |
| " " " in medium bone, | 5 |
| " " " in coarse medium bone, | 4½ |
| " " " in coarse bone, bone ash and bone black, | 4 |
| " " " in fine ground rock phosphate, | 3½ |
| Potash in high grade sulphate, | 7½ |
| " in low grade sulphate and kainite, | 5½ |
| " in muriate or potassium chloride, | 4½ |

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

*To Estimate the Value of a Fertilizer* we multiply the per cent. of Nitrogen, etc., by the trade-value per pound, and that product by 20; we thus get the values per ton of the several ingredients, and adding them together we obtain the total estimated value per ton.

In case of *Ground bone*, the fineness of the sample is graded by sifting, and we separately compute the nitrogen value of each grade of bone which the sample contains, by multiplying the pounds of nitrogen per ton in the sample, by the per cent. of each grade, taking one one-hundredth of that product, multiplying it by the estimated value per pound of nitrogen in that grade, and taking this final product as the results in cents. Summing up the separate values of each grade, thus obtained, together with the values of each grade for phosphoric acid, similarly computed, the total is the estimated value of the sample of bone. For further particulars, see page 39.

*The uses of the "Valuation"* are, 1st, to show whether a given lot or brand of fertilizer is worth as a commodity of trade what it costs. If the selling price is no higher than the estimated value, the purchaser may be quite sure that the price is reasonable. If the selling price is but $2 to $3 per ton more than the estimated value, it may still be a fair price; but if the cost per ton is $5 or more over the estimated value, it would be well to look further. 2d, Comparisons of the estimated values and selling prices of a number of fertilizers will generally indicate fairly which is the best for the money. But the "estimated value" is not to be too literally construed, for analysis cannot always decide accurately what is the *form* of nitrogen, etc., while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

*The Agricultural value* of a fertilizer is measured by the benefit received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that



Peruvian guano, superphosphates, fish-scraps, dried blood, potash salts, plaster, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

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

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

Experience leads to the conclusion that the trade-values adopted at the beginning of a year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor. It should be remembered that, in an Annual Report, 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.

## Analyses and Valuations of Fertilizers.

The classification of the Fertilizers analyzed in the Station Laboratory from January 1st to Nov. 1st, 1881, is as follows:

9 plain (non-nitrogenous) superphosphates.
44 nitrogenous ("ammoniated") superphosphates and guanos.
24 special fertilizers, or "formulas."
18 bone manures.
11 dried blood and tankage.
14 fish manures.
1 tortoise shell saw dust.
7 castor pomace and cotton seed meal.
2 night soil and Pollard's night soil fertilizer.
11 potash salts.

2 nitrate of soda.
1 salt.
2 land plaster.
5 ashes.
1 refuse lime.
1 limestone.
2 marls (one styled "bird guano").
3 soap boilers' refuse.
1 mussel bed.
2 swamp muck.
9 miscellaneous, private.

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## Plain (non-nitrogenous) Superphosphates.

These fertilizers are either prepared by treating bone black (calcined bones, see p. 67) or some high grade native phosphate with sulphuric acid, or are the result of a manufacturing process by which low grade phosphates, such as South Carolina rock, are concentrated. None of them contain any essential quantity of "bone" in the usually received and proper sense of that word, as is proved by the nearly total absence of nitrogen. Sample **554,** being designated "Dissolved Ground Bone," was analyzed for nitrogen and 0.21 per cent. of that element was found. All the samples made from bone black contain a similar quantity of nitrogen, but this nitrogen is of little or no fertilizing value.

Of the nine samples examined during 1881, seven are of excellent and nearly uniform quality, most of their phosphoric acid being soluble in water. Two are exceptional; of these, **634** is an excellent fertilizer containing a total of 19½ per cent. of phosphoric acid, of which 18¼ per cent. is available, although 8⅓ per cent. is not soluble in water. **554,** the only sample whose cost exceeds valuation, was not well prepared and contained 4.2 per cent. of insoluble phosphoric acid.

The average cost of soluble phosphoric acid, viz: 11.1 cents in the six best samples whose price is given, is well within the valuation, 12½ cents, that has been hitherto employed by the Station.

It is a fact that has been made conspicuous in former reports that soluble phosphoric acid is most cheaply and most certainly obtained in the high grade non-nitrogenous (not ammoniated) superphosphates and the increased attention given to that class of fertilizers during 1881 is encouraging evidence that consumers are studying the wants of their soils more carefully than has formerly been the custom.



Sample **635** is from one of the sets of fertilizers supplied for experimental purposes as suggested by Prof. Atwater. It is of unexceptionable quality for its purpose.

For Analyses, etc., see pp. 28 and 29.

## Nitrogenous Superphosphates, Guanos,* etc.

Under this heading are reported the various commercial fertilizers, except so-called "special fertilizers" which have been analyzed at the Station, that contain, or are claimed to contain any considerable amount of phosphoric acid soluble in water, and also of nitrogen.

This list includes 16 "phosphates," and "superphosphates," variously designated, 8 "guanos" native and manufactured, 2 "Matfield Fertilizers," 2 "Mapes' Complete Manures," an "animal fertilizer," a "fish and potash" and a "bone dissolved in sulphuric acid," making a total of 31. "Thirteen other analyses of superphosphates have been made for private use. Of these fertilizers, 24 contain potash in smaller or larger quantity.

In the table they are arranged in the order of the excess of estimated value over cost or of cost over estimated value.

For Analyses, etc., see pp. 30, 31, 32 and 33.

The percentage of *chlorine* is an indication as to whether muriate of potash or kainite has been used in the manufacture. 35½ parts of chlorine in muriate of potash correspond to 47 of potash. High grade sulphate of potash is free or nearly free from chlorine.

The "comparison of different samples of the same (or similar) brand," see page 34, mostly explains itself. Dickenson's superphosphate, a new article, manifests much more fluctuation in composition and value than will probably appear when the manufacturing process becomes settled by experience.

Peruvian guano now varies in value unpleasantly. The ancient rich deposits it is said are quite exhausted. What comes into market is therefore presumably of inferior value. Rumor has it also that very inferior or adulterated shipments from England have been coming to this country for disposal, and consumers would do well not to purchase without guaranty of composition.

* For "The Bird Guano and Fertilizer" see page 58.

## Non-Nitrogenous Superphosphates.

| Station No. | Name or Brand. | Manufacturer. | Dealer. | Sampled and sent by |
|---|---|---|---|---|
| 622 | Pure Dissolved Bone, 15%. | H. J. Baker & Bro., New York. | Manufacturers. | J. J. Webb, Hamden. |
| 623 | Superphosphate of Lime, or Pure Dissolved Bone Phosphate. | Geo. B. Forrester, New York. | " | " " |
| 615 | Superphosphate. Export brand. | Mapes F. & P. G. Co., New York. | " Hartford Branch. | T. N. Bishop, Plainville. |
| 578 | English Phosphate. | Imported by H. J. Baker & Bro. | Wilson & Burr, Middletown. | J. M. Hubbard, Middletown. |
| 592 | Bone Superphosphate (Export). | Mapes F. & P. G. Co. | Manufacturers, Hartford Br'ch. | C. E. Bunce, Manchester. |
| 634 | Dissolved Bone Black. | Bowker Fertilizer Co., Boston and New York. | Henry D. Torrey, Putnam. | W. I. Bartholomew, Putnam. |
| 663 | Bone Superphosphate. | Mapes F. & P. G. Co. | Manufacturers, Hartford Br'ch. | Sampled by the Station. |
| 554 | Cooke's Dissolved Ground Bone. | Manufactured for E. F. Cooke by Bowker Fertilizer Co. | G. P. Jennings, Green's Farms. | Geo. P. Jennings. |
| 635 | Dissolved Bone Black. | Mapes F. & P. G. Co., New York. | Manufacturers, Hartford Br'ch. | W. I. Bartholomew, Putnam. |



## Non-Nitrogenous Superphosphates.

| Station No. | Name. | Soluble Phos. Acid. | Reverted Phos. Acid. | Insoluble Phos. Acid. | Estimated value per ton. | Cost per ton. | Valuation exceeds cost. |
|---|---|---|---|---|---|---|---|
| 622 | H. J. Baker's Pure Dissolved Bone, | 13.66 | 0.99 | 1.14 | $37.30 | $30.00 | $7.30 |
| 623 | G. B. Forrester's Superphosphate of Lime, | 12.25 | 0.70 | 0.85 | 32.91 | 28.50 | 4.41 |
| 615 | Mapes' Superphosphate (Export Brand), | 13.51 | 1.66 | .82 | 37.75 | 34.00 | 3.75 |
| 578 | H. J. Baker's English Phosphate, | 13.18 | 1.30 | .90 | 36.37 | 33.00 | 3.37 |
| 592 | Mapes' Bone Superphosphate (Export), | 12.99 | 2.58 | .55 | 37.76 | 36.00 | 1.76 |
| 634 | Bowker's Dissolved Bone Black, | 9.92 | 8.35 | 1.29 | 41.38 | 40.00 | 1.38 |
| 663 | Mapes' Bone Superphosphate, | 13.41 | 1.54 | .70 | 37.14 | 36.00 | 1.14 |
| 554 | Cooke's Dissolved Ground Bone, | 7.40 | 2.01 | 4.20 | *28.00 | 31.00 | Cost exceeds valuation. 3.00 |
| 635 | Mapes' Dissolved Bone Black, | 14.18 | .36 | .51 | 36.71 | ---- | Cost not known. |
| | Average, disregarding 634 and 554 as exceptional, | 13.31 | 1.30 | .78 | $36.56 | $32.91 | |

The average cost of soluble phosphoric acid, excluding **634** and **554**, is 11.1 cts. per lb.

* Including 0.21 per cent. Nitrogen, valued above at 84 cts., but probably not worth it.

## Nitrogenous Superphosphates, Guanos, etc.

| Station No. | Name or Brand. | Manufacturer. | Dealer. | Sampled and sent by |
|---|---|---|---|---|
| 662 | Pure Fine Bone dissolved in Sulphuric Acid. | Mapes Formula & Peruvian Guano Co. | Mapes F. & P. G. Co., Hartford Branch. | Dr. E. H. Jenkins. |
| 557 | Bone Phosphate. | David Dickenson, Middle Haddam. | David Dickenson, Mid. Haddam. | D. Dickenson. |
| 627 | Superphosphate. | " " " | " " " | D. Dickenson. |
| 577 | Bone Phosphate. | " " " | " " " | H. L. Stewart, Middle Haddam. |
| 558 | Ammoniated Bone Phosphate. | " " " | " " " | D. Dickenson. |
| 581 | Phosphate. | Geo. H. Harris & Son, Eagleville. | G. H. Harris & Son. | G. H. H. & Son. |
| 604 | Peruvian Guano. | Hobson, Hurtado & Co., N. Y. | R. B. Bradley & Co., New Haven. | Experiment Station. |
| 633 | G. W. Miller's Raw Bone Phosphate. | G. W. Miller, Middlefield. | | G. W. Miller. |
| 586 | E. Frank Coe's Phosphate. | E. F. Coe, N. Y. | Simon Banks, Southport. | G. P. Jennings, Southport. |
| 576 | Ammoniated Bone Phosphate. | David Dickenson, Middle Haddam. | David Dickenson, Mid. Haddam. | H. L. Stewart, Middle Haddam. |
| 610 | Superphosphate. | Lombard & Matthewson, Warrenville. | Buck & Durkee, Willimantic. | N. P. Perkins, Willimantic. |
| 611 | Darling's Animal Fertilizer. | L. B. Darling & Co., Pawtucket, R. I. | J. A. Lewis. | W. H. Barrows, Willimantic. |
| 568 | Soluble Nitrogenous Phosphate. | Quinnipiac Fertilizer Co., New London | Olds & Whipple, Hartford. | C. E. Bunce, So. Manchester. |
| 673 | Special Phosphate. | G. W. Miles Co., Milford. | Geo. W. Miles Co. | J. W. Nettleton, Milford. |
| 671 | Bowker's Hill and Drill Phosphate. | Bowker Fertilizer Co., New York and Boston. | E. B. Clark, Orange. | " " " |



## Nitrogenous Superphosphates, Guanos, etc.

| Station No. | Name or Brand. | Manufacturer. | Dealer. | Sampled and sent by |
|---|---|---|---|---|
| 598 | Mapes' Complete Manure for Heavy Soils. | Mapes Formula & Peruvian Guano Co. | Mapes F. & P. G. Co., Hartford Branch. | C. E. Bunce, South Manchester. |
| 567 | Pine Island Guano. | Quinnipiac Fertilizer Co., New London. | Olds & Whipple, Hartford. | " " |
| 601 | Soluble Nitrogenous Superphosphate. | Quinnipiac Fertilizer Co. | R. B. Bradley & Co., New Haven. | Experiment Station. |
| 672 | Ammoniated Bone Superphosphate. | Geo. W. Miles Co., Milford. | G. W. Miles Co. | J. W. Nettleton, Milford. |
| 590 | Ammoniated Bone Phosphate. | Rafferty & Williams, N. Y. | F. Ellsworth, Hartford. | C. E. Bunce. |
| 603 | Pine Island Guano. | Quinnipiac Fertilizer Co. | R. B. Bradley & Co., New Haven. | Experiment Station. |
| 661 | Soluble Pacific Guano. | Pacific Guano Co., Boston, Mass. | H. A. Stillman & Co., Hartford. | " " |
| 602 | Fish and Potash. | Quinnipiac Fertilizer Co. | R. B. Bradley & Co., New Haven. | " " |
| 594 | Mapes' Complete Manure. | Mapes Formula & Peruvian Guano Co., N. Y. | Mapes F. & P. G. Co. | C. E. Bunce. |
| 556 | Cooke's Blood Guano. | Bowker Fertilizer Co., for Ed. F. Cooke, N. Y. City. | Geo. P. Jennings, Southport. | G. P. Jennings. |
| 565 | Soluble Pacific Guano. | Pacific Guano Co., Boston, Mass. | H. A. Stillman & Co., Hartford. | C. E. Bunce. |
| 550 | No. 1. Peruvian Guano. | | Seth Chapman, N. Y. City. | J. W. Hemingway, Plainville. |
| 619 | Matfield Fertilizer, No. 2. | Matfield Fertilizer Co., Boston. | Matfield Fertilizer Co. | T. S. Gold, West Cornwall. |
| 589 | No. 1. Standard Peruvian Guano. | Hobson, Hurtado & Co., N. Y. | F. Ellsworth, Hartford. | C. E. Bunce. |
| 561 | Mitchell's Standard Phosphate. | | H. A. Stillman & Co., Hartford. | " |

## NITROGENOUS SUPERPHOSPHATES, GUANOS, ETC.

| Station No. | Name. | Nitrogen of Nitrates. | Nitrogen of Ammonia Salts. | Nitrogen of Organic Matters. | Soluble Phos. Acid. | Reverted Phos. Acid. | Insoluble Phos. Acid. | Potash. | Chlorine. | Estimated Value per ton. | Cost per ton. | Valuation exceeds Cost. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 662 | Mapes' Pure Fine Bone dissolved in Sulphuric Acid, | ---- | ---- | 2.74 | 1.65 | 19.34 | 3.16 | ---- | ---- | $53.69 | $42.00 | $11.69 |
| 557 | Dickenson's Bone Phosphate, | ---- | ---- | 3.23 | 7.87 | 7.92 | 3.11 | 0.15 | ---- | 50.71 | 40.00 | 10.71 |
| 627 | " Superphosphate, | ---- | ---- | 3.97 | 5.04 | 9.12 | 3.96 | 0.47 | 0.32 | 50.07 | 40.00 | 10.07 |
| 577 | " Bone Phosphate, | ---- | ---- | 3.38 | 4.57 | 8.88 | 4.73 | ---- | ---- | 46.61 | 40.00 | 6.61 |
| 558 | " Ammoniated Bone Phosphate, | ---- | ---- | 3.54 | 3.90 | 9.90 | 2.18 | 0.52 | ---- | 44.92 | 40.00 | 4.92 |
| 581 | Harris' Phosphate, | ---- | ---- | 2.93 | 4.88 | 7.07 | 2.72 | ---- | ---- | 39.91 | 36.00 | 3.91 |
| 604 | Peruvian Guano, | ---- | ---- | 6.28 | 3.32 | 7.03 | 11.44 | 2.77 | 3.04 | 62.29 | 60.00 | 2.29 |
| | | | | | | | | | | | | Cost exceeds Valuation. |
| 633 | G. W. Miller's Raw Bone Phosphate, | ---- | ---- | 3.41 | 2.60 | 6.59 | 3.61 | 5.09 | ---- | 43.97 | 44.25 | 0.28 |
| 586 | E. Frank Coe's Phosphate, | ---- | ---- | 2.34 | 7.49 | 2.11 | 2.69 | ---- | ---- | 35.12 | 36.00 | 0.88 |
| 576 | Dickenson's Ammoniated Bone Phosphate, | ---- | ---- | 3.24 | 1.68 | 9.66 | 2.54 | ---- | ---- | 37.59 | 40.00 | 2.41 |
| 610 | Lombard & Matthewson's Superphosphate, | ---- | ---- | 2.91 | 2.27 | 7.42 | 5.70 | ---- | ---- | 37.51 | 40.00 | 2.49 |
| 611 | Darling's Animal Fertilizer, | ---- | 0.46 | 3.63 | 0.58 | 5.89 | 7.14 | 6.47 | 6.33 | 38.74 | 42.00 | 3.26 |
| 568 | Quinnipiac Fertilizer Co's Soluble Nitrogenous Phosphate, | ---- | ---- | 2.41 | 5.70 | 4.61 | 1.16 | 2.70 | 2.84 | 36.01 | 40.00 | 3.99 |
| 593 | "A" Brand Mapes' Complete Manure, | 0.42 | 0.32 | 1.56 | 3.40 | 7.53 | 2.27 | 3.25 | 3.18 | 37.55 | 42.00 | 4.45 |
| 673 | G. W. Miles Co's Special Phosphate, | ---- | 0.40 | 2 06 | 5.98 | 0.97 | 2.00 | 7.17 | 6.36 | 35.39 | 40.00 | 4.61 |
| 671 | Bowker's Hill and Drill Phosphate, | ---- | ---- | 2.40 | 5.40 | 2.16 | 4.60 | 2.49 | 2.02 | 34.75 | 40.00 | 5.25 |

## NITROGENOUS SUPERPHOSPHATES, GUANOS, ETC.

| Station No. | Name. | Nitrogen of Nitrates. | Nitrogen of Ammonia Salts. | Nitrogen of Organic Matters. | Soluble Phos. Acid. | Reverted Phos. Acid. | Insoluble Phos. Acid. | Potash. | Chlorine. | Estimated Value per ton. | Cost per ton. | Cost exceeds Valuation. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 598 | Mapes' Complete Manure for Heavy Soils, | ---- | 3.95 | 1.62 | 2.27 | 5.68 | 3.08 | 2.80 | 3.02 | $46.37 | $52.00 | $5.63 |
| 567 | Pine Island Guano, | ---- | ---- | 4.20 | 5.34 | 1.93 | 0.52 | 2.94 | 1.08 | 38.65 | 45.00 | 6.35 |
| 601 | Quinnipiac Fertilizer Co's Superphosphate, | ---- | ---- | 2.88 | 1.22 | 7.80 | 2.35 | 1.72 | 1.70 | 32.98 | 40.00 | 7.02 |
| 672 | G. W. Miles Co's Ammoniated Bone Superphosphate, | ---- | 0.39 | 1.81 | 6.55 | 1.01 | 2.14 | 3.46 | 3.70 | 32.68 | 40.00 | 7.32 |
| 590 | Rafferty & Williams' Ammoniated Bone Phosphate, | ---- | ---- | 2.00 | 8.05 | 1.23 | 1.38 | 2.53 | 2.24 | 34.54 | 42.00 | 7.46 |
| 603 | Pine Island Guano, | ---- | ---- | 4.58 | 3.04 | 3.31 | 1.07 | 2.83 | 0.96 | 37.41 | 45.00 | 7.59 |
| 661 | Soluble Pacific Guano, | 0.62 | ---- | 1.74 | 7.29 | 1.52 | 3.42 | 1.76 | 1.76 | 36.83 | 45.00 | 8.17 |
| 602 | Fish and Potash, | ---- | ---- | 3.56 | 0.19 | 3.52 | 3.16 | 3.20 | 4.40 | 27.73 | 36.00 | 8.27 |
| 594 | Mapes' Complete Manure for Sandy Soils, | 1.27 | 2.99 | 1.10 | 1.44 | 4.38 | 2.01 | 6.68 | 7.54 | 44.36 | 53.00 | 8.64 |
| 556 | Cooke's Blood Guano, | ---- | ---- | 2.49 | 6.16 | 1.97 | 5.14 | 2.26 | ---- | 37.11 | 46.00 | 8.89 |
| 565 | Soluble Pacific Guano, | ---- | ---- | 2.61 | 5.90 | 1.36 | 4.05 | 2.28 | 2.45 | 35.36 | 45.00 | 9.64 |
| 550 | No. 1. Peruvian Guano, | ---- | ---- | 5.57 | 3.23 | 4.33 | 8.62 | 2.40 | 6.75 | 50.16 | 60.40† | 10.24 |
| 619 | Matfield Fertilizer, No. 2, | ---- | ---- | 1.57 | ---- | ---- | 0.52 | 3.70 | 4.69 | 10.23 | 25.00‡ | 14.77 |
| 589 | No. 1. Standard Peruvian Guano, | ---- | ---- | 6.73 | 2.28 | 4.56 | 4.70 | 2.94 | 9.00 | 50.05 | 66.00 | 15.95 |
| 561 | Mitchell's Standard Phosphate, | ---- | ---- | 1.06 | 0.14 | 5.08 | 2.19 | ---- | ---- | 16.36 | 40.00 | 23.64 |
| | Average of 31 samples, | | | | | | | | | 39.21 | 43.32 | |

† In Plainville. ‡ In Boston.

### Comparison of different samples of the same (or similar) brand of Superphosphate, &c.

| | | Nitrogen. | Soluble Phos. Acid. | Revert. Phos. Acid. | Insol. Phos. Acid. | Potash. | Estim. Value. | Cost. |
|---|---|---|---|---|---|---|---|---|
| David Dickenson's Superphosphate, | **557** | 3.23 | 7.87 | 7.92 | 3.11 | 0.15 | $50.71 | $40.00 |
| | **627** | 3.97 | 5.04 | 9.12 | 3.96 | 0.47 | 50 07 | 40.00 |
| | **577** | 3.38 | 4.57 | 8.88 | 4.73 | -- - | 46.61 | 40.00 |
| | **558** | 3.54 | 3.90 | 9.90 | 2.18 | 0.52 | 44.92 | 40.00 |
| | **576** | 3.24 | 1.68 | 9.66 | 2.54 | ---- | 37.59 | 40.00 |
| Peruvian Guano, | **604** | 6.28 | 3.32 | 7.03 | 11.44 | 2.77 | 62.29 | 60.00 |
| | **550** | 5.57 | 3.23 | 4.33 | 8.62 | 2.40 | 50.16 | 60.40 |
| | **589** | 6.73 | 2.28 | 4.56 | 4.70 | 2.94 | 50.05 | 66.00 |
| Soluble Pacific Guano, | **661** | 2.36* | 7.29 | 1.52 | 3.42 | 1.76 | 36.83 | 45.00 |
| | **565** | 2.61 | 5.90 | 1.36 | 4.05 | 2.28 | 35.36 | 45.00 |
| Quinnipiac Fertilizer Co's Superphosphate, | **568** | 2.41 | 5.70 | 4.61 | 1.16 | 2.70 | 36.01 | 40.00 |
| | **601** | 2.88 | 1.22 | 7.80 | 2.35 | 1.72 | 32.98 | 40.00 |
| Pine Island Guano, | **567** | 4.20 | 5.34 | 1.93 | 0.52 | 2.94 | 38.65 | 45.00 |
| | **603** | 4.58 | 3.04 | 3.31 | 1.07 | 2.83 | 37.41 | 45.00 |
| Mapes' Complete Manure, "A" Brand | **593** | 2.30 | 3.40 | 7.53 | 2.27 | 3.25 | 37.55 | 42.00 |
| Mapes' Complete Manure, For heavy soils | **598** | 5.57 | 2.27 | 5.68 | 3.08 | 2.80 | 46.37 | 52.00 |
| Mapes' Complete Manure, For light soils | **594** | 5.36 | 1.44 | 4.38 | 2.01 | 6.68 | 44.36 | 53.00 |

* Including 0.62 in form of nitrates.

The more complete analysis of No. 1 Peruvian guano, sample **550**, is as follows:

| | |
|---|---|
| Volatile and organic matters and water, | 29.77 |
| (Containing nitrogen 5.57.) | |
| Ash, | 70.23 |
| | 100.00 |
| The Ash consists of | |
| Sand and matters insoluble in acid, | 10.15 |
| Oxide of Iron, | 1.08 |
| Lime, | 13.58 |
| Magnesia, | 2.10 |
| Potash, | 2.40 |
| Soda, | 11.39 |
| Phosphoric Acid, | 16.18 |
| Sulphuric Acid, | 8.14 |
| Chlorine, | 6.75 |
| | 71.77 |
| Deduct Oxygen equivalent to Chlorine, | 1.54 |
| | 70.23 |

Peruvian Guano formerly used to contain not more than one to two per cent. each of soda, sulphuric acid, and chlorine. The



above sample contains these bodies in much larger quantities, corresponding to about 13 per cent. of sulphate of soda and 11 per cent. of common salt. The presumption is therefore very strong that these cheap chemicals are now used to "extend" or adulterate the Guano.

The three "Mapes' Complete Manures" are distinct brands claiming different composition and selling by the manufacturers at different prices. Two of them are also included among the special manures, p. 36.

The average cost of these fertilizers, $43, exceeds the average estimated value, ($39.00), by $4.00 in round numbers. Last year the average cost of 21 samples was $39, and the average estimated value $36. Purchasers of Mitchell's Standard Phosphate have been paying a standard price for a very poor article, if sample **561** fairly represents the brand.

### Special Fertilizers or Formulas.

Of this class 26 samples have been analyzed. Two of these, viz: **593** and **594**, have been also included among superphosphates, etc. A single one of all these samples has an estimated value far above its cost. The cost of a dozen of them comes within $4.00 of estimated value. The cost of the remaining 13 exceeds estimated value from $4.50 to $22.

There are very good reasons why the individual farmer should endeavor to adapt manures to his special crops. Where large tracts of land of uniform quality have been cropped and handled alike for years there is propriety in trying to compose a fertilizer specially applicable to that land or to different classes of crops on it; but for the farmers of Connecticut at large, whose crops and soils are as diverse in their needs as well can be, to suppose that it is possible to make fertilizers that have any universal adaptation to different crops is downright nonsense. That the "formulas" now offered to farmers are the roughest guess-work is capitally illustrated by the table on page 38. There it is seen, by comparing "the highest and lowest per cent.," that the four brands of "Corn Manure" that have been in the Connecticut market, range in content of nitrogen from 3.6 to 6.2 per cent., in "available" phosphoric acid from 2. to 11.4 per cent., and in potash from 4.6 to 14.6 per cent. Greater variety is found in the five kinds of

## Special Fertilizers.

| Station No. | Name or Brand. | Manufacturer. | Dealer. | Sent by |
|---|---|---|---|---|
| 518 | Potato Manure. | H. J. Baker & Bro., N. Y. | H. J. Baker & Bro. | S. C. Hardin, Glastonbury. |
| 520 | Turnip " | " " " | " " " | " " " |
| 522 | Wheat " | " " " | " " " | " " " |
| 647 | Corn " | G. B. Forrester, N. Y. | S. B. Wakeman, Saugatuck. | J. B. Nash, Saugatuck. |
| 643 | Oat " | " " " | " " " | " " " |
| 519 | Onion " | H. J. Baker & Bro. | H. J. Baker & Bro. | S. C. Hardin. |
| 637 | Corn " | G. B. Forrester. | | M. S. Baldwin, Naugatuck. |
| 588 | Special Onion Manure. | " " | S. B. Wakeman. | G. P. Jennings, Green's Farms. |
| 523 | Cabbage Manure. | H. J. Baker & Bro. | H. J. Baker & Bro. | S. C. Hardin. |
| 648 | Strawberry " | G. B. Forrester. | S. B. Wakeman. | S. B. Wakeman. |
| 521 | Oat " | H. J. Baker & Bro. | H. J. Baker & Bro. | S. C. Hardin. |
| 517 | Tobacco " | " " | " " " | " " |
| 665 | " " Conn. Brand. | Mapes Formula and Peruvian Guano Co., N. Y. and Hartford. | Mapes F. & P.G. Co., Hartford Br. | E. H. Jenkins. |
| 593 | Turnips, Peas, Beans, Buckwheat. (Mapes Com. Manure, "A" Brand). | Mapes Formula and Peruvian Guano Co., N. Y. and Hartford. | " " " | C. E. Bunce. |
| 587 | Special Manure. | G. B. Forrester. | S. B. Wakeman. | G. P. Jennings. |
| 646 | Potato " | " " | " " | J. B. Nash. |
| 649 | Onion " | " " | " " | S. B. Wakeman. |
| 597 | Potato " | Mapes F. & P. G. Co. | Mapes F. & P. G. Co. | C. E. Bunce, So. Manchester. |
| 596 | Corn " | " " | " " | " " " |
| 645 | " " Stockbridge. | Bowker Fertilizer Co., N. Y. | Hubbell & Wakeman, Saugat'k. | J. B. Nash. |
| 594 | Early Vegetables, Onions, Hops. (Mapes Com. Man. for sandy soils). | Mapes F. & P. G. Co. | Mapes F. & P. G. Co. | C. E. Bunce. |
| 650 | Potato Manure, Stockbridge. | Bowker Fertilizer Co., N. Y. | Hubbell & Wakeman, Saugat'k. | J. B. Nash. |
| 606 | Grain " " | " " " | R. B. Bradley & Co., N. Haven. | Experiment Station. |
| 620 | Corn Fertilizer. | Matfield Fertilizer Co., Boston. | Matfield Fertilizer Co. | T. S. Gold, West Cornwall. |
| 605 | Potato Manure, Stockbridge. | Bowker Fertilizer Co. | R. B. Bradley & Co. | Experiment Station. |
| 618 | " Fertilizer. | Matfield Fertilizer Co. | Matfield Fertilizer Co. | T. S. Gold. |



## Special Fertilizers.

| Station No. | Name. | Nitrogen of Nitrates. | Nitrog'n of Ammonia Salts. | Nitrog'n of Organic matters. | Total Nitrogen. | Soluble Phos. Acid. | Revert. Phos. Acid. | Insoluble Phos. Acid. | Potash. | Chlorine. | Estimated value per Ton. | Cost per Ton. | Valuation exceeds cost. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 518 | Potato Manure, Baker's | ---- | 2.77 | 4.61 | 7.38 | 1 71 | 4.58 | 2.42 | 12.92 | 4 23 | $60.54 | $46.50 | $14.04 |
| 520 | Turnip " " | ---- | 5.47 | 0.77 | 6.24 | 2.30 | 3.72 | 1.69 | 10.56 | 3.32 | 53.79 | 52.00 | 1.79 |
| 522 | Wheat " " | ---- | 4.66 | 1.55 | 6.21 | 4.15 | 1.96 | 1.17 | 5.93 | 1 93 | 49.00 | 47.50 | 1.50 |
| 647 | Corn " Forrester's | ---- | 4.58 | ---- | 4.58 | 6.62 | 1.33 | 0.37 | 6.63 | 2.79 | 49.94 | 49.00 | 0.94 |
| 643 | Oat " " | ---- | 4.79 | ---- | 4.79 | 4.95 | 1.04 | 0.33 | 8.61 | 3.29 | 49.13 | 49.00 | 0.13 |
| | | | | | | | | | | | | | Cost exceeds Valuation. |
| 519 | Onion Manure, Baker's | ---- | 4.08 | 0.94 | 5.02 | 2.30 | 3.91 | 1.39 | 9.55 | 2.75 | 47.08 | 47.50 | 0.42 |
| 637 | Corn " Forrester's | ---- | 5.25 | 0.25 | 5.50 | 4.90 | 0.74 | 0.44 | 8.67 | ---- | 46.54 | 47.50 | 1.04 |
| 588 | Special Onion Manure, Forrester's | ---- | 5.42 | ---- | 5.42 | 5.09 | 0.75 | 0.08 | 6.76 | 1.12 | 46.70 | 48.00* | 1.30 |
| 523 | Cabbage Manure, Baker's | ---- | 4.35 | 0.77 | 5.12 | 1.56 | 3.97 | 1.18 | 10.01 | 3.61 | 46.14 | 48.00 | 1.86 |
| 648 | Strawberry " Forrester's | ---- | 3.20 | 0.23 | 3.43 | 6.31 | 0.77 | 0.21 | 6.45 | 0.66 | 42.42 | 44.50 | 2.08 |
| 521 | Oat " Baker's | ---- | 3.66 | 0.75 | 4.41 | 1.33 | 4.10 | 2.08 | 11.12 | 3.44 | 44.91 | 47.50 | 2.59 |
| 517 | Tobacco " " | ---- | 4.01 | 0.42 | 4.43 | 0.45 | 4.71 | 1.28 | 11.98 | 4.23 | 44.05 | 47.50 | 3.45 |
| 665 | " " Conn. Brand, Mapes' | 2.52 | 1.95 | 0.39 | 4.86 | 3.29 | 2.32 | 1.85 | 7.42 | 1.14 | 49.20 | 53.00 | 3.80 |
| 593 | Turnips, Peas, Beans, Buckwheat (Mapes Complete Manure, "A" Brand.) | 0.42 | 0.32 | 1.56 | 2.30 | 3.40 | 7.53 | 2.27 | 3.25 | 3.18 | 37.55 | 42.00 | 4.45 |
| 587 | Special Manure, Forrester's | ---- | 4.32 | ---- | 4.32 | 4.30 | 1.07 | 0.37 | 9.05 | 4.53 | 42.52 | 48.00* | 5.48 |
| 646 | Potato " " | ---- | 3.38 | ---- | 3.38 | 4.88 | 0.56 | 0.28 | 9.50 | 0.66 | 43.10 | 49.00 | 5.90 |
| 649 | Onion " " | ---- | 5.06 | ---- | 5.06 | 3.98 | 0.50 | 0.42 | 6.30 | 0.42 | 43.57 | 49.50 | 5.93 |
| 597 | Potato " Mapes' | 1.32 | 1.50 | 0.59 | 3.41 | 4.62 | 5.64 | 1.22 | 5.00 | 4.72 | 43.63 | 50.00 | 6.37 |
| 596 | Corn " " | 0.62 | 2.21 | 0.80 | 3.63 | 2.30 | 7.14 | 2.60 | 5.67 | 6.14 | 43.19 | 50.00 | 6.81 |
| 645 | " " Stockbridge | ---- | 0.31 | 3.73 | 4 04 | 5.46 | 1.35 | 1.97 | 5.29 | 2.33 | 42.70 | 50.00 | 7.30 |
| 594 | Early Vegetables, Onions and Hops (Mapes' Com. Manure for sandy soils.) | 1.27 | 2.99 | 1.10 | 5.36 | 1.44 | 4.38 | 2.01 | 6.68 | 7.54 | 44.36 | 53.00 | 8.64 |
| 650 | Potato Manure, Stockbridge | ---- | 0.24 | 3.08 | 3.32 | 5.54 | 1.29 | 1.93 | 4.85 | 2.21 | 39.17 | 50.00 | 10.83 |
| 606 | Grain " " | ---- | 0.28 | 2.92 | 3.20 | 6.04 | 1.42 | 0.13 | 5.89 | 6.32 | 36.06 | 50.00 | 13.94 |
| 620 | Corn Fertilizer, Matfield | ---- | --- | 4.82 | 4.82 | 1.32 | 1.63 | 0.63 | 5.28 | 5.52 | 31.02 | 45.00 | 13.98 |
| 605 | Potato Manure, Stockbridge | ---- | 0.29 | 2.72 | 3.01 | 6.26 | 0.54 | 0.43 | 4.93 | 5.60 | 33.76 | 50.00 | 16.24 |
| 618 | " Fertilizer, Matfield | 0.66 | ---- | 1.55 | 2.21 | 2.63 | 0.38 | 0.13 | 6.53 | 14.14 | 22.93 | 45.00 | 22.07 |

* At New York.

COMPARISON OF SPECIAL CORN, POTATO AND ONION MANURES.

| Station No. | Name. | Year. | Nitrogen. | Phos. acid sol. and rev. | Potash. | Crop. |
|---|---|---|---|---|---|---|
| **137** | Stockbridge. | 1878 | 5.9 | 5.4 | 6.6 | |
| **195** | " | 1878 | 6.2 | 3.8 | 7.0 | |
| **407** | " | 1880 | 4.7 | 6.0 | 6.8 | |
| N. J. | " | 1880 | 4.8 | 7.2 | 6.2 | |
| **476** | Matfield. | 1880 | 6.1 | 2.0 | 5.3 | |
| **620** | " | 1881 | 4.8 | 3.0 | 5.3 | |
| **379** | Mapes. | 1880 | 3.7 | 10.2 | 7.2 | |
| N. J. | " | 1880 | 4.0 | 11.4 | 4.6 | Corn. |
| N. J. | " | 1880 | 3.9 | 6.5 | 7.7 | |
| **596** | " | 1881 | 3.6 | 9.4 | 5.7 | |
| **300** | Forrester. | 1879 | 5.5 | 5.3 | 13.1 | |
| **421** | " | 1880 | 4.8 | 6.0 | 14.6 | |
| **643** | " | 1881 | 4.6 | 8.0 | 8.6 | |
| **637** | " | 1881 | 5.5 | 5.6 | 8.7 | |
| | highest | per cent. | 6.2 | 11.4 | 14.6 | |
| | lowest | " | 3.6 | 2.0 | 4.6 | |
| **146** | Stockbridge. | 1878 | 3.5 | 6.4 | 10.2 | |
| **260** | " | 1879 | 3.8 | 7.0 | 8.8 | |
| **409** | " | 1880 | 4.1 | 5.9 | 8.1 | |
| **417** | " | 1880 | 3.8 | 5.2 | 8.0 | |
| Mass. | " | 1879 | 4.4 | 3.8 | 7.6 | |
| **650** | " | 1881 | 3.3 | 6.8 | 4.9 | |
| **605** | " | 1881 | 3.0 | 6.8 | 4.9 | |
| **116** | Forrester. | 1878 | 5.7 | 7.6 | 11.4 | |
| **282** | " | 1879 | 4.6 | 5.5 | 9.1 | Potato. |
| **304** | " | 1879 | 4.8 | 5.3 | 10.3 | |
| **420** | " | 1880 | 4.8 | 5.4 | 11.3 | |
| **646** | " | 1881 | 3.4 | 5.4 | 9.5 | |
| **128** | Mapes. | 1878 | 3.7 | 4.5 | 14.8 | |
| **376** | " | 1880 | 3.9 | 8.6 | 7.7 | |
| **597** | " | 1881 | 3.4 | 10.3 | 5.0 | |
| **618** | Matfield. | 1881 | 2.6 | 3.0 | 6.5 | |
| **518** | Baker's. | 1881 | 7.4 | 6.3 | 12.9 | |
| | highest | per cent. | 7.4 | 10.3 | 14.8 | |
| | lowest | " | 2.6 | 3.0 | 4.9 | |
| **258** | Stockbridge. | 1879 | 3.9 | 6.4 | 8.3 | |
| **363** | " | 1880 | 3.1 | 5.3 | 7.9 | |
| **259** | Mapes. | 1879 | 5.7 | 6.2 | 7.5 | |
| **594** | " | 1881 | 5.4 | 5.8 | 6.7 | |
| **301** | Forrester. | 1879 | 7.4 | 4.5 | 7.4 | Onion. |
| **416** | " | 1880 | 7.4 | 4.6 | 7.3 | |
| **588** | " | 1881 | 5.4 | 6.8 | 6.8 | |
| **649** | " | 1881 | 5.1 | 4.5 | 6.3 | |
| **519** | Baker's. | 1881 | 5.0 | 6.2 | 9.6 | |
| | highest | per cent. | 7.4 | 6.8 | 9.6 | |
| | lowest | " | 3.1 | 4.5 | 6.3 | |



"Potato Manure," nitrogen ranging from 2.6 to 7.4, phosphoric acid from 3. to 10.3, and potash from 4.9 to 14.8 per cent. The highest per cents. in the Corn and Potato Manures respectively, are but slightly different, and the same is true of the lowest per cents.

## BONE MANURES.

### *Method of Valuation.*

The method adopted for the valuation of bone manures has been already outlined on page 20. Further details are here given, in part reproduced from former Reports.

Experience has led us to distinguish, for the purpose of valuation, five grades of ground bone, the proportions of which are found by a mechanical analysis, *i. e.*, by passing a weighed sample of the bone through a system of four sieves. These five grades have the dimensions, and during 1881, have had the trade-values below specified, viz:

| | | 1881. Estimated value per pound. | |
|---|---|---|---|
| Grade. | Dimensions. | Nitrogen. | Phos. Acid. |
| Fine, | smaller than one $\frac{1}{50}$ inch, | 15 cts. | 6 cts. |
| Fine medium, | between $\frac{1}{50}$ and $\frac{1}{25}$ inch, | 14 " | $5\frac{1}{2}$ " |
| Medium, | " $\frac{1}{25}$ and $\frac{1}{12}$ inch, | 13 " | 5 " |
| Coarse medium, | " $\frac{1}{12}$ and $\frac{1}{6}$ inch, | 12 " | $4\frac{1}{2}$ " |
| Coarse, | larger than $\frac{1}{6}$ inch, | 11 " | $3\frac{1}{2}$ " |

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.

The following may serve as an example of the valuation of a bone manure by this method. G. W. Miller's Pure Ground Bone, **632**, contained phosphoric acid 23.21 per cent. or 464.2 pounds per ton, and nitrogen 3.95 per cent. or 79 pounds per ton. By the mechanical analysis it showed:

| | | |
|---|---|---|
| 42 | per cent. | fine. |
| 33 | " | fine medium. |
| 22 | " | medium. |
| 3 | " | coarse medium. |
| 0 | " | coarse. |

The calculations are as follows:

| | |
|---|---|
| 79 × 42 ÷ 100 × 15 = | $4.98 |
| 79 × 33 ÷ 100 × 14 = | 3.64 |
| 79 × 22 ÷ 100 × 13 = | 2.26 |
| 79 × 3 ÷ 100 × 12 = | .28 |
| Estimated value of nitrogen= | $11.16 |
| 464.2 × 42 ÷ 100 × 6 = | $11.71 |
| 464.2 × 33 ÷ 100 × 5½ = | 8.42 |
| 464.2 × 22 ÷ 100 × 5 = | 5.11 |
| 464.2 × 3 ÷ 400 × 4½ = | .63 |
| Estimated value of phosphoric acid= | $25.87 |
| Total estimated value= | $37.03 |

This result agrees with the cost ($36.00) within $1.03.

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, and this year Rafferty & Williams' Bone, contain a considerable, or even a large, percentage of salt-cake; of sample **552**, 48 per cent. passed the finest sieve, but the sample yielded to water 38 per cent. of soluble matter, chiefly salt-cake, which mostly passed the finer sieves. 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 if an exact valuation is desired.

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

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 that the errors of valuation are no greater than those which arise from unavoidable variations in different portions of the same lot of fertilizer, or in different lots of the same brand. A difference of two or three dollars between cost and estimated value cannot ordinarily demonstrate that either is out of the way.



## *Analyses of Bone Manures.*

(See Tables on pp. 42 and 43.)

Of the eighteen samples of ground bone here reported, but four fall in value seriously below their cost. These four are Lister's Celebrated Ground Bone, and Rafferty & Williams' Bone Meal. These two articles contain large and variable quantities of moisture and salt-cake or sulphate of soda. (In **552** 12.2 per cent. water, and 38.3 soluble matters, mostly salt-cake; in **553** 7.3 per cent. water and 17.2 soluble matter; in **607**, 24 per cent. soluble matters.) Doubtless the nitrogen and phosphoric acid in these brands are more soluble and active than in raw bone, and this fact should enhance the estimated value. On the other hand, the pulverized salt-cake which passes the fine sieves by our mode of reckoning tends to increase the estimated value, so that the figures given for the latter are probably not far from correct.

On soils which need or are benefited by sulphates, the salt-cake in these articles has a value not to be overlooked. Perhaps they may sometimes be strikingly useful because of the presence of sulphate of soda, as might be expected on land in grass, where plaster operates well, but they may also often work injuriously from containing so much soluble salts, especially if applied with seed in the hill or drill.

"Peter Cooper's Pure Bone" contains so much less nitrogen than other brands of pure bone, because it has been boiled or steamed for the glue manufacture. The boiling has removed all the fat or grease, and also a good share of the peculiar animal matter of the bone (ossein) which dissolves in hot water as glue or gelatine, and which contains all the nitrogen. The residual bone pulverizes easily, and, by the loss of animal matter, is rendered relatively richer in phosphoric acid.

Some entertain the notion that grease in ground bone is a sign of goodness. This is true to a degree, since fresh raw bone is greasy, while old bones that have been exposed to the weather and bones which have been boiled or steamed are not greasy. It is again true that weathered bones and boiled bones are not so rich in nitrogen as fresh raw bones. On the other hand grease is not a fertilizer, and while the extraction of grease is accompanied

## Bone Manures.

| Station No. | Name or Brand. | Manufacturer. | Dealer. | Sampled and Sent by |
|---|---|---|---|---|
| 666 | Pure Bone Saw Dust. | G. W. Dickenson, Essex. | Chas. A. Sill, Saybrook. | T. S. Gold, West Cornwall. |
| 658 | Bone Turning Chips. | " " " | " " " | " " " |
| 657 | Ivory Dust. | " " " | " " " | " " " |
| 549 | Bone Saw Dust. | Holyoke Bone Co., Holyoke, Ms. | Holyoke Bone Co. | J. W. Hemingway, Plainville. |
| 585 | Peter Cooper's Pure Bone. | Peter Cooper, N. Y. | Simon Banks, Southport. | G. P. Jennings, Green's Farms. |
| 632 | Pure Ground Bone. | G. W. Miller, Middlefield. | | G. W. Miller. |
| 582 | Bone. Sample No. 1. | G. H. Harris & Son, Eagleville. | G. H. Harris & Son. | G. H. H. & Son. |
| 545 | Quinnipiac Coarse Bone. | Quinnipiac Co., Wallingford. | | J. W. Yale, Meriden. |
| 677 | Peck Brothers' Ground Bone. | Peck Brothers, Northfield. | G. P. Burnett, Bristol. | S. R. Gridley, Bristol. |
| 584 | Strictly Pure Ground Bone. | G. B. Forrester, New York City. | S. B. Wakeman, Saugatuck. | G. P. Jennings, Green's Farms. |
| 555 | Pure Ground Bone. | Stevens & Draper, Long Hill. | G. P. Jennings. | " " " |
| 644 | Ground Bone. | G. B. Forrester. | | J. H. Robinson, Saugatuck. |
| 569 | Pure Bone Meal. | Mapes' Formula and Peruvian Guano Co., N. Y. | Mapes' F. & P. G. Co. | C. E. Bunce, So. Manchester. |
| 583 | Bone. Sample No. 2. | G. H. Harris & Son, Eagleville. | G. H. H. & Son. | G. H. H. & Son. |
| 553 | Celebrated Ground Bone. | Lister Bros., Newark, N. J. | Simon Banks, Southport. | G. P. Jennings. |
| 670 | Bone Meal. | Rafferty & Williams, N. Y. | S. A. Weldon & Son, Bristol. | S. R. Gridley, Bristol. |
| 607 | Celebrated Ground Bone. | Lister Bros., Newark. | R. B. Bradley & Co., N. Haven. | Experiment Station. |
| 552 | Commonwealth Bone Meal. | Rafferty & Williams, N. Y. | Rafferty & Williams. | Staples, Coley & Co., Westport. |



## Bone Manures.

| Station No. | Name. | Nitrogen. | Phos. Acid. | Finer than 1/50 inch. | Finer than 1/25 inch. | Finer than 1/12 inch. | Finer than 1/6 inch. | Coarser than 1/6 inch. | Estimated value per ton. | Cost per ton. | Valuation exceeds Cost. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 666 | G. W. Dickenson's Pure Bone Saw Dust | 2.15 | 19.21 | 95.2 | 4.8 | --- | --- | --- | $29 40 | $20.00 | $9.40 |
| 658 | G. W. Dickenson's Bone Turning Chips | 3.73 | 25.97 | 27.6 | 29.0 | 27.4 | 12.8 | 3.2 | 37.83 | 30.00 | 7.83 |
| 657 | G. W. Dickenson's Ivory Dust | 3.38 | 26.86 | 52.0 | 20.5 | 18.5 | 9.0 | --- | 39.54 | 35.00 | 4.54 |
| 549 | Holyoke Co's Bone Saw Dust | 3.72 | 25.67 | 75.8 | 19.6 | 4.6 | --- | --- | 41.00 | 37.00* | 4.00 |
| 585 | Peter Cooper's Pure Bone | 1.40 | 29.92 | 51.0 | 15.0 | 13.0 | 15.0 | 6.0 | 36.48 | 35.00† | 1.48 |
| 632 | G. W. Miller's Pure Ground Bone | 3.95 | 23.21 | 42.0 | 33.0 | 22.0 | 3.0 | --- | 37.03 | 36.00 | 1.03 |
| 582 | Harris' Bone. Sample No. 1 | 4.05 | 21.88 | 2.0 | 2.0 | 8.0 | 34.0 | 54.0 | 28.33 | 28.00 | 0.33 |
| | | | | | | | | | | | Cost exceeds Valuation. |
| 545 | Quinnipiac Co's Coarse Bone | 3.84 | 22.32 | 13.0 | 10.0 | 12.0 | 15.0 | 50.0 | 29.94 | 30.00 | $0.06 |
| 677 | Peck Bro's Ground Bone | 4.32 | 21.89 | 7.2 | 13.9 | 17.2 | 33.4 | 28.3 | 31.24 | 32.00 | 0.76 |
| 584 | Forrester's Strictly Pure Ground Bone | 4.18 | 21.80 | 16.0 | 14.0 | 36.0 | 34.0 | --- | 33.04 | 34.50 | 1.46 |
| 555 | Stevens & Draper's Pure Ground Bone | 4.09 | 21.03 | 15.0 | 25.0 | 30.0 | 30.0 | --- | 32.41 | 34.00 | 1.59 |
| 644 | Forrester's Ground Bone | 4.01 | 20.95 | 27.0 | 27.0 | 35.0 | 11 0 | --- | 33.41 | 35.00 | 1.59 |
| 569 | Mapes' Pure Bone Meal | 2.46 | 27.46 | 100.0 | --- | --- | --- | --- | 40.33 | 42.00 | 1.67 |
| 583 | Harris' Bone. Sample No. 2 | 3.66 | 17.74 | 3.0 | 8.0 | 17.0 | 27.0 | 45.0 | 24.68 | 28.00 | 3.32 |
| 553 | Lister's Celebrated Ground Bone | 3.44 | 14.19 | 28.0 | 20.0 | 17.0 | 17.0 | 18.0 | 23.61 | 31.00 | 7.39 |
| 670 | Rafferty & Williams' Bone Meal | 1.68 | 14.36 | 52.0 | 20.0 | 14.0 | 14.0 | --- | 20.67 | 32.00‡ | 11.33 |
| 607 | Lister's Celebrated Ground Bone | 3.02 | 9.54 | 31.0 | 19.0 | 14.0 | 17.0 | 19.0 | 17.80 | 30.00 | 12.20 |
| 552 | Rafferty & Williams' Commonwealth Bone Meal | 1.48 | 12.11 | 48.5 | 20.8 | 12.6 | 10.7 | 7.4 | 17.36 | 30.00§ | 12.64 |

* At Plainville; $35.00 at Holyoke. † In Southport on time; $33.00 in New York. ‡ At Bristol. § At New York.

by more or less loss of nitrogen, this loss is partly or perhaps fully compensated by the greater friability, porosity, and more ready decomposability of the boiled bone. The bones whose grease is gone, absorb water more readily, and therefore enter into putrefactive decay more quickly and feed vegetation more promptly than fresh raw bones. If grease in ground bone is too much relied on as a test of good quality, probably no long time will transpire before "pure bone" that has been boiled and possibly mixed with plaster and crushed oyster shells, will be greased in order to give it the semblance of genuineness.

Bones, slightly boiled to extract grease, probably are not injured for fertilizing use. Bones from which much gelatine has been removed are reduced in commercial value, but are still an excellent fertilizer when they are to be had at a fair price.

The first four articles in the table are perhaps not quite so much better than those below them as the valuation would indicate. In the bone saw dust which is prepared under water and dried for market, there is liable to be a large and variable quantity of moisture. The bone saw dust, turning chips and ivory dust, are all made from the most dense and close textured material, and for that reason would be slower in action than average bone of equal fineness.

On the whole, leaving out of consideration both of the exceptional extremes, the cost and estimated values of the bone manures agree as well as could be reasonably expected.



## Dried Blood and Tankage.

Four samples of refuse from New Haven slaughter houses gave the subjoined results on analysis.

| Station No. | Name. | Manufacturer. | Sampled and sent by |
|---|---|---|---|
| **625** | Dried Blood. | S. E. Merwin & Son, New Haven. | J. J. Webb, Hamden. |
| **626** | Dried Blood and Tankage. | Strong, Barnes, Hart & Co., New Haven. | " " |
| **630** | Dried Blood. | Sperry & Barnes, New Haven. | E. P. Augur, Middlefield. |
| **631** | " " | Strong, Barnes, Hart & Co., New Haven. | E. P. Augur, Middlefield. |

### *Analyses.*

| | 625 | 626 | 630 | 631 |
|---|---|---|---|---|
| Nitrogen | 6.81 | 7.03 | 6.93 | 8.06 |
| Phosphoric Acid | 9.58 | 6.16 | 7.32 | 3.80 |
| Estimated Value per Ton | $38.74 | $35.51 | $36.50 | $36.80 |
| Cost per Ton | 30.00 | 35.00 | 30.00 | 35.00 |
| Valuation exceeds Cost | 8.74 | 0.51 | 6.50 | 1.80 |

Six other samples of higher grade, made from blood and meat, or scrap (cracklings), and more thoroughly dried, were analyzed for private parties with results as follows:—

| Station No. | Name. | Water. | Nitrogen. | Ammonia equiv. to Nitrogen. |
|---|---|---|---|---|
| **529** | Dried Blood | 23.62 | 12.48 | 15.15 |
| **528** | Ammonite | 7.00 | 11.79 | 14.32 |
| **531** | " | 6.87 | 11.28 | 13.69 |
| **533** | " | 4.69 | 12.01 | 14.59 |
| **540** | " | 5.23 | 11.95 | 14.51 |
| **546** | Azotin | 11.84 | 12.03 | 14.40 |

## Fish Manures.

Fish Scrap has been comparatively scarce in the retail market, most of the supply being consumed by manufacturers of superphosphates. Below are given analyses of two samples taken from open market. The remaining twelve analyses were made for dealers, mostly on cargo samples, and are here quoted as a contribution to the statistics of this branch of Connecticut industry.

No. **566**, made by the Quinnipiac Fertilizer Co., New London, sold by Olds & Whipple, Hartford, was sampled by C. E. Bunce, South Manchester.

No. **600**, made by the Quinnipiac Fertilizer Co., sold by R. B. Bradley & Co., New Haven, was sampled by the Station.

### Fish Scrap.

| Station No. | Name. | Water. | Nitrogen. | Ammonia equiv. to nitrogen. | Nitrogen in water-free Fish. | Phos. Acid. | Estimated Value per ton. | Cost per ton. |
|---|---|---|---|---|---|---|---|---|
| **566** | Dry Ground Fish, | ----- | 8.54 | ---- | ---- | 6.96 | $42.51 | $45.00* |
| **600** | " " | ----- | 6.17 | ---- | ---- | 5.32 | 31.06 | 45.00 |
| **512** | Fish, | 18.78 | 7.58 | 9.21 | 9.33 | | | |
| **514** | " | 45.58 | 4.79 | 5.82 | 8.80 | | | |
| **515** | " | 50.94 | 4.97 | 6.03 | 10.13 | | | |
| **591** | " | 39.35 | ---- | ---- | ---- | | | |
| **636** | " | 25.37 | 7.41 | 9.00 | 9.93 | | | |
| **639** | " | ----- | 6.83 | 8.30 | ---- | 6.83 | | |
| **641** | " | 14.42 | 9.29 | 11.28 | 10.85 | | | |
| **651** | " | 12.46 | 8.69 | 10.55 | 9.93 | | | |
| **653** | " | 17.84 | 7.01 | 8.51 | 8.53 | 6.53 | | |
| **654** | " | 40.49 | 5.13 | 6.23 | 8.62 | 5.12 | | |
| **534** | " | 15.00 | 7.41 | 9.00 | 8.72 | | | |
| **548** | " | 14.62 | 7.23 | 8.78 | 8.47 | | | |
| | Average for 1881, | 26.80 | 7.00 | 8.43 | 9.33 | | | |
| | " 1880, | 17.99 | 8.11 | 9.85 | 9.89 | | | |
| | " 1879, | 19.13 | 7.70 | 9.34 | 9.46 | | | |
| | " 1878, | 14.90 | 7.65 | 9.24 | 7.91 | | | |
| | " 1877, | 13.66 | 8.24 | 10.01 | 9.36 | | | |
| | " 1875–6, | 11.78 | 7.80 | 9.47 | 8.84 | | | |

### Tortoise Shell Saw Dust.

**551**, Tortoise Shell Sawdust, made by F. S. Johnson, Plainville, Ct., sent by J. W. Hemingway, Plainville.

* Calculated from price per cwt.



ANALYSIS.

| | |
|---|---|
| Nitrogen | 14.72 |
| Phosphoric Acid | trace |
| Estimated value per ton | $32.38 |
| Cost per ton | 30.00 |

This animal product has probably about the same value as horn and hair in a corresponding state of sub-division. Its nitrogen is reckoned at 11 cts. per lb. in the above valuation.

### Castor Pomace and Cotton Seed Meal.

*Castor Pomace.*

| No. | Made by | Sold by | Sent by |
|---|---|---|---|
| **563** | H. J. Baker & Bros., N. Y. | Buckland & Hardin, Glastonbury. | C. E. Bunce, So. Manchester. |
| **564** | " " " | Olds & Whipple, Hartford. | C. E. Bunce. |
| **621** | " " " | ---------- | H. J. Baker & Bros. |
| **660** | " " " | ---------- | H. Y. Castner & Bro., N. Y. |

*Cotton Seed Meal.*

| No. | Made by | Sold by | Sent by |
|---|---|---|---|
| **579** | B. G. Stanton, New London, Conn. | Coles & Weeks, Middletown. | J. M. Hubbard, Middletown. |
| **580** | ? | Wilson & Burr, Middletown. | J. M. Hubbard, Middletown. |
| **629** | ? | W. F. Fuller, Suffield. | H. H. Austin, Suffield. |

### Analyses.

| | Castor Pomace. | | | | Cotton Seed Meal. | | |
|---|---|---|---|---|---|---|---|
| | **563** | **564** | **621** | **660** | **579*** | **580** | **629** |
| Nitrogen, | 5.08 | 5.47 | 4.43 | 4.74 | 3.56 | 6.01 | 6.80 |
| Phos. Acid, | 1.60 | 1.61 | 1.40 | 1.56 | 1.70 | 1.70 | 3.27 |
| Potash, | 1.12 | 0.99 | 1.07 | 0.97 | 1.57 | 1.20 | 2.00 |
| Estimated value per ton, | $18.97 | 20.32 | 16.82 | 17.91 | 14.84 | 22.35 | 27.48 |
| Cost per ton, | $25.00 | 25.00 | ----- | 22.50 | 30.00 | 21.00 | 30.00 |

* No. **579** contains the almost worthless hulls.

The price of Castor Pomace has advanced since last year by $3–5 per ton. The composition remains about the same. In case of Cotton Seed Meal the price has not advanced, but an inferior article, **579** has been put upon the market. This grade of meal, which contains the black hulls, can be distinguished by close inspection from the better meal that is ground from decorticated cotton seed.

### Night Soil.

**543** received March 15th, from Wm. Burr, Fairfield.

This sample represents the material gathered from village privies during cold weather in the spring season. For comparison the analysis of a sample from a large quantity taken in the village of New Canaan in 1859 is given.

Chemical Analyses of Night Soil.

| | Fairfield. 543 | New Canaan. |
|---|---|---|
| Water, | 53.06 | 66.74 |
| Organic Matter,* | 11.62 | 17.68 |
| Sand, soil and coal ashes, | 29.76 | 8.59 |
| Potash, | .21 | .65 |
| Soda, | .26 | |
| Lime, | .82 | 2.27 |
| Magnesia, | .60 | |
| Iron oxide and alumina, | 1.79 | 2.69 |
| Phosphoric acid, | 1.41 | 1.38 |
| Sulphuric acid, | .39 | |
| Chlorine, | .08 | |
| | 100.00 | 100.00 |
| *With Nitrogen, | .74 | .87 |

No closer agreement could be expected in two samples of this material than is seen in the above analyses. The greater quantity of lime found in the New Canaan sample might have come from a sprinkling of oyster shells or the like. The large admixture of sand, soil and coal ashes is what can hardly be avoided.

The most valuable fertilizing elements of the night soil, viz: nitrogen, phosphoric acid and potash may be bought in other forms in the fertilizer market for 22½ cts., 9 cts. and 7 cts. per pound respectively. The highest commercial value of these ingredients in 100 pounds of night soil, **543**, is as follows :—



| | | |
|---|---|---|
| Nitrogen, | 0.74 × 22½ cts. | =16.6 cts. |
| Potash, | 0.21 × 7 " | = 1.5 " |
| Phos. acid, | 1.41 × 9 " | =12.7 " |
| Total | | 29.8 " |

The other substances present do not materially add to the value, and the commercial worth of the night soil is not more than 30 cts. per 100 pounds, or $6.00 per ton, on the most favorable reckoning.

### Pollard's Improved Night-Soil Fertilizer.

In the Station report for 1880 were given the analyses of two samples of "Concentrated Privy Guano," said to be manufactured by Pollard and Cook, of Providence. These samples were brought to the Station by a party who gave his name and address as F. C. Cook, 119 Ellsworth Avenue, New Haven. These samples had an estimated value of $129 per ton, and while flavored with night soil, were essentially mixtures of chemicals too costly for agricultural use. It was perfectly evident that "there was a mouse in the meal," and the question at once arose whether the Station should act as detective, or by giving rope possibly become hangman. It was decided to give rope; the analyses were mailed to the address given, and as stated in the last Report were made use of by Pollard in a swindling tour at the South.

During the present year Mr. F. C. Cook called upon the writer in company with several respectable citizens of New Haven, who appeared as his vouchers, and stated that he did not bring or send the samples of Privy Guano, and at the time they were sent knew nothing of them whatever. Mr. Cook further stated that he had negotiated with H. M. Pollard, and had bought of the same the right to make the "Patent Improved Night Soil Fertilizer," and also stated that it was his belief that it was Pollard in person who brought to the Station the samples of "Privy Guano," and used without authorization, his (Mr. Cook's) name upon the Station form for description of the samples.

Mr. Cook further wished to know whether the "Improved Night Soil Fertilizer," the patent right for manufacturing which had become his property, was worth manufacturing. If not he desired to have done with it. The patent directs to mix fresh night soil with burned plaster and various other ingredients, and

Mr. Cook having taken the trouble to prepare a quantity in the best manner, it has been submitted to analysis by the Station with the figures subjoined, the writer desiring to give full investigation to any scheme for utilizing materials that are going to waste.

The results of the analysis plainly demonstrate that night soil, at its best, is not rich enough to warrant manufacturing by the Pollard process, and show, what was indeed sufficiently evident without the analysis, that the Pollard Patent has no real value.

#### Analysis of Improved Night Soil Fertilizer.

**544,** made by F. C. Cook, New Haven, according to the specifications of the Pollard Patent.

| | | | | |
|---|---|---|---|---|
| Moisture, | | | | 15.70 |
| Organic and Volatile Matters,* | | | | 14.80 |
| Hydrated Sulphate of Lime, (same as unburned plaster or gypsum,) | containing | Water, | 13.42 | |
| | | SulphuricAcid, | 29.81 | 64.10 |
| | | Lime, | 20.87 | |
| Lime as carbonate or phosphate, | | | | .90 |
| Magnesia " " | | | | .29 |
| Potash " " | | | | .59 |
| Soda " " | | | | .73 |
| Iron Oxide, | | | | .83 |
| Phosphoric Acid, | | | | 1.25 |
| Chlorine, | | | | trace |
| Sand, | | | | .81 |
| | | | | 100.00 |

* With Nitrogen, 1.19

The sample contains at least 95 per cent. of matters that have no fertilizing value with exception of the plaster, which is commercially worth $6 per ton, or 30 cts. per 100 lbs. The value of the other ingredients is nothing commercially except in case of

| | | | | | | |
|---|---|---|---|---|---|---|
| *Potash* | worth 7 cts. per lb. | = | 4 | cts. for | $\frac{6}{10}$ | lb. |
| *Phosphoric Acid* | " 9 " | = | 11¼ | " | 1¼ | " and |
| *Nitrogen* | " 22½ " | = | 27 | " | 1⅕ | " |
| Add for Plaster, | | | 20 | " | 64 | " and |
| We have the *total value,* | | | 62¼ | cts. per 100 lbs. | | |

The commercial value per ton is accordingly $12.50, or, exclusive of plaster, $8.50, a sum insufficient to pay the cost of manufacturing and handling. If the manufacture were undertaken with the common run of privy night soil, the value would be $2–$3 less per ton, as appears from the valuation of sample **543.**



### Potash Salts.

The muriates, with but two exceptions, are equal or superior to guarantee, and average 51 per cent. of potash, or 81 per cent. of muriate. The average cost of potash is $4.14 per 100 lbs., but the fluctuations of cost amount in the extreme to $1.06 per 100 lbs. The average cost is well within the Station valuation of 4½ cts.

The single sample of high grade sulphate cost within 15 cents of the estimated value. In kainite, potash has been held as high as in the 81 per cent. sulphate, kainite selling for $18 and $20 per ton, while the wholesale quotations in New York have ranged from $6.50 to $9.

### Potash Salts.

*Muriates.*

| Station No. | Importer. | Dealer. | Sampled by |
|---|---|---|---|
| 560 | Mapes Formula and Peruvian Guano Co., N. Y. | Mapes F. & P. G. Co. | C. E. Bunce, So. Manchester. |
| 572 | Bowker Fertilizer Co., N. Y. | Wilson & Burr, Middletown. | J. M. Hubbard, Middletown. |
| 595 | Mapes F. & P. G. Co. | Mapes F. & P. G. Co. | C. E. Bunce. |
| 608 | " " " | " " " | C. Fairchild, Middletown. |
| 609 | | Wilson & Burr. | C. Fairchild, Middletown. |
| 616 | Mapes F. & P. G. Co. | Mapes F. & P. G. Co. | T. N. Bishop, Plainville. |
| 624 | H. J. Baker & Bro., N. Y. | | J. J. Webb, Hamden. |

*Sulphate.*

| | | | |
|---|---|---|---|
| 559 | Mapes F. & P. G. Co. | Mapes F. & P. G. Co. | C. E. Bunce. |

*Kainite.*

| | | | |
|---|---|---|---|
| 571 | Rafferty & Williams, N. Y. | F. Ellsworth, Hartford. | C. E. Bunce. |
| 659* 664 | Mapes F. & P. G. Co. | Mapes F. & P. G. Co. | E. H. Jenkins. |

* Private analysis.

POTASH SALTS.—*Analyses, etc.*

| | Muriates. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **560** | **572** | **595** | **608** | **609** | **616** | **624** | Average. |
| Potash (potassium oxide), | 45.87 | 49.02 | 51.21 | 53.91 | 50.16 | 53.25 | 54.26 | |
| Equivalent to pure muriate, | 72.65 | 77.63 | 81.11 | 85.30 | 79.40 | 84.34 | 86.04 | |
| Potash guaranteed or implied in brand, | 50.50 | 50.5 to 53.7 | .... | 50.50 | 50.50 | 53.00 | 52.50 | |
| Muriate guaranteed, | 80.00 | 80-85 | .... | 80.00 | 80.00 | 84.00 | 83.00 | |
| Cost per ton, | $42.00 | 45.00 | 42.00 | 38.00 | 42.50 | 42.00 | 44.00 | |
| Estimated Value per ton, | $41.28 | 44.12 | 46.09 | 48.52 | 45.14 | 47.92 | 48.83 | |
| Cost per 100 lbs. of potash, | $4.58 | 4.59 | 4.10 | 3.52 | 4.23 | 3.94 | 4.05 | 4.14 |



POTASH SALTS.—ANALYSES.

| | Sulphate. | Kainite. | | |
|---|---|---|---|---|
| | **559** | **571** | **659** | **664** |
| Potash (potassium oxide), | 43.23 | 12.51 | 12.08 | 12.68 |
| Equivalent to pure Sulphate, | 79.95 | 23.20 | ----- | ----- |
| Chlorine, | 0.88 | 27.23 | ----- | 26.08 |
| Potash guaranteed or implied in brand, | 43.81 | 11.90 to 14.06 | ----- | 13.00 |
| Sulphate guaranteed, | 81.00 | ----- | ----- | ----- |
| Cost per ton, | $65.00 | 20.00 | ----- | 18.00 |
| Calculated value per ton, | $64.85 | 13.75 | ----- | 13.95 |
| Cost of Potash per 100 lbs., | $7.52 | 8.00 | ----- | 7.10 |

## NITRATE OF SODA.

**642.** Nitrate of Soda, imported by The Mapes Formula & Peruvian Guano Co., New York and Hartford; sent by J. W. Hemingway, Plainville, Ct.

**675.** Cargo sample, analyzed for private parties.

| *Analyses.* | **642** | **675** |
|---|---|---|
| Nitrate of Soda, | 95.90 | 95.21 |
| Moisture, | 3.00 | 2.73 |
| Salt, | | 1.19 |
| Undetermined matters, | 1.10 | .87 |
| | 100.00 | 100.00 |
| Nitrogen in nitrate, | 15.79 | 15.68 |

Cost of **642** in New York, $12.75 per 300 lbs., or $4.25 per 100 lbs.

Cost of Nitrogen in **642** per lb., 26.9 cents.

The ruling *wholesale prices* in New York are $3.12 to $3.25 per 100 lbs. The latter corresponds to 21 cts. per lb. for Nitrogen.

## SALT.

**570.** Salt, manufactured by the Onondaga Salt Co., Syracuse, N. Y.; sold by Bronson & Fitzgerald, Hartford; sampled by C. E. Bunce.

| | |
|---|---|
| Pure Salt (Chloride of Sodium), | 93.60 |
| Moisture and impurities, | 6.40 |
| | 100.00 |
| Cost per ton, | $10.00 |

### Land Plaster.

**562.** Plaster, manufactured by G. A. Loudon, Berlin, Ct., sold by Olds & Whipple, Hartford, and sent by C. E. Bunce, South Manchester, Ct.

**628.** Plaster, manufactured and sent by Peck Brothers, Northfield, Ct.

*Analyses.*

| | 562 | 628 |
|---|---|---|
| Sand and insoluble matters, | 2.50 | 2.95 |
| Carbonates, etc., by difference, | 1.93 | 1.01 |
| Hydrated Sulphate of Lime (pure gypsum), | 95.57 | 96.04 |
| | 100.00 | 100.00 |
| Cost per ton, | $9.00 | $7.50 |

### Lime-Kiln Ashes.

**494.** Lime-kiln ashes from New York State.

**507.** Lime-kiln ashes from stock of Ralph Barber, Rockville. Sampled and sent by H. A. Slater, North Manchester.

**542.** "Ashes from factories in Canada." Sample sent February 10th, by George F. Chapin, Thompsonville, from J. Thayer, dealer, Boston, Mass.

Lime-kiln ashes are the mixture of wood ashes and lime, which comes from the fire places in lime kilns, where wood is used as fuel. **494** and **507** were sent to the Station as lime-kiln ashes, and doubtless are fair samples of their class.

| | 494 | 507 | 542 |
|---|---|---|---|
| Sand and matters insoluble in acids, | 10.23 (Sand, Silica, Char together) | 2.75 | 4.84 (Sand and Silica together) |
| Silica, | | 1.32 | |
| Char, | | 4.98 | 2.98 |
| Carbonic acid, | 29.40* (Carbonic acid, Moisture, Combined Water together) | 24.81 | 7.05 |
| Moisture expelled at 212°, | | 2.15 | 1.00 |
| Combined Water, | | 4.64* | 13.46* |
| Oxide of iron and alumina, | 3.73 | .22 | .57 |
| Lime, | 50.53 | 53.85 | 67.42 |
| Magnesia, | 3.19 | 1.30 | 1.28 |
| Potash, | 1.74 | 1.94 | .23 |
| Soda, | .55 | .73 | .42 |
| Phosphoric acid, | .63 | 1.31 | .38 |
| Sulphuric acid, | undet. | undet. | .37 |
| | 100.00 | 100.00 | 100.00 |
| Cost per bushel, | ? | 20 cts. | |

* Includes loss in analysis.



*Analyses.*

Sample **494** was analyzed for private use, and the Station has no information as to cost, etc.

Both **494** and **507** have a composition more nearly like that of leached ashes than anything of common occurrence with which they can be compared. From leached ashes they differ in containing little or no moisture, and about 20 per cent. more lime. They agree more closely with leached ashes in the proportion of alkalies, magnesia and phosphoric acid present, although their potash is more and their phosphoric acid less than leached ashes commonly contain. Of the lime, in sample **507**, about 31 per cent. exists united to the carbonic acid, making 56 per cent. of carbonate of lime; about 14 per cent. is united to water, forming 19 per cent. of slacked lime; and the remaining 8 per cent. is present as quick-lime. The sample contains, therefore, about 83 per cent. of lime and its carbonate and hydrate. These ashes are, in fact, unleached wood ashes mixed with four to six times their weight of partly slacked and carbonated lime. They must be used with caution, but if properly applied will no doubt prove a valuable fertilizer on some soils.

Sample **542** was offered at Thompsonville as "Canada ashes." In it the 7 per cent. of carbonic acid is united to 9 per cent. (in round numbers) of lime, making about 16 per cent. of carbonate of lime. The combined water is united to about 42 per cent. of the lime, making 55 per cent. of hydrate of lime (slacked lime) and the remainder of the lime—16 per cent.—exists as quick-lime. Accordingly the sample contains 87 per cent. of lime and its carbonate and hydrate. It contains also 9 per cent. of sand, char, oxide of iron and moisture, leaving 2.7 per cent. of magnesia, alkalies, phosphoric acid and sulphuric acid.

These "ashes from factories in Canada" are, in fact, lime, so slightly admixed with wood ashes, as not to differ essentially from oyster-shell lime in composition or value whether commercial or agricultural. The presence of so much caustic and slacked lime renders this sample very unlike ashes in its action on the soil. From their presence in such large quantity this material might occasion serious loss if applied to growing crops or to land ready to plant. The name is misleading and fraudulent, and evidently we have a material which will scarcely pay the farmers of Connecticut to transport from the "factories in Canada," or rather from Boston, where it is believed to have originated.

The weight of the struck bushel of **542** is about 55 lbs., its commercial value is not far from that of an equal weight of slacked oyster-shell or other cheap lime. The other samples must be reckoned at about the same commercial value. Their agricultural value must be estimated as that of lime, and not that of leached ashes.

## Cotton Seed Ashes.

**505** sample received from G. Balloch, dealer, 90 Broad street, New York.

*Analysis.*

| | |
|---|---|
| Silica and sand, | 12.55 |
| Oxide of iron and alumina, | 3.54 |
| Lime, | 7.52 |
| Magnesia, | 11.06 |
| Potash (sol. in water, 17.18 per cent.), | 29.40 |
| Sulphuric acid, | 2.27 |
| Phosphoric acid (sol. in am. citrate, 5.13 per cent.), | 17.72 |
| Carbonic acid, | 7.63 |
| Chlorine, | .22 |
| Char, | 1.42 |
| Water, | 5.67 |
| Combined water and loss, | 1.05 |
| | 100.05 |
| Deduct oxygen equivalent to chlorine, | .05 |
| | 100.00 |

This is an excellent fertilizer. Reckoning its potash at 4½ cts., and phosphoric acid at 6 cts., the sample has a value of $47.72 per ton. The analysis does not, however, fully establish the availability of these ingredients. Evidently some 12 per cent. of the potash is present in the form of silicate insoluble in water, and a considerable amount of phosphoric acid is of uncertain solubility. Mr. Balloch was unable to put any price on the ashes and they do not appear to have come into market to any noteworthy extent. Should they do so the Station will give them further investigation.

## Leached Ashes.

**652,** Canada Ashes. Sampled and sent by Robert S. Cone, Moodus, from lot of 1,000 bushels purchased of James A. Bill, Lyme. Part of cargo (8,000 bushels) of barge A. P. Wright.



*Analysis.*

| | 652 |
|---|---|
| Sand and matters insoluble in acid, } Silica, } | 8.61 |
| Char, | 2.27 |
| Carbonic acid, | 23.42 |
| Moisture, } Combined water, } | 24.25 |
| Oxide of iron and alumina, | 1.49 |
| Lime, | 34.65 |
| Magnesia, | 2.68 |
| Potash, | 1.05 |
| Soda, | .50 |
| Phosphoric acid, | .88 |
| Sulphuric acid, | .20 |
| | 100.00 |
| Cost per bushel, | 17 cts. |

The sample accords well in composition with those formerly analyzed at this Station. The lime exists mostly as carbonate, and is therefore without injurious action on vegetation. This fertilizer appears to be very popular in Connecticut, the importations from Canada direct, during 1881, having amounted to about 250,000 bushels.

## Refuse Lime from Beet Sugar Works.

**516.** This sample was sent in December, 1880, by Edgar Stoughton, Esq., of South Windsor, and came from the Franklin Beet Sugar works, in Massachusetts.

*Analysis.*

| | |
|---|---|
| Moisture, | 42.19 |
| Carbonic acid, organic matter* and water, | 23.99 |
| Lime, | 19.85 |
| Potash, | .32 |
| Phosphoric acid, | 3.10 |
| Undetermined matter, | 10.55 |
| | 100.00 |
| Estimated value, per ton, | $9.30 |
| * With nitrogen, | .44 |

In Bulletin 51, dated Jan. 27, 1881, the lime in this sample was valued at $1.59. At the present advanced price of lime at New Haven it would be worth $2.38, which would bring the total value of **516** to $10.10 per ton. The Franklin Works are, however, suspended, and this refuse is not in the market.

"THE BIRD GUANO AND FERTILIZER."

**527.** Sample received Jan. 26, from Samuel Hubbard, Hartford. Dealer, L. A. Bradley, 17 Colony street, West Meriden. "Selling price at factory, $30 per ton."

*Composition.*

| | |
|---|---|
| Organic and volatile matter,* | 5.37 |
| Carbonate of lime, | 56.10 |
| Carbonate of magnesia, | 2.38 |
| Sand, silica and clay, | 33.45 |
| Oxide of iron with traces of alkalies, chlorine, sulphuric and phosphoric acid, | 2.70 |
| | 100.00 |
| *With nitrogen, | 0.20 |

This quack fertilizer is an inferior quality of shell marl, said, in the accompanying circular, to be taken from the shores of Cayuga lake, in New York. It corresponds most nearly in composition and fertilizing value to leached ashes, is however rather inferior to ordinary leached ashes which cost from $4.50 to $7.50 per ton, according to the amount of transportation.

ANALYSES OF ROCKS.

**655.** Limestone. Sent by H. N. Bill, Willimantic.

*Chemical Analysis.*

| | 655. | A. | B. | C. |
|---|---|---|---|---|
| Lime, | 20.28 | 29.32 | 5.69 | .46 |
| Magnesia, | .43 | 4.16 | 2.10 | 1.80 |
| Potash, | .03 | .29 | .54 | .47 |
| Soda, | ·30 | .70 | .67 | .28 |
| Oxide of iron and alumina, | 1.89 | 3.28 | 8.89 | 7.75 |
| Phosphoric acid, | trace | trace | .15 | .10 |
| Soluble in strong acids, | 22.93 | 37.75 | 18.04 | 10.86 |
| Silica and silicates insoluble in acids, | 61.20 | 32.86 | 75.59 | 86.06 |
| Carbonic acid (and loss on ignition), | 16.47 | 29.39 | 6.37 | *3.08 |
| | 100.60 | 100.00 | 100.00 | 100.00 |

* Water.



**655** is said to be situated about two and a half miles from Willimantic and to occur in layers that in the aggregate amount to three feet in thickness. It burns and slacks like common limestone. It contains in round numbers, 40 per cent. of carbonates of lime and magnesia.

The sample analyzed was from a loose fragment believed by Mr. Bill to be identical with the rock of the ledge.

Very probably the impure lime obtained by burning this rock may be of great advantage if skillfully employed upon the contiguous farms.

The analyses **A, B** and **C** above given were made by Dr. Jenkins in 1873 and are copied from the writer's note books as a useful contribution to the knowledge of our agricultural raw materials.

**A** is the "Limestone" occurring in Woodbridge, a few miles west of New Haven. It was some years ago burned for making "hydraulic cement" or "water lime," but the manufacture was shortly abandoned. Portions of the rock which have long been exposed well illustrate the process of "weathering" whereby rocks are transformed into soil. In some cases the carbonates of lime and magnesia have been dissolved out for a depth of several inches, leaving the comparatively insoluble silica and silicates as a rough porous coating which is dark in color, owing to the conversion of the iron originally present in white carbonate or pale green silicate to the brown hydrated peroxide. This rock contains a large proportion of carbonates of lime and magnesia and one per cent. of alkalies, including 0·3 of potash.

**B** and **C** were samples of rock from the farm of David J. Stiles of Southbury. The former is a hard compact "Limestone," the latter a soft shale or slaty rock, easily broken up by action of the weather. These rocks are from or near the well-known locality where fossil fish have been found. They contain notable quantities of phosphoric acid and half a per cent. of potash. These rocks if pulverized would act as fertilizers on most poor soils, and under favorable circumstances some of them may perhaps yield a profit by such application. Soils which have been formed and are still forming by the decay of these rocks are, it is to be presumed, amply stocked with lime, magnesia, potash and phosphoric acid or such of these bodies as are abundantly indicated by the analyses. Investigation of the composition of our rocks may evidently furnish useful hints to the thoughtful agriculturist.

### SOAP BOILERS' REFUSE.

**573.** Scraps from rendering vat.
**575.** Liquid from rendering vat.
**574.** Lye from condenser.

The above were sent to Station by A. A. Hills, Greenville.

*Analyses.*

| | 573 | 575 | 574 |
|---|---|---|---|
| Nitrogen | 2.25 | 1.07 | ---- |
| Phos. acid | 0.51 | 0.22 | ---- |
| Potash | ---- | ---- | 2.40 |
| Estimated value per ton | $7.81 | $4.83 | $2.16 |

The ton of **575** and **574** equals about 230 gallons or 7⅓ bbls.

### MUSSEL BED.

**617.** From Maine; brought to Station by Wm. Romer, Jr., of Warren, R. I. A useful fertilizer but not one that will warrant much cost of transportation.

| | |
|---|---|
| Water | 29.10 |
| Sand and insoluble | 52.73 |
| Organic matter * | 2.20 |
| Alumina and Oxide of Iron | 4.55 |
| Lime | 4.15 |
| Magnesia | .86 |
| Potash | .30 |
| Soda | .57 |
| Sulphuric acid | .57 |
| Phosphoric acid | .18 |
| Carbonic acid, chlorine and loss, | 4.69 |
| | 100.00 |

* Containing nitrogen 0.144.

This sample is more than four-fifths sand or clay and water. It contains about seven per cent. of carbonate of lime and one per cent. of carbonate of magnesia, which are commonly useful applications to New England soils. Of the more costly fertilizing elements—nitrogen, phosphoric acid and potash—it contains less than exist in stable manure of average quality.



### SWAMP MUCK.

**612.** Swamp muck sent by N. P. Perkins, Willimantic. This muck was dug in November, 1880, lay in heaps in the field during the winter and until about the middle of May, when it was sent to the Station.

**680.** Swamp Muck from J. W. Nettleton, Milford.

| *The Fresh Muck contains:* | 612 | 680 |
|---|---|---|
| Water | 77.59 | 73.13 |
| Organic matters * | 15.65 | 14.64 |
| Ash † | 6.76 | 12.23 |
| | 100.00 | 100.00 |
| * With Nitrogen | .41 | .35 |
| † With Sand and silicates | 6.15 | 9.79 |
| " Oxide of iron, alumina and phosphoric acid | .38 | 1.09 |
| " Lime | .14 | .19 |
| " Soluble iron-salts | *trace* | *none* |
| " undetermined matter | .09 | 1.16 |
| | 6.76 | 12.23 |
| *The Dry (Water-free) Muck contains:* | | |
| Organic matters | 69.82 | 54.46 |
| Ash | 30.18 | 45.54 |
| Lime | .62 | .65 |
| Nitrogen | 1.83 | 1.31 |
| *The Organic Matters contain:* | | |
| Nitrogen | 2.62 | 2.40 |

These samples are quite similar in composition. Their *direct fertilizing value* is comparatively small, lying mainly in the small quantities of nitrogen and lime they contain. The nitrogen amounts to but 7 to 8 lbs. per ton of muck, about half as much as is usually found in stable manure. Of lime there is but 3 to 4 lbs. per ton. The nitrogen exists doubtless in a less active state than that of stable manure. As a "fertilizer" therefore, using that word in its strictest sense, muck of the quality of these samples has little value.

Mr. Perkins in forwarding samples wrote as follows: "The analysis of the swamp muck is of greater importance to us than that of phosphates, as we can have thousands of loads of the former for the drawing, while we must pay largely for the phosphates. I have no confidence in the muck except as an absorbent. Mr. Barrows mixes ashes with it and claims great results from its use. Mr. Lewis has to haul his more than a mile and hauls hundreds of loads, tips a load in a place, covers the ground all over and claims good results, and certainly he grows the finest vegetables I ever saw. In years past he has used great quantities of stable manure, ashes, etc. Mr. Barrows' and my muck beds are so handy we can haul an ox load each hour in the day."

Mr. Perkins' cultivable land in Pleasant Valley lies nearly level, and but slightly higher than the Muck Swamp into which it gradates. The soil consists largely of clay and silt washed from the surrounding hills, or brought in by the streams from distant higher lands. It appears to be mostly a deep, moist, fine-textured loam, and to have, for a New England soil, a more than usual stock of native fertility. It is a soil which needs nothing to help it retain moisture, which is not deficient in organic matter and which only requires small amounts of fertilizing applications with judicious tillage and rotation, and in the moister parts, deep drainage, to maintain it in a productive state. Such a soil is evidently not of the kind to be benefited by swamp muck. Some of Mr. Perkins' neighbors who work coarse-textured, hungry soils which let the water through them like a riddle, find that Swamp Muck is very useful to them. They, however, do not rely upon it as a direct source of plant food. They use with it "large quantities of stable manure, ashes, etc." The muck is just as valuable as an "amendment," to give to ground the texture and physical qualities of "loam" or of "garden soil" as stable manure is, and the stable manure, ashes, etc., serve to set up that "fermentation" or decomposition in Swamp Muck which renders its nitrogen of avail.

The use of Swamp Muck on grass land, or on tilled soil newly broken up from grass and therefore well stocked with humus, is of the nature of "carrying coals to Newcastle." In market gardening, where the continual tillage tends to the rapid removal of organic matter, muck may well take, more or less, the place of stable manure, according to its quality and cost.

The quality of Swamp Muck can be roughly inferred from the following considerations: When the swamp is a basin with a small outlet or none, when the "wash" that enters it comes copiously from good or rich soil, when the herbage that grows on it is tall and rank, when large quantities of forest leaves accumulate in it, we may safely assume that the muck will be relatively rich in plant-food. It is from such deposits that the muck has been obtained, which is reported to have nearly equaled stable manure in fertilizing effect. On the other hand, when the wash into the swamp is scanty and from coarse, poor soil, when the vegetation is mere moss or a spare growth of sedge, and when large volumes of water flow through it and leach out its soluble matters, then it would be strange if the muck had any considerable active fertilizing quality. It may, nevertheless, even then, be very serviceable for *amending* poor, coarse, sandy or gravelly soils, but the amending must be followed up by real "manure" of the appropriate kind.



Mr. Perkins says further: "Our muck beds are from two to ten feet deep. At the bottom of them we find stone that are quite white and remain so for many years. I can point out in our walls every stone that came from the muck." This interesting statement illustrates one of the modes in which swamp muck, as well as stable manure, green crops ploughed under and decaying vegetable matter, generally operate as *indirect fertilizers*. The white stones observed by Mr. Perkins, differ from those taken out of the arable land or those that originally strewed the surface of much of the higher land simply in one respect. The stones long weathered on or in the soil, are colored yellow or brown by compounds of iron, which are constant ingredients of nearly all our rocks. The stones dug out of the muck are white because these iron compounds have been dissolved away by the action of the acids which are developed in the decay of vegetable matter, and which are essential ingredients of Swamp Muck.

The productiveness of unmanured land is kept up by natural processes which liberate potash, phosphoric acid, lime, etc., from the stony matter or rock-dust of the soil. Living roots attack this rock-dust by the vegetable acids (oxalic acid) which they contain. Stable manure and swamp muck attack it by the humic acids which they contain and by the carbonic acid of which in their decay they are the constant and abundant sources. These and similar applications, which consist largely of humus or decaying vegetable matters, thus prepare for crops the nutriment of which the soil is the great storehouse, and manure the land by making its own supplies available.

Mr. Perkins also states in his letter: "I think it remarkable that we can raise the nicest and largest potato crops on our blackest, most mucky soil, and they never rot."

Since low damp situations are commonly favorable to the potato rot, this observation suggests that possibly the potato fungus is counteracted by some ingredient of this mucky land, and recalls the statement made by Prof. Cook, Director of the New Jersey Agricultural Experiment Station in the first Report of that Station (1880), p. 66, which is to the effect that the "cranberry scald," a disease due to a fungus, does not appear on certain marls and bogs which contain free acid or acid salts. It was at first thought that sulphate of iron (copperas) was the preventive, but experiments with that substance on various cranberry bogs during 1880, did not give conclusive results. It is important that the experience of those who have raised potatoes on mucky land be made public, in order to guide investigation on this subject, should the facts warrant undertaking its study.

The sample of long weathered Swamp Muck sent by Mr. Perkins, contains a trace of soluble iron salts. These in minute quantities are not harmful to agricultural plants. When their amount increases beyond certain limits, they destroy our common crops. Bog vegetation, the cranberry included, tolerates them in greater quantities. It is possible that the potato may flourish when its juices contain enough iron-salts to destroy the fungus which causes the "rot." This fungus, as is well-known, may go into the ground with the seed potatoes, and may develop as an internal parasite within the growing potato plant, penetrating its stems and leaves, and finally so multiplying under favorable conditions—hot and moist weather—as to injure or destroy the crop.

It would first be necessary to establish beyond question, the fact that mucky soils or some mucky soils, furnish immunity from the potato rot under circumstances favorable to its development, in soils of ordinary character. The Station could coöperate in such an investigation if it had suitable grounds and the means for carrying on experiments in various soils and mixtures.

### Sea-Weed.

In answer to inquiries as to the Commercial Value of Sea-weed and sea-weed ashes, I give below the results of analyses made by me or under my direction, in former years:* These analyses refer to the more or less well-dried material. When newly gathered the sea-weed contains from 70 to 90 per cent. of water.

* The analysis of Eel-grass was made in 1860, by my former pupil, William H. Bergen, Esq.



*Analyses.*

| | 1860 | 1862 | 1871 |
|---|---|---|---|
| | Eel-grass. | Kelp. | Rock-weed. |
| Moisture, | 17.75 | 9.81 | 11.01 |
| Organic matter and loss in analysis, | 64.90 | 71.41 | 69.10 |
| Sand, | 5.72 | 0.13 | 1.59 |
| Lime, | 2.73 | 1.40 | 1.10 |
| Magnesia, | 1.82 | 0.20 | 1.19 |
| Oxide of Iron, | 0.72 | 0.26 | 0.37 |
| Soda, | 1.14 | 1.64 | 2.22 |
| Potash, | 0.94 | 2.46 | 2.18 |
| Chloride of Sodium (common salt). | 2.73 | 5.93 | 4.14 |
| Sulphuric acid, | 0.54 | 6.19 | 6.82 |
| Phosphoric acid, | 1.01 | 0.57 | 0.28 |
| | 100.00 | 100.00 | 100.00 |
| Nitrogen, | ----- | 1.77 | 1.20 |
| Ammonia equivalent to Nitrogen, | ----- | 2.15 | 1.46 |

Sea-weed as ordinarily gathered is a mixture of various plants, and more or less animal matter, living and dead, adheres to it, so that there is considerable variety in the material and in its composition. Where sea-weed is thrown up in large quantities too remote from cultivated land to be of direct use as manure, it may be burned and the ashes transported to some distance with a profit. Sea-weed is, however, rather difficult to burn and the ashes are likely to be quite variable in character and value.

### Reduction of Unground Bones. Bone Black.

The following questions were received and answered substantially as follows, through *The Connecticut Farmer:*

"What is the best way of rendering fresh bones available for land? Is it not practicable to dissolve them with sulphuric acid when there is no mill near at hand? How much acid is required per hundred pounds of bones, and what is the *modus operandi?* How is 'bone-black' prepared?

*Answer.*

It is not an easy matter to reduce fresh whole bones to a suitable form for use as a fertilizer. Treatment with sulphuric acid does not appear to be practicable. The acid, suitably diluted, acts energetically on bones at first and readily disintegrates them to a certain depth. Unless, however, a large of excess of acid be used the action soon becomes sluggish, because where the acid is in contact with the bone it forms sulphate of lime, itself being spent as an acid or solvent in the operation, and its place is taken by the bulky sulphate. Fresh acid must then be brought in contact with the bone by abundant stirring in order to renew and maintain the action. The pulpy sulphate of lime holds mechanically a large quantity of liquid and thus hinders the desired result. The excess of sulphuric acid rapidly absorbs moisture from the air and the final result is the solution of the bone or most of it at the expense of a wasteful excess of acid and the product requires mixture with something to take up the water and neutralize the excess of sulphuric acid.

These difficulties would not be so serious if suitable and cheap vessels could be had in which to carry on the process, for after the bones were disintegrated the sloppy mass could be dried and its excess of sulphuric acid utilized by admixture of South Carolina phosphate rock, or other similar material, which would be thereby converted into superphosphate.

On a very small scale cast-iron vessels could be employed. A pit lined with blue flag-stones or with hard bricks closely laid in common lime mortar (not cement), would be more suitable for large quantities. It would appear, however, that there is doubtful profit in undertaking to reduce whole bones by sulphuric acid on the small scale, especially since the use of this acid is attended by considerable risk to those inexperienced in handling it.

In Russia, Ilienkoff and Engelhardt claim to have successfully employed caustic potash for the conversion of bones into a pulverulent fertilizer.

Their method of reducing entire bones with caustic potash, or what amounts to the same thing, with *wood ashes and lime*, is described by Ilienkoff as follows:

"To 4,000 pounds of bone take 4,000 pounds of unleached wood ashes, 600 pounds of fresh-burned lime and 4,500 pounds of water. First slack the lime to a powder, mix it with the ashes, and placing a layer of bones in a suitable receptacle—a pit in the ground lined with boards, stone slabs or brick—cover them with the mixture; lay down more bones and cover and repeat this until half the bones, or 2,000 pounds are interstratified with the ashes and lime; then pour on 3,600 pounds of water, distributing it well,



and let stand. From time to time add water to keep the mass moist. So soon as the bones have softened so that they can be crushed between the fingers to a soft soap-like mass, take the other 2,000 pounds of bones and stratify them in another pit with the contents of the first. When the whole is soft, shovel out to dry and finally mix with dry muck or loam (4,000 pounds), or enough to make it handle well."

I should suppose that this method might be advantageously modified somewhat as follows: Arrange a circular layer of bones closely laid on a bed, a foot thick of good loam, under shelter; wet them from a watering pot and sprinkle over them wood ashes enough to fill all the chinks. Then give a coating of gypsum; × put upon that a few inches of muck or loam, adding all along as much water as will well moisten the earth and ashes but not more than the mass can easily absorb; then place another layer of bones with ashes, gypsum, loam or muck, and water as before, until the heap is built up several feet; finally, cover with loam and keep moist by adding water from time to time, but not enough to run away from the bed. When the bones are sufficiently softened, mix well together with the loam used as bed and cover, and with more if need be. This plan would require more time but perhaps would be as efficacious and more convenient than the process last described.

Instead of wood ashes a mixture of lime and some form of "potash salts" might be employed, but trials on a large scale would be needful to learn the proper proportions and mode of working.

A third method of disintegrating bones is to induce decomposition of the animal matter (ossein), by composting or interstratifying them with fermenting horse dung, and keeping the mass moist by covering with loam and adding occasionally urine or dung-heap liquor. As to the details of this method or the practicability of it, I can give no information.

BONE-BLACK is prepared by heating bones in close pots or retorts until the animal matter is destroyed and most of it driven off as water, gases, "animal oil" and ammonia. What remains behind in the pots is the "bone-black." It consists of the phosphate of lime of the bones mixed with some ten per cent. of carbonate of lime and sand and six per cent. of carbon. The bone-black thus obtained is broken up for use in sugar refining. The refiners mostly employ it in a coarse, granular form. The dust

× no! use no $CaSO_4$. It converts $KHO$ or $K_2CO_3$ in $K_2SO_4$ Hilgard which results from the granulation goes to the superphosphate manufacturers, and is one of the best materials for their use. When the granulated bone-black has been used in decolorizing a certain amount of sugar it loses its efficacy and is subjected to a red heat in close pots in order to restore (partially), its defecating power. After some repetitions of this process it becomes of no further use to the sugar refiner and goes to the fertilizer maker. This "spent bone-black" is less valuable than the refuse powder, above mentioned, because its phosphoric acid is reduced by five to ten per cent., and the carbonates considerably increased. The demand for bone-black on the part of fertilizer makers is so great that unwholesome stories are in circulation to the effect that inferior native phosphates, under false colors, i. e., suitably blackened, are in the market carrying the name and style of bone-black but in fact and with intent spurious, although not altogether worthless.

I will add here an estimate of the commercial value of the product that would result from the quantities of bones, wood-ashes, etc., used in Ilienkoff's process as above described:

4,000 pounds of average bones contain 4 per cent. or 160 pounds of nitrogen and 20 per cent. or 800 pounds of phosphoric acid.

4,000 pounds of average wood ashes, unleached, contain 8½ per cent. or 340 pounds of potash, and 2 per cent. or 80 pounds of phosphoric acid. The bones and ashes together contain—

| | | |
|---|---|---|
| 160 | pounds of nitrogen, worth, at 20 cents, | $32.00 |
| 880 | " phosphoric acid, worth, at 9 cents, | 79.20 |
| 340 | " potash, worth, at 5½ cents, | 18.70 |
| | | $129.70 |

Admitting that there is no loss of nitrogen and no loss or gain of water or of loam, etc., this value of $129.70 would belong to 13,100 pounds or 6½ tons of the finished bone compost. The value of one ton would accordingly be, in round numbers, $20.

## Preparation of Bone Superphosphate.

In answer to repeated inquiries from various sources, the method of "dissolving" ground bone, i. e. of preparing a bone superphosphate by help of sulphuric acid—useful where soluble phosphoric acid and nitrogen are desired—is here given.



Most of the ground bone that comes into market contains a considerable, often a large, proportion of coarse fragments which remain in the soil for years before they become of avail to plants. The finest parts of ground bone are, on the other hand, adapted to feed crops at once. If ground bone be treated directly with sulphuric acid, the fine parts are promptly decomposed, but the coarse portions are but little acted on unless a large amount of acid and much time are consumed. Dr. Alexander Müller has proposed the following very rational method of treating ground bone, which is the best adapted for domestic use of any of the processes involving the use of the oil of vitriol.

Take 100 lbs. of ground bone such as contains 20 to 50 per cent., more or less, of material coarser than ½ inch, 25 lbs. of oil of vitriol of 66°, the strongest commercial acid, and six quarts of water.

Separate the bone by sifting into two, or if the proportion of coarse bone is large, into three parts, using sieves of $\frac{1}{16}$ inch and ⅛ inch mesh.

Mix the coarser part of the bone in a cast-iron or lead-lined vessel with the oil of vitriol. When the bone is thoroughly wet with the strong acid, add the water, stirring and mixing well. The addition of the water to the acid developes a large amount of heat which favors the action. Let stand, with occasional stirring, for twenty-four hours, or until the coarsest fragments of bone are quite soft; then, if three grades of bone are used, work in the next coarser portion of bone, and let stand another day or two until the acid has softened all the coarse bone, or has spent its action; and finally, dry off the mass by mixing well with the finest bone. In carrying out this process, the quantity of oil of vitriol can be varied somewhat—increased a few pounds if the bone has a large proportion of coarse fragments, or diminished if it is fine.

Stoeckhardt gives a somewhat different procedure, viz: "From a mixture of sifted wood or coal ashes and earth thrown upon a barn or shed floor form a circular wall, so as to enclose a pit capable of containing one hundred weight of ground bone; the surrounding wall of ashes may be rendered so firm as not to yield by being trodden down or beaten firm with a board.

Sift off the finer part of the bone and set it aside. Throw the coarser part into the cavity, and sprinkle it during continued stirring with three quarts of water until the whole is uniformly moistened; add gradually eleven pounds of oil of vitriol of 66°, the agitation with the shovel being continued. A brisk effervescence of the mass will ensue (from decomposition of the carbonate of lime in the bones), which will not, however, rise above the margin of the pit if the acid is poured on in separate small quantities. After twenty-four hours, sprinkle again with three quarts of water, add the same quantity of sulphuric acid as before, with the same brisk shoveling of the mass, and leave the substances to act for another twenty-four hours upon each other. Then intermix the fine bone previously sifted off, and finally shovel the ashes and earth of the pit into the decomposed bone until they are all uniformly mixed together."

## "Available" Phosphoric Acid.

The current uses of the term "available" as applied to phosphoric acid have occasioned some confusion and may appropriately be noticed here.

In an *agricultural sense* available phosphoric acid is that which can be of use to vegetation. The three states of phosphoric acid which are distinguished in this report, viz: "soluble," i. e. freely dissolved in water, "reverted," or very slightly soluble in water, but freely dissolved in ammonium citrate, and "insoluble," which means not freely dissolved either by water or by ammonium citrate, are all more or less fully and rapidly available for the nutrition of crops. The least "available" of these three forms—the "insoluble"—is the form which in nature is chiefly accessible to plants, and is sufficient for the slow growth of prairie and forest, and under favorable conditions answers most of the purposes of agriculture. For immediate effect, on quick-growing crops, or on infertile soils, the soluble and reverted are desirable and advantageous.

Some chemists, in reporting the analyses of fertilizers, are in the habit of classing together "soluble" and "reverted" under the designation "available." In so doing they have various reasons, some of which are good. They assert or imply that the distinction between "soluble" and "reverted" is too fine-drawn for practical purposes; that in many cases "reverted" is as good or better for crops than "soluble;" that therefore it is useless to estimate them separately.



If the *cost* of soluble and reverted phosphoric acid were the same, there would be some good grounds for rejecting the distinction, but the cost is not the same, and the purchaser ought for that reason to know what he has to pay for. Again, in some cases, on mucky soils, soluble phosphoric acid in large doses appears to be a damage, while on others it is much more efficacious than reverted. From two distinct points of view then, that of commercial value or cost, and that of applicability to certain soils or crops, the consumer may require or may desire the distinction to be maintained.

Manufacturers who are not able or are not willing to give the purchasers of their "superphosphates" any considerable quantity of soluble phosphoric acid, are apt to be pleased with the term "available," which relieves them from a troublesome responsibility, since they can manufacture and furnish such "available" more cheaply and certainly than they can supply a constant proportion of soluble and of reverted.

On the other hand, manufacturers who make a "superphosphate" in the original and strict sense of this much-abused term, containing soluble phosphoric acid in large quantity, would be aggrieved if that quality of their product were ignored.

When consumers come to agree that reverted phosphoric acid is practically as good a fertilizing agent as soluble, and when manufacturers generally understand how to give the consumer his money's worth in reverted phosphoric acid, i. e. to give him more pounds corresponding to the less cost per pound, as compared with soluble, then it will be time to abolish the distinction which it now appears needful to maintain. No one should be more pleased with this simplification than the Experiment Station chemist whose labors would thus be materially lessened.

## Review of the Fertilizer Market.

*Organic Nitrogen* in Dried Blood, Azotin* and Ammonite,* was quoted in New York *at wholesale* in May last at $21.25 to $21.87 per hundred lbs. In August the wholesale price advanced to $23.37, and in November and December to $24.30 per hundred. The retail cost of nitrogen in New Haven samples of low grade dried blood sent to the Station during May and June, ranged between 14 and 20 cents per lb. The retail cost of nitrogen in Blood and Azotin reported from the New Jersey Station Sept. 20th, varied from 22¼ to 28¾ cts. per lb., the average being nearly 24 cts.

In the two samples of Dry Ground Fish examined here in April and May, nitrogen cost 21½ and 31 cts. per lb. respectively. Four samples at the New Jersey Station gave, nitrogen for 18 to 21½ cts. The *wholesale price* of Fish Scrap has advanced since April from $36 to $40–42 per ton.

Castor Pomace has furnished nitrogen in our markets at 21 cts. In decorticated cotton seed meal it has cost 15 to 18 cts.—in cotton seed meal with hulls, 37 cts. per lb.

In really pure Ground Bone the average cost of nitrogen has not varied essentially from the Station values given on page 23, viz: from 11 to 15 cts. per lb., according to degree of fineness.

*Nitrogen in Ammonia-salts* has advanced in price and throughout the season has held at 24 to 26 cts. per lb., wholesale, the latter price ruling in New York at the close of 1881. No retail ammonia-salts have come to the Station during 1881. In four samples reported from the New Jersey Station in September, Nitrogen cost on the average 26 cts. The fact that the wholesale and retail prices of ammoniacal nitrogen have been quite the same, probably comes from the circumstance that the articles which give the retail cost were purchased before the advance. In 1882, nitrogen in ammonia-salts will probably retail at about 30 cts. per lb.

*Nitrogen of Nitrates.*—Nitrate of Soda has been largely imported during the year and has supplied nitrogen at about 21 cts. per lb., *wholesale*. The retail cost of nitrogen in the sample of nitrate analyzed here was 26.9 cts. The average retail cost in four samples examined in New Jersey was 26½ cts.

* Trade names for animal matter (meat scrap, cracklings), very dry and free from grease. For analyses see p. 45.



*Soluble Phosphoric Acid.*—The average retail cost of soluble phosphoric acid in seven samples of the best quality of plain superphosphate analyzed here during 1881, was 11.1 cts. per lb. Four samples gave the cost at the New Jersey Station at 11½ cts.

*Phosphoric acid in really pure Ground Bone* of the spring deliveries, has not, on the average, varied in cost from the Station valuations.

*Insoluble Phosphoric Acid.*—Charleston Rock, ground and delivered, has advanced *at wholesale* from $15 per ton in May and June to $16 in October, and to $17 in November. This advance is perhaps largely due to the increased demand during the manufacturing season, and it does not appear that phosphoric acid in any of its forms has cost the consumer more than during 1880.

*Potash in Muriate* has cost from $3.52 to $4.59 per 100 lbs. retail, in seven samples, the average having been $4.14; *in Sulphate*—one sample, the 100 lbs. cost $7.52; *in Kainite*—2 samples, the cost of potash per hundred was $8.00 and $7.10, but should not have been more than half these figures judging from the wholesale quotations, viz: $6.50–$9.00 per ton. See p. 51.

Notwithstanding the increased price of ammonia-salts and of the higher grades of blood and animal matters, the aggregate average cost of the several fertilizing elements in the Nitrogenous Superphosphates and Guanos, good and bad taken together, has during 1881, exceeded the Station valuation by only 9¾ per cent. as against 12 per cent. in 1880. The advance in cost of this class of goods over the cost in 1880, is also 9¾ per cent.

In "Special Manures" the fertilizing elements cost in the aggregate average, 8.8 per cent. above the Station valuation, as against 10.9 per cent. in 1880.

The growing demand for nitrogenous fertilizers naturally enhances the prices of the raw materials which enter into their composition and the prospect is that their cost will rather increase than diminish in the future, and it is probable that the Station will be obliged to advance considerably its valuations of the various forms of nitrogen for the year 1882. What ratings it will be proper to adopt for the coming year cannot be now determined.

## POISONS.

### Poison Mittens.

A leather mitten believed to have caused a painful eruption on the wrist and arm of the wearer, was sent to the Station from Dr. J. R. Sanford, of West Cornwall, through Dr. C. W. Chamberlain, Secretary of the State Board of Health. The back of the mitten was apparently sheepskin, dressed with the wool on, the wool was mostly dyed black, but numbers of the fibers were yellow, as if a yellow die had been first applied and afterwards a black. The palm of the mitten was lined with similar skin with the wool dyed yellow. The yellow dye is readily dissolved to some extent, both from the yellow and black wool-lining, by warm water, and is more freely taken up by dilute alkalies and acids. A careful examination makes very probable that the yellow dye is Martius' Yellow (Dinitronaphtol) a coal-tar product that is known to have an irritating action on the skin.

### Cattle Poisoned by Blue or Mercurial Ointment.

A resident of this State has brought the following interesting case to the notice of the Station:

In December, 1880, the owner of some 30 head of cattle applied "blue ointment" to his animals for the destruction of lice. The ointment was purchased of a druggist and was mixed, melted and well worked together with more than an equal weight of unsalted lard or tallow. The diluted ointment was applied with the fingers to places least liable to be reached with the tongue and but once to each animal. The application was made by the proprietor himself who had in previous years repeatedly used blue ointment of full strength and without any bad results. The animals were, with exception of two milch cows, store cattle, steers and heifers coming 2 years old. Some of the heifers were with calf.

Seventeen head (Durham grades and common stock, except two Jersey grades,) were to all appearance uninjured by the application. Thirteen animals, including eight Jersey grades, were more or less seriously affected in consequence of using the ointment.



Nine or ten had fever attacks a few days after the ointment was used, with incessant panting and loss of appetite, from which they mostly recovered in two or three days. Nearly all the sick animals had chronic itching sores and eruptions, which, in most cases, appeared where the ointment was applied, and generally also elsewhere. In five or six cases, the inside of the hind legs were extensively excoriated. In several instances there was great swelling of the fore legs above the knee, with copious secretion at first of serum, and afterwards of purulent matter. In four cases the poisoning reached a fatal termination. Two of the animals that died had no eruption. One of them lived until May, and two others until July, 1881. The others have mostly recovered, but at least one of them still shows, after a twelve-month, traces of the effects of the mercurial poison.

Three questions were put to the Station respecting the ointment used:—

1. Is the sample blue ointment?

2. As compared with samples procured from other druggists, is this ointment of the usual strength and made in the usual way?

3. Has the ointment undergone any chemical change by age or otherwise?

To answer these questions, the sample (1) was compared with two others (2) and (3), obtained respectively at Klock's drug store and at Apothecaries' Hall, New Haven.

As is well known, blue ointment is usually prepared by rubbing together lard, a little suet, and metallic mercury (quicksilver), until the latter is no longer distinguishable by its silvery luster. Thus made, blue ointment is grease intimately mixed with metallic mercury in a state of extreme subdivision.

The results of the examinations are as follows:—

| | (1) | (2) | (3) |
|---|---|---|---|
| Mercury soluble in ether, | 1.80 | trace. | trace. |
| Mercury soluble in hydrochloric acid, | .74 | none. | trace. |
| Mercury insoluble both in ether and hydrochloric acid, | 29.03 | 33.76 | 29.35 |
| Total mercury, | 31.57 | 33.76 | 29.35 |
| Water (?) loss at 212°, | 1.67 | 1.21 | 1.66 |
| Fat by difference, | 66.76 | 65.03 | 68.99 |
| | 100.00 | 100.00 | 100.00 |

The agreement in the quantities of fat and mercury in the three samples is as close as could be expected, and shows that the sample (1) contained the proper proportions of its ingredients. Careful testing demonstrated the absence of other poisonous metals, especially lead, and also proved that no corrosive sublimate was present. The ointment was warmed with ether in order to dissolve the fat and separate it from the metallic mercury. On evaporating the clear ether-solution, there was deposited in case of (1) a dark gray substance, which proved to contain mercury in no inconsiderable quantity. From the ether-solution there was obtained in each of the samples evidence of the presence of mercury, but in those purchased in New Haven the quantity of mercury was unweighable. Sample (1), however, yielded 1.8 per cent. of mercury soluble in ether, and existing probably as oleate, stearate or palmitate of that metal. After extracting the ointments (2) and (3) with ether there remained nearly pure metallic mercury, which, in case of (3), contained a trace of some mercury compound soluble in hydrochloric acid. On the contrary, the metallic mercury of (1) was mixed with a gray substance, which dissolved in hydrochloric acid and yielded 0.74 per cent. of mercury, reckoned as metal.

The ointment which caused the disastrous results contained, accordingly, 2½ per cent. of mercury, or one-twelfth of the whole, in a soluble and highly active state, and it is to this fact that its poisonous effects are doubtless to be attributed.

The analysis throws little light on the reason why the sample contained such a quantity of soluble mercury. Christison long ago observed that mercurial ointment may contain mercury in a soluble state. It is extremely probable that the use of rancid lard and long keeping occasioned the solution of the metal. In becoming rancid, fats undergo a decomposition which results in the formation of acids. Where mercury is long exposed to or agitated in contact with air, it is gradually, in part, converted into a black powder of mercurous oxide. This oxide readily dissolves in acids. Bärensprung asserts that this oxide is the active ingredient of mercurial ointment. He says, also, that its quantity increases with the age of the ointment, which, as is known, gradually becomes darker in color on keeping. A variety of circumstances are likely to influence the quality of blue ointment, and, plainly enough, it is sometimes a very dangerous remedy.



## FODDER AND FEEDING STUFFS.

Thirty-seven samples of Feeding Stuffs have been analyzed, viz:

2 of sorghum seed.
1 of maize.
1 of corn and cob meal.
1 of oats.
3 of New Process linseed meal.
1 of cotton seed meal.
1 of brewers' grains.
2 of wheat bran.
2 of sugar feed.
2 of mangolds.
1 of turnips.
1 of sugar beet pulp.
1 of apple pomace.
5 of hay.
4 of maize fodder.
2 of ensilage.
7 of mixed provender.
—
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As in former Reports, I give here a few pages explanatory of the analyses of Fodder and Feeding Stuffs. The recent publication of Dr. Armsby's *Manual of Cattle Feeding*,* enables me to refer to that book for further information on these and other points connected with the composition and use of feeding stuffs.

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

Full Tables of the Composition of Feeding Stuffs, of Feeding Standards, and concise directions for their use, together with

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

much other useful matter of a similar kind, will be found in *The Farmer's Annual Handbook for* 1882, by Drs. Armsby and Jenkins.*

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, Digestible Nutritive Ingredients and Money Value of some of the most important Feeding Stuffs (page 81), is taken from the German of Dr. Emil Wolff, of the Agricultural Academy at Hohenheim, and represents the most recent and most trustworthy knowledge on these subjects.†

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

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

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

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

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

These figures are intended to express the average *money values* of the respective food-elements in the German markets. Whether

* Published by D. Appleton & Co., New York.

† From "*Mentzel u. Lengerke's Kalender*," for 1882.

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

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



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

The column headed "*nutritive ratio*" in the table on page 81, gives the proportion of digestible albuminoids to digestible carbhydrates inclusive of fat.* The albuminoids, which are represented in animal food by the casein or curd of milk, the white of egg and lean meat, and in vegetable food by the gluten of wheat (wheat gum), and other substances quite similar to milk-casein and egg-albumin, have a different physiological significance from the carbhydrates, which are fiber or cellulose, starch, the sugars, the gums, and similarly constituted matters.

The albuminoids may easily be made over by the animal into its own substance, i. e., into muscles, tendons, and the various working tissues and membranes which are necessary parts of the animal machine, because they are the same kind of materials, are, chemically speaking, of the same composition.

The carbhydrates, on the other hand, probably cannot serve at all for building up the muscles and other parts of the growing animal, and cannot restore the waste and wear of those parts of mature animals, because they are of a very different nature. They contain no nitrogen, an element which enters into all the

* 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.

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, that for each special case of animal nutrition a special ratio of digestible albuminoids to digestible carbhydrates is the best and most economical, and, within certain limits, is necessary. This proportion we designate as the *nutritive ratio*, and these explanations make its significance evident.

To allow of directly comparing the money-value of feeding stuffs with some universally accepted standard, the last column of the table (page 81) gives a comparison with good average meadow hay taken as 1.



*Average Composition, Digestibility and Money Value of Feeding Stuffs as given by Dr. Wolff for Germany for* 1882, *except those in italics.*

| | Water. | Ash. | Nitrogenous Matters, Albuminoids & Amides. | Fiber. | Nitrogen-free Extract. | Fat. | Digestible nutrients. Albuminoids. | Digestible nutrients. Carbhydrates including fiber. | Digestible nutrients. Fat. | Nutritive Ratio 1:* | 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 | .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 | .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 79.

## ANALYSIS OF FEEDING STUFFS.

The samples taken by Dr. Armsby are further noticed in his "Observations on the Feeding of Milch Cows," page 90. The analyses there given, with the exception of a number made on mixed fodders, are tabulated here for convenience of comparison and reference.

### Sorghum Seed.

XC, Seed of Minnesota Early Amber Cane, from E. M. Dunn, Grafton, Mass.

XCII, Sorghum Seed, from E. D. Pratt, West Cornwall.

*Composition.*

| | Air-dry. | | Water-free. | |
|---|---|---|---|---|
| | XC. | XCII. | XC. | XCII. |
| Water, | 15.04 | 16.76 | | |
| Ash, | 1.73 | 2.17 | 2.04 | 2.60 |
| Albuminoids or protein, | 8.13 | 7.69 | 9.57 | 9.23 |
| Crude fiber | 1.94 | 3.21 | 2.28 | 3.85 |
| Nitrogen-free extract, | 69.65 | 66.81 | 81.98 | 80.30 |
| Fat, | 3.51 | 3.36 | 4.13 | 4.02 |
| | 100.00 | 100.00 | 100.00 | 100.00 |

No determinations of the digestibility of sorghum seed have been reported. Its composition is quite similar to that of the ordinary cereal grains, and it is to be anticipated that it will prove equally digestible. In computing the following table, the averages of the digestion coefficients for all the cereals yet experimented on were used.

Probable amount of digestible nutrients in air-dry substance:

| | XC. | XCII. |
|---|---|---|
| Albuminoids, | 6.59 | 6.23 |
| Carbhydrates, | 62.47 | 60.26 |
| Fat, | 2.60 | 2.40 |
| Nutritive ratio, | 1:10.4 | 1:10.6 |
| Estimated value,* per 100 lbs., | $0.96 | $0.92 |

* This estimated value is simply intended to furnish an approximately fair comparison between different feeding stuffs. See p. 78.



### Grain and Meal.

CVI. Maize from farm of E. Norton, Farmington. Sampled by H. P. Armsby, April 1st, 1881.

XCIX. Corn and Cob Meal from farm of T. S. Gold, West Cornwall. Sample taken by H. P. Armsby, March 19th, 1881.

CIV. Oats from farm of E. Norton, Farmington. Sampled by H. P. Armsby, April 1st, 1881.

| | Fresh. | | | Water-free. | | |
|---|---|---|---|---|---|---|
| | CVI. | XCIX. | CIV. | CVI. | XCIX. | CIV. |
| Water, | 18.16 | 20.99 | 13.48 | ---- | ---- | ---- |
| Ash, | 1.43 | 2.38 | 3.46 | 1.76 | 3.02 | 4.00 |
| Protein, | 9.60 | 8.18 | 9.38 | 11.73 | 10.35 | 10.83 |
| Crude Fiber, | 1.47 | 4.35 | 9.28 | 1.79 | 5.50 | 10.72 |
| N. fr. extract, | 64.95 | 60.44 | 59.52 | 79.36 | 76.50 | 68.81 |
| Fat, | 4.39 | 3.66 | 4.88 | 5.36 | 4.63 | 5.64 |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

### Sugar Feed.

CI, Sugar Feed, private analysis.

CXXX, Sugar Feed. Sent Oct. 14th by J. J. Webb, Esq. Sold by D. B. Crittenden & Co., New Haven.

| | CI. | CXXX. | Water-free. CI. | Water-free. CXXX. |
|---|---|---|---|---|
| Water, | 6.57 | 10.40 | | |
| Ash, | 3.22 | .78 | 3.44 | .87 |
| Albuminoids or protein, | 13.50 | 13.13 | 14.45 | 14.66 |
| Crude fiber, | 10.65 | 8.44 | 11.40 | 9.42 |
| Nitrogen-free extract, | 54.85 | 61.38 | 58.72 | 68.51 |
| Fat, | 11.21 | 5.87 | 11.99 | 6.54 |
| | 100.00 | 100.00 | 100.00 | 100.00 |

If we assume that the same coëfficients of digestibility apply to this substance as have been determined for maize meal, the digestible nutrients are, in CXXX,

| | |
|---|---|
| Protein, | 10.37 per cent. |
| Fiber, | 5.23 " |
| Nitrogen-free extract, | 55.85 " |
| Fat, | 4.99 " |
| Nutritive Ratio, | 1:7 |
| Valuation,* | $1.17 per 100 lbs. |
| Cost, | $1.20 " " " |

* Reckoned from the data used for comparison in former Reports which make the value of the best maize $1.10 and of wheat bran $1.04 per 100 lbs.

This "Sugar Feed" is a kiln-dried residue or waste from the manufacture of Glucose (or corn sugar) which is obtained by the action of acids on the starch of maize. It is in fact corn concentrated by removal of starch so that the protein is raised from 10 to 13 per cent., fiber from 2 to 9 per cent., while nitrogen-free extract (carbhydrates) is diminished from 68 to 58 per cent. CXXX contains but little more fat than average maize. In CI twice as much is present. Judged by these analyses alone Sugar Feed must be regarded as a valuable feeding stuff. It is rumored that dairymen find it objectionable for milk cows, and experience must be appealed to for positive information as to its merits.

## New Process Linseed Meal.

XCI, From T. S. Gold, West Cornwall.

XCV, Sold by Smith, Northam & Robinson, Hartford, sent by E. Norton, Farmington.

XCVI, Sent by E. Norton.

| | XCI. | XCV. | XCVI. | LXXV. |
|---|---|---|---|---|
| Water, | 12.91 | 9.85 | 11.11 | 10.76 |
| Ash, | 6.08 | 5.67 | 5.61 | 6.71 |
| Albuminoids or protein, | 32.01 | 37.62 | 36.90 | 35.64 |
| Fiber, | 8.77 | undet. | undet. | 8.86 |
| Nitrogen-free extract, | 37.56 | undet. | undet. | 35.22 |
| Fat, | 2.67 | 4.87 | 5.89 | 2.81 |
| | 100.00 | | | 100.00 |

LXXV is the Station analysis of this excellent feeding stuff, made in 1879. The recent analyses show that the composition is fairly uniform. The estimated value of LXXV was $1.69 per hundred lbs. The cost was $1.50, which is also the present price.

## Cotton Seed Meal.

CXXIX. Cotton Seed Meal. Sent by H. H. Austin from stock of W. F. Fuller, Suffield. The same as fertilizer **629**, p. 47. Cost, $30 per ton.

| | | Water-free. |
|---|---|---|
| Water, | 9.06 | ---- |
| Ash, | 7.50 | 8.24 |
| Protein, | 42.50 | 46.75 |
| Fiber, | 4.24 | 4.66 |
| N. fr. extract, | 22.12 | 24.30 |
| Fat, | 14.58 | 16.05 |
| | 100.00 | 100.00 |



## Bran and Brewers' Grains.

CIII. Wheat Bran from E. Norton, April 1st.

CXXI. Wheat Bran from F. R. Starr, April 8th.

CXIV. Brewers' Grains from J. J. Webb, April 5th.

The above were sampled by H. P. Armsby at the dates given from the material in use at the dairies of the above named parties.

| | Fresh. | | | Water-free. | | |
|---|---|---|---|---|---|---|
| | CIII. | CXXI. | CXIV. | CIII. | CXXI. | CXIV. |
| Water, | 13.56 | 13.94 | 78.21 | ---- | ---- | ---- |
| Ash, | 6.15 | 5.52 | 1.36 | 7.11 | 6.41 | 6.29 |
| Protein, | 16.56 | 14.89 | 4.79 | 19.17 | 17.32 | 22.00 |
| Fiber, | 8.22 | 7.31 | 3.20 | 9.51 | 8.52 | 14.69 |
| N. fr. extract, | 51.56 | 55.95 | 11.65 | 59.63 | 65.07 | 53.40 |
| Fat, | 3.95 | 2.39 | 0.79 | 4.58 | 2.68 | 3.62 |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

## Roots.

CXII. Mangolds raised by J. J. Webb, Hamden. Sampled April 5, 1881, by H. P. Armsby.

CXX. Mangolds, Golden-globe, from farm of F. R. Starr, Litchfield. Sampled by H. P. Armsby, April 8, 1881.

CXIII. Turnips raised by J. J. Webb. Sampled by H. P. Armsby, April 5, 1881.

| | Fresh. | | | Water-free. | | |
|---|---|---|---|---|---|---|
| | CXII. | CXX. | CXIII. | CXII. | CXX. | CXIII. |
| Water, | 92.82 | 91.44 | 88.89 | ---- | ---- | ---- |
| Ash, | .91 | 1.17 | .71 | 12.65 | 13.64 | 6.36 |
| Protein, | 1.89 | 1.65 | 1.34 | 26.36 | 19.27 | 12.14 |
| Fiber, | .76 | .80 | .86 | 10.54 | 9.28 | 7.76 |
| N. fr. Ext., | 3.56 | 4.91 | 8.11 | 49.63 | 57.46 | 72.90 |
| Fat, | .06 | .03 | .09 | .82 | .35 | .84 |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

### Sugar Beet Pulp.

XCIV. Sent by A. W. Cheever, Esq., Sheldonville, Mass., from the Franklin Beet Sugar Works.

| | Fresh. | Water-free. |
|---|---|---|
| Water, | 91.31 | ---- |
| Ash, | .47 | 5.42 |
| Albuminoids or Protein, | .94 | 10.84 |
| Fiber, | 2.13 | 24.48 |
| Nitrogen-free extract, | 5.11 | 58.86 |
| Fat, | .04 | .40 |
| | 100.00 | 100.00 |

This Pulp is perhaps the most watery and least concentrated cattle food of vegetable origin that is employed. Turnips even are a little better in composition. Whey alone, of all feeding stuffs, surpasses it in dilution. That it will bear but little cost of transportation or handling is evident.

### Apple Pomace.

In January, Mr. J. H. Dickerman of Mt. Carmel, brought a sample of frozen fresh apple pomace to the Station, with the statement, that while horned cattle scarcely touched it, his horses and colts ate it with evident relish and benefit. The sample, No. XCVII, was analyzed with the following result. An analysis by Prof. F. H. Storer,* is given by way of comparison:

| | XCVII. | | XCVII. Water free. |
|---|---|---|---|
| Water, | 72.62 | 77.21 | |
| Ash, | 0.81 | .50 | 2.96 |
| Albuminoids, | 1.65 | .98 | 6.03 |
| Crude Fiber, | 5.92 | 3.90 | 21.62 |
| Nitrogen free extract, | 17.03 | 15.71 | 62.19 |
| Fat and wax, | 1.97 | 1.70 | 7.20 |
| | 100.00 | 100.00 | 100.00 |

In respect to the quantities of the various food-elements the analysis shows that this pomace is superior to corn-fodder, and to turnips, mangolds and all of our root crops except the potato, and that it is but little inferior to the last named tuber.

* In his paper On the Fodder Value of Apples. Bulletin of the Bussey Institution, vol. i, p. 365.



The digestibility of the food-elements in the pomace is not known with certainty, but probably the nitrogen free-extract is nearly equivalent to the same amount of digestible carbhydrates (starch, sugar) and there can be little doubt that the pomace is, in nutritive quality, equal if not superior to the feeding stuffs above named, potatoes alone excepted.

This sample was from a press of more than ordinary power and therefore rather dryer than apple pomace commonly is. It is considerably richer in albuminoids and fiber than Prof. Storer's sample, which may probably be due to the greater proportion of seeds, cores, and skins contained in common cider apples over that found in the sound Baldwins from which his sample was obtained.

Prof. Storer in his paper, published in 1875, remarks: "It would be interesting to determine by actual trial whether a process of preservation which is largely employed in Europe for keeping a variety of soft and juicy materials might not be available for the preservation of pomace." He refers here to the "sour fodder" of the Germans, which is neither more nor less than a kind of "ensilage," and his suggestion is well worth considering.

### Hay.

C. Timothy hay, farm of T. S. Gold, West Cornwall. Taken March 19, 1881.

CVIII. Low-meadow hay from farm of E. Norton, Farmington, April 1.

CXVIII. Hay fed (not raised), by F. R. Starr, Litchfield, April 8.

CVII. Uneaten portion of CVIII, April 1.

CXIX. Uneaten portion of CXVIII, April 8.

The above were sampled by Dr. Armsby at the dates given.

| | C. | CVIII. | CXVIII. | CVII. | CXIX. |
|---|---|---|---|---|---|
| Water, | 13.47 | 14.51 | 15.83 | 19.25 | 23.93 |
| Ash, | 3.86 | 5.84 | 4.21 | 5.04 | 3.70 |
| Protein, | 7.63 | 10.10 | 6.68 | 6.04 | 4.44 |
| Fiber, | 29.26 | 25.05 | 27.06 | 28.31 | 26.71 |
| N. fr. Ext., | 43.48 | 42.45 | 44.74 | 39.65 | 40.08 |
| Fat and Wax, | 2.30 | 2.05 | 1.48 | 1.71 | 1.14 |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

| | Water-free. | | | | |
|---|---|---|---|---|---|
| | C. | CVIII. | CXVIII. | CVII. | CXIX. |
| Ash, | 4.45 | 6.83 | 5.00 | 6.25 | 4.87 |
| Protein, | 8.82 | 11.82 | 7.93 | 7.48 | 5.84 |
| Fiber, | 33.83 | 29.31 | 32.15 | 35.07 | 35.11 |
| N. fr. Ext., | 50.24 | 49.64 | 53.17 | 49.08 | 52.69 |
| Fat and Wax, | 2.66 | 2.40 | 1.75 | 2.12 | 1.49 |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Mr. Gold's Timothy hay, like the sample from his farm, analyzed in 1879, is rather low in content of protein (albuminoids), and ranks as "inferior" compared with Wolff's standard. Dr. Armsby leaves us to infer that it was completely eaten, while of the low-meadow hay of Mr. Norton, which "analyzes better," some 12 per cent. was left uneaten in feeding. Of the still poorer hay fed by Mr. Starr (but not raised by him), about 7 per cent. was uneaten. The parts rejected by the cows, CVII and CXIX, are seen by the analyses to be much inferior in composition to the entire hay. The uneaten portions, as every farmer knows, consist chiefly of the coarse woody stems of grasses and of weeds. The analyses show that these contain more water by 5 to 8 per cent. than the entire hay, doubtless derived from the saliva and warm breath of the cows. Comparison of the analyses reckoned on dry matter shows a less content of protein by 2 to 4 per cent., and a correspondingly larger proportion of fiber in the uneaten hay.

For the composition of the eaten parts of these samples see pages 95 and 100.

### Maize Fodder and Stover.

CX. Corn fodder, farm of E. Norton, Farmington.
CIX. Uneaten part of CX. April 1.
CXI. Stover (Corn stalks), farm of J. J. Webb, Hamden.
CXVI. Uneaten part of CXI. April 5.
The above were sampled at the dates given by Dr. Armsby.

| | | | | | Water-free. | | | |
|---|---|---|---|---|---|---|---|---|
| | CX. | CIX. | CXI. | CXVI. | CX. | CIX. | CXI. | CXVI. |
| Water, | 14.84 | 18.29 | 23.13 | 39.74 | | | | |
| Ash, | 4.47 | 4.14 | 4.34 | 4.24 | 5.26 | 5.06 | 5.65 | 7.04 |
| Protein, | 5.76 | 4.72 | 7.19 | 3.72 | 6.77 | 5.78 | 9.36 | 6.18 |
| Fiber, | 25.93 | 28.70 | 27.24 | 22.20 | 30.46 | 35.13 | 35.44 | 36.83 |
| N. fr. Ext., | 47.55 | 42.77 | 36.45 | 29.28 | 55.77 | 52.35 | 47.41 | 48.59 |
| Fat, | 1.45 | 1.38 | 1.65 | .82 | 1.74 | 1.68 | 2.14 | 1.36 |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |



Of Mr. Norton's Corn-fodder about 16 per cent., of Mr. Webb's Stover, 35 per cent., were left uneaten. The analyses show a striking difference between the composition of the entire fodder and the rejected portions. The latter, as in case of hay, and for the same reason, probably, are much more watery than the former, and less rich in protein.

In Dr. Armsby's paper, pages 95 and 98, will be found statements of the composition of the eaten portions of these maize fodders.

### Ensilage.

XCVIII. Maize Ensilage, received Feb. 5th.
CXXIII. Cabbage Ensilage, received April 14th.
Both sent by B. C. Platt, of Suffield.

| | XCVIII. Fresh. | CXXIII. Fresh. | XCVIII. Water-free. | CXXIII. Water-free. |
|---|---|---|---|---|
| Water, | 82.09 | 87.61 | | |
| Ash, | 1.04 | 4.16 | 5.84 | 33.59 |
| Albuminoids, | 1.27 | 1.19 | 7.07 | 9.64 |
| Crude fiber, | 5.76 | 1.59 | 32.15 | 12.84 |
| Nitrogen free extract, | 9.50* | 4.52 | 53.03† | 36.43 |
| Fat and wax, | 0.34 | 0.93 | 1.91 | 7.50 |
| | 100.00 | 100.00 | 100.00 | 100.00 |

* Contained free acid 0.66 reckoned as acetic acid.
† " " " 3.69 " "

Further information as to the composition and feeding value of Ensilage will be found in the New Jersey Station Bulletin on that subject, which is reprinted on subsequent pages.

# OBSERVATIONS ON THE FEEDING OF MILCH COWS

## AS PRACTICED IN CONNECTICUT.

By Professor H. P. Armsby, Ph.D.

The observations described in the following pages were made for the purpose of comparing the rations used by good farmers in this State with those which foreign, and especially German, experience and investigation have shown to be best adapted to the conditions prevailing in the countries where those investigations were made.

Owing to the comparatively limited time available for work of this sort, and the very considerable amount of analytical work involved, but four rations have been thus compared, and consequently these observations can only be considered as a beginning in this direction.

The farms visited were those of Secretary T. S. Gold, of West Cornwall, Edward Norton, Esq., of Farmington, J. J. Webb, Esq., of Hamden, and F. R. Starr, Esq., of Litchfield, and the thanks of the Station are due to these gentlemen for the interest they took in the investigations and the willingness with which they placed all possible facilities at the Station's disposal and contributed their own time and personal attention to the proper carrying out of the trials.

The method pursued at each place was substantially the same. A quantity of each fodder more than sufficient for a day's feeding was weighed out. From this amount the cows were fed exactly as usual, and by the same person. The amount of each fodder remaining after the day's feeding was weighed; any fodder left uneaten was also weighed, and from these data the amounts of the several feeding-stuffs actually consumed were found. Samples of the feeding-stuffs were also taken for analysis, and on the combined results of the weighings and analyses the calculations of the following pages are based.

The first farm visited was that of T. S. Gold, Esq., of West Cornwall (Cream Hill). The stock was nearly all Ayrshires and Ayrshire grades, and was fed chiefly for the milk, which was sent to New York. The feeding-stuffs used were hay, maize meal (ground with the cob), and "new process" linseed meal. The hay was mostly timothy and was cut June 30, 1880, cutting fully two tons per acre. Much hay is raised on the farm and it is the aim to feed as much of it as possible, using only what grain is necessary. The cows were fed hay and grain in the morning after milking, and hay at noon and night.



Two stables, containing together twenty-five cows in all stages of lactation, were selected for observation, and the fodder which they consumed was weighed for two consecutive days with the following results:

| | 1st Day. | 2d Day. | Average. | Average per Head. |
|---|---|---|---|---|
| Hay eaten | 549.00 lbs. | 552.00 lbs. | 550.50 lbs. | 22.02 lbs. |
| Maize meal eaten | 39.25 | 39.00 | 39.13 | 1.57 |
| Linseed meal eaten | 55.50 | 57 50 | 56.50 | 2.26 |

The close agreement of the results on the two days is, to a certain extent, a guarantee of their correctness, and is interesting as showing the uniformity in feeding attainable by practice.

In the above form, however, the ration cannot be readily compared with others in which different feeding-stuffs may have been used. The most practicable way in which to render it comparable with others is to estimate, as may be done with considerable accuracy from the chemical composition of the feeding-stuffs, the amounts of really nutritive (digestible) matters contained in the ration. The feeding-stuffs used were found to contain the following percentages of moisture:—

| | |
|---|---|
| Hay | 13.47 % |
| Maize meal | 20.99 |
| Linseed meal | 12.91 |

The water-free substance of these feeding-stuffs had the following composition in 100 parts:—

| | Ash. per cent. | Protein. per cent. | Crude fiber. per cent. | N. fr. Extract. per cent. | Fat. per cent. |
|---|---|---|---|---|---|
| Hay | 4.45 | 8.82 | 33.83 | 50.24 | 2.66 |
| Maize meal | 3.02 | 10.35 | 5.50 | 76.50 | 4.63 |
| Linseed meal | 6.98 | 36.76 | 10.07 | 43.14 | 3.05 |

From these data we proceed to estimate the digestibility of the ingredients of these feeding-stuffs. The hay has approximately the same composition as the average of those designated by Wolff as "Inferior," particularly as regards protein and crude fiber, and since experience has shown that the digestibility of hay is largely determined by its chemical composition, we may assume this hay to have had the same digestibility as the average of Wolff's "Inferior," and say that about 52 per ct. of its protein and

49 per ct. of its fat were digested. The digestible carbhydrates we consider to be equal to the total amount of nitrogen-free extract, because experiment has shown that this is almost always the case with coarse fodder, within narrow limits. We conclude, then, that the *dry matter* of this sample of hay contained 52 per cent. of 8.82 per cent., or 4.59 per cent. of *digestible* protein, 49 per cent. of 2.66 per cent., or 1.30 per cent. of *digestible* fat, and 50.24 per cent. of *digestible* carbhydrates. That these numbers are not exact is sufficiently evident from the manner in which they are obtained. They are simply the best estimate of the digestibility of this particular sample which the results of numerous digestion experiments enable us to form.

In very much the same way we estimate the digestibility of the other feeding-stuffs used, except that there is less uncertainty involved, the digestibility of concentrated fodders having usually been found to vary less than that of coarse fodders. In the case of the maize meal the estimate is complicated by the presence of an indeterminate amount of cob. In twelve samples of maize examined at this Station in 1878,* the cob was found to amount on the average to about 20 per cent. of the weight of the corn. On this basis, and assuming the cob to be of average composition, it will be found that a separate estimate of the digestibility of corn and cob will yield a final result differing by less than 0.05 lb. per head from that obtained by applying the digestion coëfficients of maize directly to the cob-meal. We are therefore at liberty to pursue the latter and simpler course. Our digestion coëfficients, then, which express the percentage digestibility of the several ingredients of the feeding-stuffs are:

| | Protein. | Crude Fiber. | N. fr. Extract. | Fat. |
|---|---|---|---|---|
| Hay, | 52 | -- | -- | 49 |
| Maize meal, | 79 | 62 | 91 | 85 |
| Linseed meal, | 85 | 44 | 81 | 90 |

The dry matter of our feeding-stuffs, therefore, contains of digestible matters:

| | Protein. per cent. | Carbhydrates, per cent.† | Fat, per cent. |
|---|---|---|---|
| Hay, | 4.59 | 50.24 | 1.30 |
| Maize meal, | 8.18 | 73.03 | 3.93 |
| Linseed meal, | 31.25 | 39.37 | 2.75 |

* Report, 1878, p. 74.

† The digestible portions of the crude fiber and of the N. fr. extract, have the same composition and are added together as carbhydrates.



It is now a very simple matter to calculate the amounts of total dry matter, and of digestible protein, carbhydrates and fat, contained in the daily ration per head. We obtain the following results:

| | Total dry matter. lbs. | Digestible. Protein. lbs. | Digestible. Carbhydrates. lbs. | Digestible. Fat. lbs. |
|---|---|---|---|---|
| Hay ........22.02 lbs. | 19.05 | 0.87 | 9.57 | 0.25 |
| Maize meal .... 1.57 " | 1.24 | 0.10 | 0.91 | 0.05 |
| Linseed meal... 2.26 " | 1.97 | 0.62 | 0.78 | 0.05 |
| Total, | 22.26 | 1.59 | 11.26 | 0.35 |
| Total per 1,000 lbs. live weight, | 26.19 | 1.87 | 13.25 | 0.41 |
| Wolff's standard, | 24.00 | 2.50 | 12.50 | 0.40 |

The cows weighed by estimate 800–900 lbs. each, and hence the total of the above ration has been re-calculated to the basis of 1,000 pounds live-weight to render it comparable with the ration recommended by Wolff, which is placed below it. It will be noticed at once that the two differ considerably, but any remarks on this difference will be deferred until the remaining rations have been considered.

The average yield per day and head of the whole herd was about 6.3 quarts of milk.

The second farm which was visited was that of Mr. Edward Norton, of Farmington. Here the cows were mostly Guernseys and Jerseys. The milk is sold to the Farmington Creamery and hence care is taken to feed nothing which could injure the flavor of the butter. For this reason no oil-cake is used. The fodder of twenty-six cows, in all stages of lactation, was weighed. This included nearly all the cows in milk. The average weight of the animals was, by estimate, 925 pounds. The following feeding-stuffs were used:

Low meadow hay, cut in July, 1880. The cows had just been changed to this from better hay, and ate rather less than usual in consequence.

Corn fodder from northern corn, cut in September, 1880. Three bushels of seed per acre in drills $2\frac{1}{2}$ feet apart.

Oats, maize meal, and wheat bran. The oats and maize are ground together in the proportions of $\frac{1}{3}$ oats and $\frac{2}{3}$ maize, and one bag of this mixture is added to two bags of bran, this being estimated to be about equal parts by weight. This mixture we will designate as "grain."

The order of feeding was grain followed by corn fodder in the morning, hay at noon, and grain followed by hay at night. The hay lay in the mangers over night.

The following weighings were made on two successive days:

| | 1st Day. | 2d Day. | Average. | Av. per day and head. |
|---|---|---|---|---|
| Hay fed, | 475.5 lbs. | 472.5 lbs. | 474.0 lbs. | 18.23 lbs. |
| Hay left uneaten, | 73.5 | 44.5 | 59.0 | 2.27 |
| Hay eaten, | 402.0 | 428.0 | 415.0 | 15.96 |
| Corn fodder fed, | 101.0 lbs. | 95.0 lbs. | 98.0 lbs. | 3.77 lbs. |
| " left uneaten, | 18.0 | 13.5 | 15.8 | 0.61 |
| " eaten, | 83.0 | 81.5 | 82.2 | 3.16 |
| Grain eaten, | 115.0 lbs. | 116.0 lbs. | 115.5 lbs. | 4.44 lbs. |

The fodders were found to contain the following amounts of moisture at the barn:

| | |
|---|---|
| Hay, | 14.51 per cent. |
| Hay left uneaten, | 19.25 " |
| Corn fodder, | 14.84 " |
| Corn fodder left uneaten, | 18.29 " |
| Oats, | 13.48 " |
| Maize, | 18.16 " |
| Wheat bran, | 13.56 " |

Their dry matter had the following composition:

| | Ash. Per cent. | Protein. Per cent. | Crude Fiber. Per cent. | N. fr. Extr. Per cent. | Fat. Per cent. |
|---|---|---|---|---|---|
| Hay, | 6.83 | 11.82 | 29.31 | 49.64 | 2.40 |
| Hay left uneaten, | 6.25 | 7.48 | 35.07 | 49.08 | 2.12 |
| Corn fodder, | 5.26 | 6.77 | 30.46 | 55.77 | 1.74 |
| Corn fodder left uneaten, | 5.06 | 5.78 | 35.13 | 52.35 | 1.68 |
| Oats, | 4.00 | 10.83 | 10.72 | 68.81 | 5.64 |
| Maize, | 1.76 | 11.73 | 1.79 | 79.36 | 5.36 |
| Wheat bran, | 7.11 | 19.17 | 9.51 | 59.63 | 4.58 |

Analyses were also made of the mixed oats and maize, and of the mixed "grain" as fed. A comparison of these analyses showed that the mixed "grain" was composed of very nearly one part of oats, two parts of maize, and four parts of bran, by weight. If these proportions are taken as the basis of the calculation, the amount of non-nitrogenous matters contained in the 4.44 lbs. of "grain" fed, differs by less than 0.04 lbs. from that



found when the actual composition of the "grain" is made the basis of the calculation, while the amount of protein differs less than 0.01 lb. We may, therefore, estimate without essential error that the 4.44 lbs. of "grain" fed were composed of

| | |
|---|---|
| Oats, | 0.63 lbs. |
| Maize, | 1.27 |
| Wheat bran, | 2.54 |
| | 4.44 |

It will be noticed that analyses were made of the hay and corn fodder left uneaten and that these, as was to be expected, were of poorer quality than the original materials. It follows that the portions actually eaten were of correspondingly better quality, and it is the composition of these which must furnish us with the correct basis for our estimate of digestibility. The 18.23 pounds of hay fed per day and head contained 12.07 pounds of dry matter, and the 2.27 pounds left uneaten contained 1.75 pounds of dry matter. By subtracting the amounts of the several ingredients contained in the latter quantity from those contained in the former, we shall obtain the amounts contained in the 10.32 pounds of dry matter actually eaten, from which its percentage composition may readily be computed. The calculation is as follows:

| | Dry matter of hay fed out. lbs. | Dry matter of hay uneaten. lbs. | Dry matter of hay eaten. (Difference.) lbs. | Percentage composition of dry matter of hay eaten. |
|---|---|---|---|---|
| Ash, | 0.82 | 0.11 | 0.71 | 6.88 |
| Protein, | 1.43 | 0.13 | 1.30 | 12.60 |
| Crude Fiber, | 3.54 | 0.61 | 2.93 | 28.39 |
| N. fr. extract, | 5.99 | 0.86 | 5.13 | 49.71 |
| Fat, | 0.29 | 0.04 | 0.25 | 2.42 |
| | 12.07 | 1.75 | 10.32 | 100.00 |

Making a similar computation for the corn fodder we obtain the following results:—

| | Dry matter of fodder fed out. lbs. | Dry matter of fodder uneaten. lbs. | Dry matter of fodder eaten. (By difference.) lbs. | Percentage composition of dry matter of fodder eaten. per cent. |
|---|---|---|---|---|
| Ash | 0.12 | 0.02 | 0.10 | 5.15 |
| Protein | 0.16 | 0.02 | 0.14 | 7.22 |
| Crude fiber | 0.72 | 0.15 | 0.57 | 29.38 |
| N. fr. extract, | 13.2 | 0.22 | 1.10 | 56.70 |
| Fat | 0.04 | 0.01 | 0.03 | 1.55 |
| | 2.36 | 0.42 | 1.94 | 100.00 |

The composition thus found differs somewhat from the composition of the hay and corn fodder as fed, and indicates a greater digestibility. The following digestion coefficients may be assumed to represent fairly the digestibility of the various feeding-stuffs here used. Those for the maize fodder are not those given under that head in the tables, but are the average coefficients for Wolff's "Inferior" meadow hay, with which this sample of corn fodder agrees approximately in composition. The only coefficients which we have for maize fodder are the results of but a single experiment on fodder of unusually excellent quality and hence are much too large for a sample of this sort.

*Digestion coefficients.*

| | Protein. | Crude fiber. | N. fr. extract. | Fat. |
|---|---|---|---|---|
| Hay eaten | 60 | -- | -- | 48 |
| Corn fodder eaten | 56 | -- | -- | 48 |
| Oats | 74 | 21 | 73 | 82 |
| Maize | 79 | 62 | 91 | 85 |
| Wheat bran | 88 | 20 | 80 | 80 |

The dry matter of our fodders, then, contains the following percentages of *digestible* nutrients:—

| | Protein. per cent. | Carbhydrates. per cent. | Fat. per cent. |
|---|---|---|---|
| Hay eaten | 7.56 | 49.71* | 1.16 |
| Corn fodder eaten | 4.04 | 56.70* | 0.74 |
| Oats | 8.01 | 52.48 | 4.62 |
| Maize | 9.27 | 73.33 | 4.56 |
| Wheat bran | 16.87 | 49.61 | 3.66 |

* Equal to total N. fr. extract.

The ration per day and head was, therefore, thus constituted:—

| Eaten. | | Total dry matter. lbs. | Digestible. Protein. lbs. | Carbhydrates. lbs. | Fat. lbs. |
|---|---|---|---|---|---|
| Hay | 15.96 lbs. | 10.32 | 0.78 | 5.13 | 0.12 |
| Corn fodder | 3.16 " | 1.94 | 0.08 | 1.10 | 0.01 |
| Oats | 0.63 " | 0.55 | 0.04 | 0.29 | 0.03 |
| Maize | 1.27 " | 1.04 | 0.10 | 0.76 | 0.05 |
| Wheat bran | 2.54 " | 2.20 | 0.37 | 1.09 | 0.08 |
| Total | 23.56 " | 16.05 | 1.37 | 8.37 | 0.29 |
| Per 1,000 lbs. live weight, | | 17.35 | 1.48 | 9.05 | 0.31 |
| Standard, | | 24.00 | 2.50 | 12.50 | 0.40 |

The average yield of milk per day and head by the whole herd for the week previous to these observations was 7.7 quarts.



The third farm visited was that of J. J. Webb, Esq., of Hamden. Six cows were selected by Mr. Webb as representing a fair average of his herd. Some of them were good milkers but not fresh. Their average weight was, by estimate, 925 pounds each.

The following feeding-stuffs were in use:

"Meal," a mixture of 200 parts wheat bran, 100 parts cotton seed meal, and 60 parts malt sprouts. Brewers' grains. Mangolds. Turnips. Hungarian hay and sheaf oats, cut. Stover, also cut.

The order of feeding was as follows:— In the morning brewers' grains, "meal," turnips, hay; at about 10 A. M., stover; at about 2.30 P. M., mangolds; at about 4 P. M., brewers' grains, "meal," stover. The stover lies in the mangers over night.

The following weights were obtained:

| | 1st Day. | 2d Day. | Average. | Average per head. |
|---|---|---|---|---|
| Stover fed out | 72.00 lbs. | 61.75 lbs. | 66.88 lbs. | 11.15 lbs. |
| " uneaten | 30.25 | 17.40 | 23.83 | 3.97 |
| " eaten | 41.75 | 44.35 | 43.05 | 7.18 |
| Hay eaten | 35.00 | 31.75 | 33.38 | 5.56 |
| "Meal" eaten | 15.00 | 14.75 | 14.88 | 2.48 |
| Brewers' grains eaten | 121.75 | 112.00 | 116.88 | 19.48 |
| Mangolds | 79.50 | 88.50 | 84.00 | 14.00 |
| Turnips | 74.25 | 63.50 | 68.88 | 11.48 |

The analyses of the feeding-stuffs employed and of the uneaten stover gave the following results:—

*Moisture.*

| | |
|---|---|
| Stover | 23.13 per cent. |
| Stover uneaten | 39.74 " |
| Hay | 19.33 " |
| Brewers' grains | 78.21 " |
| "Meal" | 13.75 " |
| Mangolds | 92.82 " |
| Turnips | 88.89 " |

*Composition of Dry Matter.*

| | Ash. per cent. | Protein. per cent. | Crude fiber. per cent. | N. fr. extract. per cent. | Fat. per cent. |
|---|---|---|---|---|---|
| Stover | 5.65 | 9.36 | 35.44 | 47.41 | 2.14 |
| Stover uneaten | 7.04 | 6.18 | 36.83 | 48.59 | 1.36 |
| Hay | 8.57 | 13.22 | 31.37 | 45.04 | 1.80 |
| Brewers' grain | 6.29 | 22.00 | 14.69 | 53.40 | 3.62 |
| "Meal" | 7.06 | 26.18 | 8.52 | 52.43 | 5.81 |
| Mangolds | 12.65 | 26.36 | 10.54 | 49.63 | 0.82 |
| Turnips | 6.36 | 12.14 | 7.76 | 72.90 | 0.84 |

The very large proportion of protein in the mangolds is noteworthy, and indicates that much of it belongs to nitrates, amides, and other non-albuminoid nitrogenous compounds.

Computing the percentage composition of the stover actually eaten we get the following results:—

| | Dry matter of stover fed out. lbs. | Dry matter of stover uneaten. lbs. | Dry matter of stover eaten. (By difference.) lbs. | Percentage composition of dry matter of stover eaten. |
|---|---|---|---|---|
| Ash | 0.44 | 0.15 | 0.29 | 5.21 |
| Protein | 0.72 | 0.13 | 0.59 | 10.59 |
| Crude fiber | 2.74 | 0.80 | 1.94 | 34.83 |
| N. fr. extract | 3.67 | 1.06 | 2.61 | 46.86 |
| Fat | 0.17 | 0.03 | 0.14 | 2.51 |
| | 7.74 | 2.17 | 5.57 | 100.00 |

No samples could be obtained of the bran, malt sprouts, or cotton seed meal used, and therefore the averages of the digestion coefficients of these substances are applied to the mixture of the three. The coefficients for malt sprouts are only estimates, no determinations of their digestibility having yet been made, and the same is true of those for brewers' grains. Those for cotton seed meal are results recently obtained by Wolff* in experiments on sheep, with "decorticated" cotton-seed meal, and are notably higher than those previously obtained with a sample which was not "decorticated."

*Digestion Coefficients.*

| | Protein. | Crude fiber. | N. fr. extract. | Fat. |
|---|---|---|---|---|
| Hay | 60 | -- | -- | 50 |
| Stover | 50 | -- | -- | 30 |
| Brewers' grains | 85 | -- | -- | 80 |
| Wheat bran | 88 | 20 | 80 | 80 |
| Cotton seed meal | 85 | 0 | 95 | 88 |
| Malt sprouts | 80 | -- | -- | 80 |
| Average for "meal" | 84 | 10(?) | 90 | 83 |

The roots are assumed to be entirely digestible and the digestible crude fiber and nitrogen-free extract of the brewers' grains and malt sprouts are assumed to equal the total nitrogen-free extract. On the basis of these coefficients, the dry matter of the fodders contained the following amounts of digestible matters:—

| | Protein. per cent. | Carbhydrates. per cent. | Fat. per cent. |
|---|---|---|---|
| Hay | 7.93 | 45.04 | 0.90 |
| Stover eaten | 5.29 | 46.86 | 0.75 |
| Brewers' grains | 18.70 | 53.40 | 2.90 |
| "Meal" | 21.99 | 48.04 | 4.82 |
| Mangolds | 26.36 | 60.17 | 0.82 |
| Turnips | 12.14 | 80.66 | 0.84 |

* Landw. Versuchs-Stationen, xxvii, 226.



The daily ration per head was, accordingly, thus constituted:—

| | | Dry matter. lbs. | Digestible. Protein. lbs. | Digestible. Carbhydrates. lbs. | Digestible. Fat. lbs. |
|---|---|---|---|---|---|
| Hay | 5.56 lbs., | 4.49 | 0.36 | 2.02 | 0.04 |
| Stover | 7.18 " | 5.57 | 0.29 | 2.61 | 0.04 |
| Brewers' grains | 19.48 " | 4.24 | 0.79 | 2.26 | 0.11 |
| "Meal" | 2.48 " | 2.14 | 0.47 | 1.03 | 0.10 |
| Mangolds | 14.00 " | 1.01 | 0.27 | 0.61 | 0.01 |
| Turnips | 11.48 " | 1.28 | 0.16 | 1.03 | 0.01 |
| Total, | | 18.73 | 2.34 | 9.56 | 0.31 |
| Total per 1,000 lbs. live weight, | | 19.25 | 2.53 | 10.34 | 0.34 |
| Standard, | | 24.00 | 2.50 | 12.50 | 0.40 |

The average yield of milk per head on the two days of the experiment was 22.3 lbs. and 23.3 lbs. respectively, or an average of about 10.4 quarts per head for the two days.

The fourth farm visited was that of F. R. Starr, Esq., of Litchfield (Echo Farm). The stock is Jerseys and Jersey grades. Part of the milk is shipped directly to New York and the rest is made into butter on the premises.

Eight pure Jersey cows, not including the best milkers, were selected by Mr. Starr as fairly representing the average of his herd. They had been in milk for from one to eight months and were on full feed. Their average weight was 890 pounds. The cows being valuable, it is considered of the first importance to keep them in good condition for breeding, and hence it is intended to feed them only moderately.

At the time the farm was visited the supply of home grown hay was exhausted and hay was being bought, so that frequent changes in the quality of the hay fed were being made. Owing to this and other unavoidable circumstances the results obtained were less satisfactory than in the other cases and the weighings were continued only through one day.

The feeding-stuffs employed were hay, provender (equal weights of maize and oats), wheat bran, and mangolds. The order of feeding was:—In the morning, provender, bran and hay; at noon, hay; at 3 P. M., mangolds; at night, provender, bran and hay.

The following tables contain the results of the weighings and analyses made:—

| | Total. | Per head. |
|---|---|---|
| Hay fed out | 203.00 lbs. | 25.38 lbs. |
| Hay uneaten | 14.86 | 1.86 |
| Hay eaten | 188.14 | 23.52 |
| Bran eaten | 20.00 | 2.50 |
| Provender eaten | 37.50 | 4.69 |
| Mangolds eaten | 60.00 | 7.50 |

### Moisture in Fodders.

| | |
|---|---|
| Hay | 15.83 per cent. |
| Hay uneaten | 23.93 |
| Bran | 13.94 |
| Provender | 17.28 |
| Mangolds | 91.44 |

### Composition of Dry Matter of Fodders.

| | Ash. Per ct. | Protein. Per ct. | Crude fiber. Per ct. | N. fr. extr. Per ct. | Fat. Per ct. |
|---|---|---|---|---|---|
| Hay | 5.00 | 7.93 | 32.15 | 53.17 | 1.75 |
| Hay uneaten | 4.87 | 5.84 | 35.11 | 52.69 | 1.49 |
| Bran | 6.41 | 17.32 | 8.52 | 65.07 | 2.68 |
| Provender | 2.46 | 11.25 | 5.23 | 76.99 | 4.07 |
| Mangolds | 13.64 | 19.27 | 9.28 | 57.46 | 0.35 |

### Composition of Dry Matter of Hay Eaten.

| | Dry matter of hay fed out. lbs. | Dry matter of hay uneaten. lbs. | Dry matter of hay eaten. lbs. | Percentage composition of dry matter of hay eaten. |
|---|---|---|---|---|
| Ash | 0.85 | 0.07 | 0.78 | 4.96 |
| Protein | 1.36 | 0.08 | 1.28 | 8.14 |
| Crude fiber | 5.49 | 0.48 | 5.01 | 31.87 |
| N. fr. extract | 9.09 | 0.72 | 8.37 | 53.25 |
| Fat | 0.30 | 0.02 | 0.28 | 1.78 |
| | 17.09 | 1.37 | 15.72 | 100.00 |

### Digestion Coëfficients.

| | Protein. | Crude fiber. | N. fr. extract. | Fat. |
|---|---|---|---|---|
| Hay eaten | 52 | | | 49 |
| Maize | 79 | 62 | 91 | 85 |
| Oats | 74 | 21 | 73 | 82 |
| Average for provender | 77 | 47 | 82 | 84 |
| Bran | 88 | 20 | 80 | 80 |

### Perecntage of Digestible Nutrients in Dry Matter.

| | Protein. | Carbhydrates. | Fat. |
|---|---|---|---|
| Hay eaten | 4.23 | 53.25 | 0.87 |
| Provender | 8.66 | 65.59 | 3.42 |
| Bran | 15.24 | 53.76 | 2.14 |
| Mangolds | 19.27 | 66.74 | 0.35 |



*Daily Ration per Head.*

| | | Dry matter. lbs. | Digestible. Protein. lbs. | Digestible. Carbhydrates. lbs. | Digestible. Fat. lbs. |
|---|---|---|---|---|---|
| Hay | 23.52 lbs. | 15.72 | 0.66 | 8.37 | 0.14 |
| Provender | 4.69 " | 3.88 | 0.34 | 2.54 | 0.13 |
| Bran | 2.50 " | 2.15 | 0.33 | 1.16 | 0.05 |
| Mangolds | 7.50 " | 0.64 | 0.12 | 0.43 | --- |
| Total, | | 22.39 | 1.45 | 12.50 | 0.32 |
| Total per 1,000 lbs. live weight, | | 25.16 | 1.63 | 14.04 | 0.36 |
| Standard, | | 24.00 | 2.50 | 12.50 | 0.40 |

The average daily yield of milk per head for five days preceding these weighings was 24.74 lbs., equal to about 11.3 quarts.

In the foregoing pages we have sought to make as accurate a comparison as is possible under the circumstances of the rations in use on these four farms with that which German investigators have found to produce the best results. In every case we have found more or less difference and in all but one a very noticeable difference. For the sake of easy comparison the five rations are brought together in the following table:—

| | Mr. Gold's Ration. lbs. | Mr. Norton's Ration. lbs. | Mr. Webb's Ration. lbs. | Mr. Starr's Ration. lbs. | Dr. Wolff's standard Ration. lbs. |
|---|---|---|---|---|---|
| Dry matter | 26.19 | 17.35 | 19.25 | 25.16 | 24.00 |
| Digestible protein | 1.87 | 1.48 | 2.53 | 1.63 | 2.50 |
| " carbhydrates | 13.25 | 9.05 | 10.34 | 14.04 | 12.50 |
| " fat | 0.41 | 0.31 | 0.34 | 0.36 | 0.40 |
| Total digestible matter | 15.53 | 10.84 | 13.21 | 16.03 | 15.40 |
| Nutritive ratio | 1:7.6 | 1:6.7 | 1:4.4 | 1:9.1 | 1:5.4 |

One point to be remembered in comparing these rations is that Mr. Webb's and Mr. Starr's both contained roots. The very high percentage of nitrogen in these roots indicates that they contained large amounts either of nitrates or of the various amide-like bodies which have been found in relative abundance in mangolds. Consequently the numbers given under "protein" should be diminished somewhat to represent the true amount of this ingredient. The difference thus made, however, is so small comparatively as to have little effect on our conclusions.

The question now presents itself, which of these five rations is the best one, or are they all the best for their respective circumstances? Obviously no complete answer can be given to this question. We are not justified in concluding that the Connecticut rations are in so far incorrect as they differ from the German standard, nor on the other hand are we warranted in assuming without question that the Connecticut rations are the best that could be devised under the circumstances. The object of this paper being chiefly statistical, it is not proposed to enter into an elaborate discussion of this point, and still less to make any criticisms on the methods of feeding practiced, but there are certain fairly well established general principles concerning the feeding of milk cows which may throw some light on the subject.

In the first place, it may be remarked that Wolff's standard ration is unquestionably a good one, as has been shown by abundant experience in Germany and to some extent in this country. It is no theoretical deduction from chemical or physiological laws, but rests on the firm basis of actual trial on the farm.

In comparing the other rations with it, it is noticeable at once that, with one exception, they contain a much larger proportion of non-nitrogenous nutrients to nitrogenous (protein or albuminoids) than is the case with the standard, while in one case there is also as compared with the standard a decided deficiency in the amount of total digestible matter. It therefore seems reasonable to conclude that if, in Mr. Norton's ration, the *amount* of the several nutrients had been increased, without altering their proportions, the result would have been a larger yield of milk.* Furthermore, all experiments on milk-production have shown that the most milk is produced on a ration containing a large proportion of protein, and there can be no reasonable doubt that if the relative amount of protein in these rations had been increased and that of carbhydrates and fat decreased, so as to keep the total amount of digestible matters the same, more milk would have been produced. Of these conclusions we may feel very certain. Our figures, to be sure, rest on estimates of the digestibility of the feeding stuffs and in some cases of the live weights of the animals and therefore are not exact, but they are probably exact enough to show that in these rations with one exception the nutritive ratios, viz: 1 : 7.6, 1 : 6.7 and 1 : 9.1, are much wider than that adapted to the most abundant production of milk (1 : 5.4). In Mr. Webb's ration the nutritive ratio is narrower, viz: 1 : 4.4. We are therefore justified in regarding it as in the highest degree probable, if not certain, that a narrowing of the nutritive ratio in the three cases to that of the standard ration, by decreasing the

* i. e. If the animals were not too far advanced in lactation.



hay and increasing the bran or linseed meal, for example, would have resulted in an increased milk production, while, if the feed had been made even richer than the standard ration, still more milk might have been obtained.

But in practice the question to be solved is not what ration produces the most milk. If that were all, the problem before the feeder would be a comparatively simple one. The question is, what ration produces milk at the greatest profit, and the answer to this must obviously depend not only on the producing power of the ration, but on its cost, the price of the milk, the cost of labor, etc., and will be likely to be quite different under diverse circumstances. It is not difficult, however, to compute with a fair degree of accuracy whether, in any given case, an improvement of the ration by the addition of more protein is likely to be profitable.

As an example of the manner of making such a calculation, I have taken Mr. Gold's ration. At the time of these observations about 40 cows were being fed, and they averaged about 6 quarts of milk per day. Reducing Wolff's standard to the amounts called for by a cow weighing 850 pounds, the estimated weight of Mr. Gold's, we get

| | |
|---|---|
| Total dry matter, | 20.40 lbs. |
| Digestible protein, | 2.13 " |
| " carbhydrates, | 10.63 " |
| " fat, | 0.34 " |

If, now, in Mr. Gold's ration we replace four pounds of hay by one and three-fourths pounds of linseed meal, we get a ration corresponding very nearly to the standard, viz:

| | Total Dry matter. lbs. | Digestible. | | |
|---|---|---|---|---|
| | | Protein. lbs. | Carbhydrates. lbs. | Fat. lbs. |
| Hay, 18 lbs. | 15.58 | 0.72 | 7.83 | 0.20 |
| Maize meal, 1.57 lbs. | 1.24 | 0.10 | 0.91 | 0.05 |
| Linseed meal, 4 lbs. | 3.48 | 1.09 | 1.37 | 0.10 |
| | 20.30 | 1.91 | 10.11 | 0.35 |

If the hay saved by this method of feeding could have been sold at $13.13 per ton, it would have just paid for the extra linseed meal used at $30.00 per ton, leaving the extra yield of milk on the better ration as so much gained. Or, in case it was thought desirable to feed the hay on the farm, more cows could have been kept. Instead of 40 cows, 49 might have been kept on the same amount of hay, by purchasing extra corn meal and linseed meal. It is easy to calculate that the extra amounts thus required per day would be:—Of corn meal 14 pounds, and of linseed meal 106 pounds. At the rate of $1.50 per hundred for the corn meal and $30.00 per ton for the linseed meal, these would cost, together, $1.80. If we suppose that the cows yielded no more milk on this ration than on the old one, the 54 quarts of milk from the nine new cows would cost $1.80, or 3.3 cents per quart, plus the cost of the extra labor involved. If we suppose the yield of milk to have been increased to 7 quarts per day, then we obtain 103 quarts of milk more than before, at a cost for extra feed of $1.80, or at the rate of 1.7 cents per quart, plus the extra labor required.

Plainly, the results of such a calculation will vary with the prices of the feeding stuffs, while the question of gain or loss will depend also on the price which can be got for the milk, and would properly involve the value of the manure also. The above computation is simply intended to illustrate the principle on which such calculations can be made. It would be easy to make a similar computation for the other rations, and to estimate whether, under any given circumstances, better feeding would probably pay. Other elements, of course, might also enter into the calculation, such as the necessity of producing good butter in Mr. Norton's case, or considerations of the health of valuable cows, as in Mr. Starr's case.

Mr. Webb's ration differs from the others in containing nearly the amount of digestible protein called for by the standard, but less carbhydrates. The difference is not great, and several ingredients whose digestibility is doubtful enter into this ration, so that it would not be entirely safe to base positive conclusions on the results obtained. If our estimates represent accurately the quantities of digestible nutrients, it is probable that an increase of the digestible carbhydrates by two or three pounds would cause a somewhat greater flow of milk, or that as good a result could have been reached with less of the costly protein (albuminoids) and more of the cheap carbhydrates.

Another point worthy of notice in these rations is the amount of total dry matter. This, compared with the total digestible matter, shows us how much indigestible matter the animal had to work over to get the digestible nutrients. In the above rations the indigestible matter varies from 10.66 pounds to 6.04 pounds, and this means a corresponding difference in the internal work of digestion. A certain bulk of food is normally required by ruminating animals, but within reasonable limits, the less the amount of indigestible matters, the less energy is expended in digestion and the more is available for productive purposes, while the celebrated experiments of Miller on exclusive meal feeding seem to indicate that this saving by concentrated fodder may be temporarily made very large.



Still one more point remains to be briefly noticed. It may be said, as it is by some, that the results of foreign experimenters are good for their circumstances, but that it is doubtful if they apply to the quite different conditions prevailing here. If by this is meant that it is doubtful if the German standards will prove the most profitable under our conditions of climate, etc., the claim may perhaps be admitted. The point is one which can be settled only by numerous carefully conducted feeding trials, made by those who have had training in the art of experimenting and are familiar with the precautions necessary in such investigations. If, however, what is meant is that the general laws of animal nutrition as worked out by other observers do not apply to our conditions, we can only say that such a claim has a very slender basis in fact. In the case of milk production, for instance, there are some things that are settled beyond reasonable doubt. It has been established that the supply of protein in the food has a direct and striking influence on the amount of milk produced, and this is just as true in Connecticut as in Saxony. If the addition of protein to a ration like one of those given above produced a larger yield of milk on a Saxon farm, there is no obvious reason why the same result should not follow on a Connecticut farm. The increase might not be the same—probably it would not be—but neither our climate nor our cattle are so different from those of Europe as to give any reason for believing that the result would be any different in kind or largely different in degree. In one case the increase might be profitable, and in the other the reverse—that would depend on other considerations.

## FEEDING EXPERIMENTS

On Milch Cows, with the use of Standard Rations, including Ensilage, made at the New Jersey Agricultural Experiment Station.

In previous Reports I have called attention to the Feeding Standards which the German Experiment Stations have elaborated by a large number of exact and laborious practical feeding trials. Early in 1881 the New Jersey Experiment Station published in its bulletins X and XI the results of some feeding experiments carried on under its immediate charge that fully confirm the estimate in which these feeding standards are held in Germany. These bulletins are so full of valuable information that, with consent of Dr. Cook, Director of the New Jersey Station, I reprint them for the benefit of Connecticut stock feeders.

An account of the Feeding Standards may be found in the Report of this Station for 1879, pp. 94–98; also in Dr. Armsby's *Manual of Cattle Feeding*, p. 368, and in Drs. Armsby and Jenkins' *Farmers' Annual* for 1882, p. 184.

### "Bulletin X.

The object of this bulletin is to call the attention of the intelligent farmers of this State to a rational system of stock feeding. For illustration, a ration for milch cows has been computed, its cost estimated and its practical value shown by a feeding trial which has now lasted over fifty days.

A farmer feeding a good quality of clover hay will find that nearly thirty-five pounds per day will be necessary to maintain the flow of milk and prevent loss of flesh in a cow of about 1,000 lbs. live weight. Now according to an analysis recently made at the Station, thirty-five pounds of second growth clover hay from the College Farm contained:

4.6 lbs. Protein.
.9 lbs. Fat.
13.9 lbs. Starchy matter (Nitrogen-free extract*).
10.0 lbs. Woody " (Fiber).
1.7 lbs. Ash.
3.9 lbs. Water.

* See foot note, p. 78.



These constituents, however, are not all digestible. A chemical examination of the solid excrements of the cow would show that

1.85 lbs. Protein,
.40 lbs. Fat,
10.70 lbs. Woody and Starchy matter,

had passed through the animal undigested, and as far as nutrition is concerned, had been lost.

If now we subtract from the food eaten, the amount of indigestible matter found in the manure, we shall know how much digestible food there is in thirty-five pounds of clover hay. It will be found to be $2\frac{3}{4}$ lbs. protein, $\frac{1}{2}$ lb. fat and $13\frac{2}{10}$ lbs. starchy matter.

The cow then which consumes thirty-five pounds of clover hay daily, lives, increases perhaps a trifle in live-weight, and produces its milk from $2\frac{3}{4}$ lbs. protein, $\frac{1}{2}$lb. fat, and $13\frac{2}{10}$ lbs. starchy matter. German agricultural chemists have shown that an ordinary milch cow of 1,000 lbs. live weight does not require more than $2\frac{1}{2}$ lbs. digestible protein, $\frac{4}{10}$ lbs. digestible fat, and $12\frac{1}{2}$ lbs. digestible starchy matter daily, and German farmers have proved the correctness of these figures by years of practical experience. Of course, if a cow gives an unusual amount of milk, an unusual quantity of food will be necessary, if loss of live weight is to be avoided. In such cases the quantity of digestible matter can be increased to $2\frac{3}{4}$ lbs. of protein, $\frac{1}{2}$ lb. fat, and $13\frac{2}{10}$ lbs. starchy matter. It will rarely be found profitable, however, to feed more than this amount.

The farm should supply an abundance of digestible starchy matter in the form of fodder-corn, straw, chaff, turnips, etc. The digestible protein and fat can probably, in most cases, be bought at a lower price than the market value of that raised in New Jersey.

The following table will give an idea of the wide range of prices between farm products and such commercial articles as cotton-seed meal, oil cake, brewers' grains, etc.

| 100 lbs. of | Cost. | Contain of digestible Protein. | Fat. | Starch.* |
|---|---|---|---|---|
| Timothy Hay, | $1.00 | 3.02 | 1.37 | 48.58 |
| Clover Hay, | .75 | 7.83 | 1.48 | 39.71 |
| Corn Meal, | 1.12 | 6.23 | 2.89 | 66.90 |
| Brewers' Grains, | .25 | 4.73 | 1.50 | 14.29 |
| Cotton Seed Meal, | 1.30 | 33.00 | 10.89 | 12.62 |

* i. e., of *Carbhydrates*; see p. 78.

One hundred pounds of digestible protein, fat and starch, costs in

| | Protein. | Fat. | Starch. |
|---|---|---|---|
| Timothy Hay, | $6.70 | $6.70 | $1.40 |
| Clover Hay, | 4.30 | 4.30 | .90 |
| Corn Meal, | 4.90 | 4.90 | 1.00 |
| Brewers' Grains, | 2.80 | 2.80 | .60 |
| Cotton Seed Meal, | 2.80 | 2.80 | .60 |

The second table shows that digestible protein in Brewers' grains and cotton seed meal can be bought for about $2.75 per hundred pounds, while in corn meal it costs nearly $5.00 per hundred pounds, and in timothy hay $6.70 per hundred pounds. A farmer who can sell his Indian meal at $1.12 per hundred, will see that he is receiving five cents per pound for his protein, and can buy for his own use the same material for $2\frac{3}{4}$ cents per pound.

The point now to be explained is how to use cotton-seed meal in place of corn meal. By looking at the first table it will be seen that 100 lbs. of cotton seed meal contain 33 pounds of digestible protein; that we know is enough to last a cow over thirteen days; it contains too, fat enough to last twenty-one days, while the digestible starch in one hundred pounds is just enough for one day. To express the same idea in another way, we would need only eight pounds of the cotton seed meal to furnish the cow with the $2\frac{1}{2}$ pounds of protein, while the 8 pounds would give twice as much fat and only about $\frac{1}{12}$ as much starch as is necessary. We see then that the cotton-seed meal must be mixed with something which contains a large quantity of digestible starch, and a very small quantity of protein and fat. Wheat straw which contains in one hundred pounds only $\frac{8}{10}$ lbs. of digestible protein and $\frac{3}{10}$ lbs. of digestible fat, while it yields $37\frac{1}{2}$ lbs. of digestible starchy matters would seem to answer our purpose exactly. It would do exactly, if a cow were simply a milk machine, but a living creature is much more complicated than any machine can possibly be. One objection would be a difficulty to induce the animal to eat such a large amount of coarse fodder. Another would be a fact not yet mentioned, viz: the digestible food should be contained in a ration which when perfectly free from all traces of moisture, should not weigh more than from 24–28 pounds. If the food be mixed with a larger amount of indigestible matter, it is scarcely to be expected that it can be digested and assimilated. Now our ration of eight pounds of cotton-seed meal and thirty-three pounds of wheat straw would contain almost thirty-five pounds of dry matter, nearly ten pounds more than is allowable.



The ration fed to a herd of six mixed grade cows at the College Farm, has given perfect satisfaction; it was made up as follows, the calculation being for 1,000 lbs. live weight per day:

| | Containing pounds of digestible Protein. | Fat. | Starch. |
|---|---|---|---|
| 6 lbs. Clover Hay, | 0.47 | .09 | 2.27 |
| 13 lbs. Wheat Straw, | 0.11 | .04 | 4.88 |
| 20 lbs. Brewers' Grains, | 0.99 | .33 | 2.86 |
| 20 lbs. Turnips, | 0.26 | | 2.06 |
| 2 lbs. Cotton Seed Meal, | 0.66 | .22 | 0.24 |
| Total, | 2.45 | .65 | 12.31 |
| The total dry matter was, | | 25.5 lbs. | |

The total weight of the six cows, taken with all usual precautions, was 5,770 lbs. To find the amount of fodder and feed needed for the herd, we have therefore to multiply the weights, which, as above stated, are for 1,000 lbs., by 5.77; for example:

| | |
|---|---|
| 6 lbs. of Clover Hay, | $\times$ 5.77 = $34\frac{1}{2}$ pounds. |
| 13 lbs. Wheat Straw, | $\times$ 5.77 = 75 " |
| 20 lbs. Brewers' Grains, | $\times$ 5.77 = 115 " |
| 20 lbs. Turnips, | $\times$ 5.77 = 115 " |
| 2 lbs. Cotton Seed Meal, | $\times$ 5.77 = $11\frac{1}{2}$ " |

The daily cost of the ration for 6 cows can now be easily computed:

| | |
|---|---|
| 35 lbs. Clover Hay, at $15 per ton, | =26 cents. |
| 75 lbs. Wheat Straw, at $7 per ton, | =26 " |
| 115 lbs. Brewers' Grains, at $5 per ton, | =29 " |
| 115 lbs. Turnips, 10c. per bushel, | =19 " |
| $11\frac{1}{2}$ lbs. Cotton Seed Meal, at $26 per ton, | =15 " |
| | $1.15 |
| Daily cost for each cow, | 19 cents. |

The straw was passed through a cutter and thoroughly mixed with the Brewers' Grains, Cotton Seed Meal and Turnips. The mixture was fed in equal portions morning and evening. The hay was fed at mid-day.

The cows were mixed grades taken from a herd of twenty-four head. They were milked twice daily—the milk of each cow being carefully weighed, and a sample of the mixed milk together with the record of the yield, sent each day to the Station by Mr. Theodore West, Farm Superintendent.

The following table gives a description of each cow and her total yield of milk:

| | | | | | | |
|---|---|---|---|---|---|---|
| Name of Cows,. | Strawberry. | Starface. | Daly. | Dominie. | Sutphen. | Camel. |
| Age of Cows,... | 6 years. | 6 years. | 4 years. | 7 years. | 9 years. | 7 years. |
| Weight of Cows, | 965 | 1,000 | 825 | 917 | 880 | 1,220 |
| Date of Calving, | Oct. 23, '80. | Oct. 10, '80. | June 12, '80. | July 15, '80. | Oct. 8, '80. | Apr. 15, '80. |
| Next Calf ex'd,. | Aug. 29, '81. | ........... | July 13, '81. | Aug. 1, '81. | .......... | Apr. 1, '81. |

YIELD OF MILK.

| | lbs. oz. | lbs. oz. | lbs. oz. | lbs. oz. | lbs. oz. | lbs. oz. |
|---|---|---|---|---|---|---|
| From Nov. 16-Nov. 26—11 days,... | 273.8 | 274 | 166 | 256 | 279.12 | 223.8 |
| From Nov. 27-Dec. 7—11 days,.... | 292.8 | 261 | 185 | 259 | 272 | 218 |
| From Dec. 8-Dec. 16—8 days, ..... | 199.8 | 185.8 | 147.12 | 190 | 199.8 | 160.4 |
| Total yield for 30 days,............ | 765.8 | 720.8 | 498.12 | 705 | 751.4 | 601.12 |

The total yield for the entire herd is 4,042 lbs., 12 oz.

The weight of a quart of milk for practical purposes may be taken as two pounds. The total yield then for 30 days is 2,021 quarts, or 67.3 quarts daily, an average yield for each cow of over 11 quarts.

1. From the experiments it appears then that the cows have gained a little in flesh by being fed on this ration, and that their flow of milk has not diminished.

2. It is fairly proved that the ration saved directly 30 per cent. on the cost of a full ration of clover hay, and still more than this on one of clover and Indian meal.

3. The ration also saved indirectly by turning to profitable account the straw and coarse products which are ordinarily only used for manure.

4. The whole experiment shows that the live stock on a farm can be kept in good condition, and a much larger amount of its high priced products sold, than it is now the practice to sell, or that a greatly increased amount of live stock can be profitably kept while consuming all the food products.

The above is but a single example of the use of a computed ration. It was made for a special purpose; and there might have others calculated which would have been quite as economical.

GEORGE H. COOK, *Director*.

New Brunswick, N. J., Jan. 15, 1881."



"NEW JERSEY AGRICULTURAL EXPERIMENT STATION.

BULLETIN XI.—ENSILAGE.

In this bulletin we give the results of a feeding experiment with corn ensilage.

On November 16th four cows of native breed were taken from the herd at the College Farm, placed side by side in the same barn and for a term of ninety-one days were fed, exercised and milked at the same time.

During the first period of twenty-eight days a ration was divided among them, made up of twenty-two and one-half pounds of clover hay, forty-nine pounds of wheat straw, seventy-five pounds of brewers' grains, seventy-five pounds of turnips, and seven and one-half pounds of cotton seed meal. It was calculated to furnish daily to each 1,000 lbs. of live weight.

2.5 lbs. digestible protein.
0.5 lbs. digestible fat.
12.5 lbs. digestible carbhydrates.

This being according to German investigators the necessary amount of food.

For the second period of twenty-eight days no change was made in the ration fed cows Nos. I and II, while in that fed III and IV, 100 lbs. of ensilage was substituted for 40 lbs. of turnips; in other respects it remained the same as that fed during the first period; it furnished daily to each 1,000 lbs. of live weight

2.50 pounds digestible protein.
.90 pounds digestible fat.
14.90 pounds digestible carbhydrates.

This was fed in order to determine whether an increased amount of the heat-producing compounds, fat and starch, was rendered necessary by the severity of the weather. The additional food caused no increase in the yield of milk; cows I and II on the poorer ration gave during this period more milk than during the preceding.

Our intention thus far was to ascertain the quantity of food required to keep these cows up to their full yield of milk.

For the third period, of five weeks ending Feb. 17, Nos. I and II were fed the same as during the first and second periods; to III and IV an equal amount of digestible food was given daily, in 120 pounds of ensilage and five pounds of cotton seed meal per cow; it was eaten without waste and with apparent relish.

We tabulate below the yield of milk for 13 weeks. It must be remembered that during the first period all four cows received the same ration; that during the second and third periods cows I and II received the same as during the first; that cows III and IV were fed during the second period with an unusually rich ration, and during the third period with one made up of ensilage and cotton seed meal alone, containing however an amount of food equal to that fed during the first period.

| | I. 7 yrs. old. Calved July 15. lbs. | II. 9 yrs. old. Calved Oct. 8. lbs. | III. 6 yrs. old. Calved Oct. 23. lbs. | IV. 6 yrs. old. Calved Oct. 10. lbs. |
|---|---|---|---|---|
| Average daily yield for 1st period, | 23.5 | 25.1 | 25.6 | 24.1 |
| " " " " 2d " | 25.2 | 26.1 | 24.9 | 24. |
| " " " " 3d " | 25.2 | 23.2 | 23.8 | 24. |
| " " " " 91 days, | 24.6 | 24.8 | 24.8 | 24. |

An opportunity is here offered to call attention to the fact that up to a certain point the yield of milk may be influenced by the quantity of digestible food, but beyond this point, which is determined by breed, time of calving and individual peculiarity, an increased amount of food fails to increase the yield of milk; ensilage can produce no more milk than any other fodder which contains an equal amount of food, a point well illustrated by the above table.

While the yield of milk and its per centage of butter cannot be increased at will, it is well known that its quality may be very materially influenced by the feeding. It is claimed for ensilage that it makes "Winter butter equal to June butter." A claim willingly admitted, butter made from the fodder being to our knowledge of unusually fine color and flavor.

The composition of ensilage is by no means constant, as the following table of analyses shows: soil, variety of corn, method of planting and cultivating, and above all the time of harvesting, exert a decided influence on its quality.

The samples furnished by Mr. Platt and Messrs. Whitman & Burrill had the characteristic vinous smell which indicated that they had been exposed to the air before reaching the laboratory—and probably an analysis of a perfect sample would have indicated a larger amount of nutritive matter. From personal observation at the silo we know that Mr. Platt's ensilage was as well preserved as any we have seen.



In this table the samples have been arranged with reference to their percentages of water and carbhydrates:

| | Loss at 212° F. Pr. ct. | Protein. Pr. ct. | Fat. Pr. ct. | Fiber. Pr. ct. | Ash. Pr. ct. | Carbhydrates Pr. ct |
|---|---|---|---|---|---|---|
| Mr. Mills, Pompton, N. J., | 77.4 | 1.02 | 0.68 | 6.85 | 1.00 | 13.04 |
| Mr. Morris, Oakland Manor, Md., | 78.51 | .88 | 0.62 | 6.43 | 1.53 | 12.03 |
| Buckley Bros., Port Jervis, N. Y., | 80.86 | 1.27 | 0.67 | 5.47 | 1.00 | 10.73 |
| Coe Bros., West Meriden, Conn., | 82.10 | 1.21 | 0.71 | 5.34 | 1.02 | 9.62 |
| College Farm, New Brunswick, N. J., | 83.52 | .94 | 0.65 | 5.18 | 1.43 | 8.28 |
| Mr. Platt, Suffield, Conn., | 83.56 | 1.06 | 0.73 | 5.76 | .81 | 8.08 |
| Whitman & Burrill, Little Falls, N. Y., | 83.54 | 1.06 | 0.50 | 5.85 | 1.40 | 7.65 |
| James Lippincott, Mt. Holly, N. J., | 84.28 | 1.37 | 0.50 | 4.68 | 1.26 | 7.91 |
| Dr. J. M. Bailey, Billerica, Mass., | 84.87 | 1.06 | 0.45 | 5.61 | .98 | 7.03 |

The amount of ensilage to be used depends entirely upon its quality and upon the plans of the farmer.

Mr. Mills, for instance, could make up a full ration for a cow of 1,000 lbs. live weight, by feeding daily eighty pounds of his ensilage and five and one-half pounds of cotton seed meal; while at the College Farm with five pounds of cotton seed meal, one hundred and twenty pounds were necessary. In these rations nearly all the carbhydrates needed and a portion of the protein and fat are furnished at a very low price by the ensilage; the balance of the protein and fat is drawn from the cotton seed meal. If desirable, a much smaller quantity of ensilage could be used and the carbhydrates given in form of corn meal or any feed rich in these compounds; in ensilage they can be had, however, much cheaper than in any feed known to us at present. One thing must be considered: if the quality of the ensilage obliges the farmer to feed his cows more than eighty or ninety pounds daily per head, there is reason to fear that they will scour. The amounts fed by the above named gentlemen have varied from sixty-five to eighty pounds, and with these amounts no trouble whatever has been experienced. We therefore conclude that if the ensilage is of first-class quality, eighty pounds per day will furnish an animal with the full amount of carbhydrates; if it is of medium quality it will be safer to limit the amount to about ninety pounds, furnishing the rest of the carbhydrates in form of feed or straw.

From the above experiment we feel justified in concluding that milch cows can be safely fed large quantities of this fodder, and that it is a perfect substitute for hay. The question of expense we reserve for a future bulletin.

GEORGE H. COOK, *Director.*

New Brunswick, March 7, 1881."

## AN ACT ESTABLISHING THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

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

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

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

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

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

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



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

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

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

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

Approved March 21, 1877.

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

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

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

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

Approved, March 19, 1879.

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## AN ACT CONCERNING COMMERCIAL FERTILIZERS.

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

SEC. 1. Every lot or package of commercial manure or fertilizer sold, offered, or exposed for sale, in this State, at a price of one-half cent or more a pound, shall be accompanied by a plainly-printed label or stencil mark on each package, which shall clearly and truly state its name or brand, its weight, the name and address of the manufacturer or seller, and its chemical composition, expressed in the terms and manner approved, and currently employed, by the Connecticut Agricultural Experiment Station. Every lot or package of commercial fertilizer or manure sold at a price less than one-half cent a pound shall be accompanied by a printed label, which shall give a correct general statement of its composition and ingredients.

SEC. 2. Every manufacturer or importer of commercial fertilizers or manures, excepting rock plaster or sulphate of lime, shall, before offering the same for sale in this State, procure a license from the Secretary of State, as manufacturer or importer of the same, and shall pay into the treasury of the State the sum of fifty dollars annually for one kind or brand of fertilizer or manure, and fifteen dollars for each other distinct kind or brand of fertilizer, and shall at the same time file with the Secretary of State, and also with the director of the Connecticut Agricultural Experiment Station, a statement of the names of his agents, and also the name or brand, and the composition of each fertilizer or manure, manufactured or imported by him for sale. Every manufacturer of fish guano, or fertilizers of which the principal ingredient is fish or fish-mass from which the oil has been extracted, shall, before manufacturing or heating the same, and within thirty-six hours from the time such fish or mass has been delivered to him, treat the same with sulphuric acid or other chemical, approved by the director of said experiment station, in such quantity as to arrest decomposition: *provided, however*, that in lieu of such treatment such manufacturers may provide a means for consuming all smoke and vapors arising from such fertilizers during the process of manufacture.



SEC. 3. Every person who shall bring into the State ashes for the purpose of sale shall, before offering the same for sale, procure a license from the Secretary of State, and shall pay therefor into the treasury of the State the sum of fifty dollars annually.

SEC. 4. All moneys collected by the State as license fees, as provided in sections two and three of this act, shall be appropriated to the support and maintenance of the Connecticut Agricultural Experiment Station, and shall be paid over to the Treasurer of said Station quarterly.

SEC. 5. Any person violating any provision of sections one, two, and three of this act shall be fined one hundred dollars for the first offense, and two hundred dollars for each subsequent violation.

SEC. 6. The director of the Connecticut Agricultural Experiment Station is hereby authorized, in person, or by deputy, to take samples for analysis from any lot or package of manure or fertilizer, which may be in the possession of any dealer.

SEC. 7. This act shall not apply to parties manufacturing fertilizers for their own private use, or in quantities of less than twenty-five tons per year; *provided*, the same is sold only to consumers and on the premises where manufactured.

SEC. 8. Title sixteen, chapter fifteen, sections fifteen and sixteen, and title twenty, chapter twelve, section five of the General Statutes are hereby repealed.

SEC. 9. This act shall take effect immediately.

Approved, April 14, 1881.

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