Connecticut Agricultural Experiment Station
Preliminary Report - 1876

PRELIMINARY REPORT.

CONNECTICUT

Agricultural Experiment Station,

MAY 1, 1876.

FROM THE REPORT OF THE SECRETARY OF THE CONN. BOARD OF AGRICULTURE, 1875.

HARTFORD:
PRESS OF THE CASE, LOCKWOOD & BRAINARD COMPANY.
1876.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

PRELIMINARY REPORT.

The Committee of the Trustees of Wesleyan University, to whom has been entrusted the organization of a "work appropriate to an Agricultural Experiment Station," contemplated in the legislative appropriation for that purpose, take pleasure in presenting the following report of the Director.

That the portion thus far expended of the installments which have accrued has been economically and profitably employed will, they trust, appear from the fact that, while considerable other and no less useful labor has been performed, analyses of fertilizers have been made during the first half year which, at the prices charged by leading chemists, would alone have cost more than the appropriation from the State for an entire year.

The Committee are happy to bear testimony to the skill, faithfulness and zeal with which the chemists of the Station have performed its work.

ORANGE JUDD,
A. B. CALEF,
C. D. FOSS,
} *Committee.*

PRELIMINARY REPORT.

To attempt any report of the work of the Experiment Station, when but little more than half a year has elapsed since its first organization, would be some like giving an account of the operations of a farm before a single summer had passed since the clearing of the land. The plan of operations and the incipient stages of the work might be explained sufficiently for comment and criticism, but the prospect of success or failure would be more certain when a season's crops had been harvested.

In the following brief preliminary report are described some of the main features of the organization and first labors of the Station.

The bill making an appropriation of $2,800 per annum to Wesleyan University "to be used in employing competent scientific men to carry on the appropriate work of an Agricultural Experiment Station," was approved July 20, 1875, during the summer vacation at the College.

Prompt efforts were made by the trustees of the University to secure the services of proper men for the work. Early in October, very shortly after the opening of the fall term, a chemist was on the ground, and as soon as practicable two assistants were secured. Arrangements were also made by which the professor of chemistry in the College was relieved of a part of his regular labor of instruction and enabled to assume charge of the work as Director.

Feeling that this enterprise should be entirely for the benefit of the farmers of the State, and that their counsel, sympathy, and coöperation were indispensable to its success, the Committee of the Trustees of the University to whom the organization of the Station had been referred, invited the

State Board of Agriculture and the Farmers' Experiment Station Committee to meet at the college, October 12, 1875, and advise concerning plans for carrying out the purpose of the appropriation.

Both the Board and the Committee evinced their interest in the matter by a full attendance at the meeting. From the gentlemen present an Advisory Committee was appointed, whose number was afterwards enlarged so as to include prominent and progressive farmers from all the counties of the State. The writer feels that whatever measure of success may attend the labors of the Station will be largely due to the wise and liberal counsels, earnest sympathy and active support of the Advisory Committee.

It has been felt from the first that more abstract scientific investigations would afford not only the proper, but also the most widely and permanently useful field of labor. But the need of a fertilizer control system was so pressing and so vital to the interests of a considerable portion of the farmers of the State that it seemed absolutely necessary to turn the first efforts in this direction. Accordingly analyses of fertilizers sold in the State were undertaken, and circulars giving directions for the selection and forwarding of samples were widely distributed. Some of the further efforts made to introduce into this State a system of trade in commercial fertilizers by which the same shall be "bought and sold upon the basis of their commercial value as shown by their composition," are given herewith.

The following is a copy of a circular which was sent to a large number of persons interested, and published in the press of the State:

WETHERSFIELD, CONN., Dec. 28, 1875.

Dear Sir:

"It is plainly for the interest of both dealer and consumer that fertilizers should be bought and sold upon the basis of their actual value as determined by their composition. To further such a regulation of the trade in commercial fertilizers, arrangements will be made with those dealers who wish to place their stock under the supervision of the Agricultural Experiment Station, whereby their wares will be inspected, samples taken for analysis, and results of same reported under authority of the director."

As harmony of action is necessary to insure confidence, you are requested to be present at a meeting of Farmers and Dealers, to be held at Orange Judd Hall.

Middletown, Conn., at 11 o'clock, A. M., Thursday, Jan. 13th, 1876, to devise and accept means by which these desirable results may be attained.

S. M. WELLS, CHAIRMAN,
Of Advisory Committee, Connecticut Agricultural Experiment Station.

The success of this meeting was greater than any but the most sanguine had hoped. Not only were over seventy farmers, representative men from all parts of the State, present, but a large number of leading manufacturers and merchants connected with the fertilizer trade in this and other States, showed their interest in the matter by attending themselves, or sending special representatives to the meeting. Among the latter, were parties from Boston, New York, Baltimore and intervening places. A report says:

"Many of the merchants here represent other large concerns, so that it may be affirmed that the fertilizers trade generally gives this Experiment Station its entire and cordial support. And I may add that farmers are more than satisfied with the action of this meeting. The good feeling manifested here between all parties in the warmest terms is worth coming to Middletown to see."

"The following resolutions, drafted by a joint committee of dealers and farmers, were adopted after full deliberation and with entire harmony. They were emphasized by the gentlemen present, without a dissenting voice, and in a manner that promises their fulfillment":

WHEREAS, An Agricultural Experiment Station has been established at Middletown for the promotion of the interest of the agriculture of the State; in order to avail ourselves of the benefits of said institution, be it

Resolved, That all fertilizers sold in the State should be sold under a guarantee of their composition, to be determined by analysis at the Station.

Resolved, That we recommend to all manufacturers and dealers to place their stocks under the supervision of the Station, subject to their examination at all times.

Resolved, That as consumers of fertilizers we will give the preference in our purchases to those dealers who offer their goods under this guarantee.

At the close of the meeting, in a conference of the manufacturers and dealers present with the Director of the Station,

the outlines and general tenor of an agreement between the Station and the sellers of fertilizers were decided upon. It was then proposed that, as soon as the details could be arranged by needed and proper consultation, a form of agreement should be drawn up and presented to the sellers of fertilizers in this State for approval and signature.

After due consultation with the advisory committee on the one hand, and with leading sellers and consumers of fertilizers on the other, a form of agreement was drawn up and forwarded to dealers. Further details of the carrying out of this and other parts of the general plan for the establishment of a fertilizer control system, may be found in subsequent pages.

A report on the fertilizers sold in the state would, at this time, be premature. We are still in the midst of the fertilizer season, samples are continually coming in from dealers and consumers, and a good many are yet to be collected. As soon as the investigation of the articles thus received from various sources shall be completed, we hope to be able to make quite a full report of the condition of the fertilizer market in the state. Meanwhile we offer the following "Circular No. 4" as a partial account of analyses made up to the present time.

In the first edition, which was published by the Station, the following note was appended.

> Every effort has been made to communicate the results of the work of the Station to the farmers of the state. To this end accounts of its organization and labors have been furnished to the press, circulars have been issued and farmers' meetings held at the Station. It is hoped that this pamphlet which, in lack of public appropriation, is printed at private expense, may be found useful in explaining one of the many ways in which science may be made useful to agriculture.

That edition, 2,000 copies, having been exhausted, and the call for them still continuing, the circular is herewith offered for re-publication. Some changes, suggested by further experience and by questions from parties interested, are made in this second edition.

The analysis of fertilizers is by no means the most impor-

tant work of an Agricultural Experiment Station. Such an institution will be worthy of the name in proportion as it carries on accurate and thorough investigations and experiments in agricultural science. The knowledge thus gained of the principles that underlie the right practice of agriculture, has a very much wider and more permanent value than exposure of frauds or regulation of the trade in fertilizers. This is simply in accordance with the fact that the knowledge of any principle is of more consequence than any one special application of it. It is important for the farmers of Connecticut to know whether they get the worth of their money in the manures they buy, but is of equal consequence that they should know how to use them. And it is of still more importance to them to learn how they shall manage their fertilizers, their crops, their fodder materials, and their stock, so as most economically and profitably utilize the products and the productive power of their farms. That these facts are appreciated by our best farmers is very gratifying. That such knowledge is becoming increasingly valued for its own sake is still more so.

During the last summer some experiments were undertaken with the hope of making new contributions to our knowledge of the development of sundry of our common farm plants, and throwing some light on the question of rotation of crops and the feeding values of the products. Specimens of grass, clover and cereal crops, grown on different soils, and with different methods of manuring and culture, were cut at different periods of growth, from plots of known size, weighed and portions reserved for analysis. Samples of the roots and of the soils in which they grew were also gathered. Over forty specimens of roots and tops, and several of soils were thus collected. It was hoped that opportunity would be found during the winter for proper investigations in the laboratory of these products of the fields, but the various details of labor incident to getting the work of the Station systematized and, more especially, the analyses of fertilizers, have demanded so much attention that little time has yet been found to prosecute these investigations.

But few persons have any adequate conception of the amount of labor needed for accurate scientific researches. In the experiments above mentioned, the separation of a single lot of roots from the soil, required, in each of a number of cases, the painstaking labor of a whole week.

A number of specimens of muck and of natural manures of various sorts have been received, and investigations upon them begun. So soon as the stress of work upon artificial fertilizers is over, these and studies other will be continued.

Large numbers of letters of inquiry have come to the Station. These have been replied to, as fully as the time and opportunity of the laborers would permit. We ask those who may feel that their communications have not received as ready and full answers as their importance would demand, to remember that many of their inquiries can not be answered without previous study and experiment, and that even were the knowledge at hand, the putting of it in satisfactory form in individual letters consumes a great deal of time that is needed for other work. Still these inquiries are always welcome, and will be answered as well as is in our power.

The cordial sympathy which has been manifested on all sides in behalf of this enterprise has been very encouraging. Thanks are especially due to a number of persons for valuable assistance in various ways.

A very essential addition to the means for the prosecution of experiments has been afforded by the liberal offer, on the part of its proprietor, Dr. J. W. Alsop, Jr., of Middletown, of free use of lands and appliances of Arawana farm. The accuracy with which this farm has been surveyed, its thorough drainage and complete equipment, its systematic management and its ready accessibility to the Station give it an unusual fitness for purposes of experiment.

W. O. ATWATER, Director.
Orange Judd Hall, Wesleyan University.

MIDDLETOWN, CONN., May 1, 1876.

COMMERCIAL FERTILIZERS.

CONNECTICUT

Agricultural Experiment Station.

Circular No. 4.

2D EDITION.

CHEMICAL LABORATORY, ORANGE JUDD HALL,
WESLEYAN UNIVERSITY:
MIDDLETOWN, CONN.

CHEMISTS.

W. O. ATWATER, PH. D., DIRECTOR,
W. C. TILDEN, M. D.,
W. BALENTINE, B. S., ASSISTANT,
R. B. GRIFFIN, ASSISTANT.

TO THE FARMERS OF CONNECTICUT.

We call your attention to the following circular on Commercial Fertilizers from the Connecticut Agricultural Experiment Station. This includes explanations of the composition and uses of Commercial Fertilizers, of the methods of judging of their value from analysis, and of the means adopted by the Station to introduce a Fertilizer Control System in this State.

The State law requires packages of commercial fertilizers sold or offered for sale in the State, to be accompanied by an analysis, giving the percentages of valuable ingredients. The Station supplements this by securing from dealers an agreement to guarantee the correctness of the analyses by which they sell, and tests the reliability of the latter by inspecting wares offered for sale. Still further it provides that farmers may have the fertilizers they buy analyzed at small cost or for nothing.

We earnestly advise all buyers of these fertilizers in the State to purchase of those dealers, and those only who place their wares under the supervision of the Station, and to select those articles which furnish the valuable fertilizing ingredients in the best form, and at the lowest price per pound. Ample means for protection against fraud and the securing of good fertilizers at fair prices, are thus offered to us by the Station.

In the furtherance of this as of the other departments of the work of our State Agricultural Experiment Station, we invite your most hearty sympathy and co-operation.

S. M. WELLS, J. B. OLCOTT,
J. M. HUBBARD, H. LARRABEE,
T. S. GOLD, T. B. WAKEMAN,
J. J. WEBB, W. H. YEOMANS,
GEO. AUSTIN BOWEN,

Advisory Committee,
Connecticut Agricultural Experiment Station.

COMMERCIAL FERTILIZERS.

The brief experience of the Station has shown that elementary explanations of scientific facts, are necessary to make its work most useful to the largest number of those whom it is intended to benefit.*

When a miner wishes to know whether it is safe to invest his money in a mine, he has the ore analyzed to determine how much of precious metals it contains. What he wishes is not earth nor quartz, for these are plenty and have no commercial value. He wants rather the gold and silver which are scarce and valuable.

Guanos, phosphates and other fertilizers are mixtures of various materials. Some of these materials are abundant in every soil, others, though indispensable to the growth of every crop, are often lacking. These latter are valuable because of their necessity to crops and their scarcity in the soil, and are to artificial fertilizers what gold and silver are to their ores.

In buying fertilizers the object should be to get those which furnish the materials which the land and crops need, in the best form and at the lowest cost. How much Connecticut farmers need more definite knowledge of the composition and uses of fertilizers, is illustrated by some of the facts brought out by such work as is being done at the Station.

Nitrogen is one of the most important and necessary ingre-

* For those who are not fresh or well-versed in chemistry, this circular may not be easy reading. It is a somewhat difficult task to translate the results of scientific work from the technical phraseology of the laboratory into the more familiar language of daily life. The subject is, however of the greatest importance, and its study will not only be of great aid in judging of the value of fertilizers, but will also help those who may be interested, to understand more fully the circulars which will be hereafter issued by the Experiment Station.

dients of commercial fertilizers. At the prices at which the farmers of the State have been buying these articles, they have been paying often as high as 40 or 50 cents, or more, a pound for nitrogen, and this in what, from their continued sale may, be called standard articles. And yet they can obtain nitrogen in the very best forms at from 20 to 25 cents per pound and less, and there is no reason why they need pay more than this if they only know how to make their selections. But while they are without just this information, foreign manufacturers who have it, are coming into our markets, taking the materials which furnish nitrogen more cheaply, carrying them away for European farmers to use, and leaving the poorer and costlier sources of supply for our farmers to draw from. Fish and slaughter house products, in which any farmer in Connecticut can have nitrogen at from 20 to 25 cents per pound, are thus in demand for foreign exportation, while large quantities of low grade fertilizers, many of which contain these same materials mixed with others of inferior value, are sold to our farmers at prices which bring the nitrogen at 30, 40, and 50 cents, and still higher, per pound.

Potash is another of the valuable ingredients of manures. Potassic fertilizers can be had by any farmer in Connecticut at such prices and of such quality as to make the cost of the potash from 6 to 8 cents per lb. At the same time they are sold so as to bring the potash up to 10, 15, and in some cases over 30 cents per lb.

With phosphoric acid the case is similar. In many low grade phosphates it costs the buyer twice or more than twice as much as he would pay for it in the higher grade wares.

And what is worse than all this, positive frauds are continually practiced by unscrupulous sellers who palm off inferior or worthless stuffs upon our farmers as pure and high grade fertilizers. And it is often impossible, from their appearance alone, to tell the good from the bad.

And finally the best artificial fertilizers often fail because they are not properly applied.

The reason of these facts is simple. Our farmers do not

know, and they have only too little means of learning what fertilizers to select, and when, and where, and how to use them.

WHAT IS THE USE OF COMMERCIAL FERTILIZERS?—PLANT FOOD.

Plants, like animals, require food for life and growth. A part of the food of plants is supplied from the atmosphere, the remainder is derived from the soil. No ordinary cultivated plant can thrive without a sufficient supply of each of a number of substances needed for its food. With an abundance of all of these, in forms in which the plant can use them, and with other circumstances favorable, the plant will flourish and the yield be large. But if the available supply of any one of them be too small, a light yield is inevitable. For instance, *potash* is an *essential ingredient* of the food of plants. If all the other conditions for a profitable crop of corn or potatoes, or other plants are fulfilled in the soil, except that potash is deficient, the crop will inevitably fail. But if the potash be supplied, the yield will be abundant. The chief use of fertilizers is to supply the plant-food which the soil lacks.

A SHORT LESSON IN CHEMISTRY.

TO BE CAREFULLY STUDIED.

Vegetable and animal substances, and manures and soils as well, contain, besides WATER, two kinds of materials, the so-called "ORGANIC MATTER" and the MINERAL MATTER" or ASH. By keeping a wisp of hay or a bone for a time in a hot oven, the water may be driven out. If the dried material be put in the fire the organic substance will be burned away and escape as gas or smoke, while the mineral matter will be left as ashes.

THE ORGANIC MATTER consists chiefly of the four chemical elements CARBON, OXYGEN, HYDROGEN, and NITROGEN. We are familiar with Carbon in charcoal and lamp black, which are nearly, and in diamond which is quite pure Carbon. Hydrogen and Oxygen united form water. We do not need to trouble ourselves about these in fertilizers because they are supplied to the plant in abundance by the atmosphere and the soil, through the leaves and through the roots. But the

NITROGEN

is an important ingredient of fertilizers. It is, in its pure state, a gas, and makes up about four-fifths of the air. Combined with hydrogen it forms AMMONIA; combined with oxygen it is known as NITRIC ACID. In these and other combinations it occurs in minute quantities in the atmosphere, and in considerable quantities in soils and manures. Plants are unable to make use of the pure nitrogen of the air, though some, if not all, absorb a very little combined nitrogen from the atmosphere. By far the largest part of the nitrogen of plants is absorbed from the soil through the roots. From the facts that nitrogen is available to plants only in certain combinations, that it is slow to form and easily leaves these compounds, that it readily escapes from manures and soils into the air and is leached away by water, it is one of the most commonly deficient and hence the most costly ingredients of the food of plants.

THE MINERAL MATTER OR ASH

of plants is derived entirely from the soil. It consists of several ingredients, known as Potash, Soda, Lime, Magnesia, Iron, Silica, Sulphuric Acid, Phosphoric Acid, and Chlorine. Of these, POTASH is dissolved and leached out of ashes by water, and is the chief ingredient of the lye thus produced. LIME is well known to us, though not in a chemically pure form, in ordinary quick-lime. SULPHURIC ACID is familiarly known in the form of oil of vitriol. Combined with lime it forms SULPHATE OF LIME or Plaster.

PHOSPHORIC ACID SOLUBLE AND INSOLUBLE. PHOSPHATES AND SUPER-PHOSPHATES.

Lime combined with Phosphoric Acid forms Phosphate of Lime, which is the chief constituent of the mineral matter of bones and of the South Carolina, Navassa, and other mineral Phosphates. There are several different compounds of Phosphoric Acid and Lime. The one which occurs in bones and mineral phosphates is called "Bone phosphate of lime." The ordinary phosphate of lime, or bone phosphate, is not

easily dissolved in water, and is likewise but very slowly available to crops as food. The reason of this is simple.

The plant may be said to live, not by eating, but by drinking. That is to say, the roots absorb food from the soil not in solid particles, but after it has been dissolved. The plant food is dissolved by the water in the soil and absorbed in solution by the roots of the plant, just as the sugar dissolves in our coffee before we drink it.

In order, then, that the ordinary phosphate of lime may be available as food to the plant, it must be changed to a soluble form. This alteration goes on slowly in the soil. The same result is quickly effected in the manufacture of *Super*-phosphates, by treating the "bone phosphate" with sulphuric or other acid. In this process the sulphuric acid takes away part of the lime from the "bone-phosphate" and forms with it sulphate of lime. The compound of phosphoric acid and lime which has thus lost part of its lime is called *Super-phosphate of lime*, and is soluble in water. According as more or less sulphuric acid is used, more or less of the *Insoluble Phosphoric acid* of the "bone-phosphate" becomes the *Soluble Phosphoric acid* of the *Super-phosphate.*

The other substances which plants remove from the soil and fertilizers supply, are also found in compounds sold in every drug-store, and in constant use in our daily life. Magnesia occurs combined with sulphuric acid, as sulphate of magnesia in Epsom Salts. Glauber's Salt is a sulphate of soda. Soda is a compound of the metal sodium with oxygen, just as potassa or potash is a compound of the metal potassium with oxygen. If sodium be combined with chlorine instead of oxygen, we have chloride of sodium, which we know by the name of salt, and use to give flavor to our food, and to preserve our meat. So potassium combines with chlorine to form Chloride of potassium, which is largely used as a fertilizer under the name of Muriate of Potash. Silica occurs pure in quartz or "rock crystal," and is the chief constituent of sand and many other minerals.

When we have learned what substances the plant takes from the soil, the next question is whether these are all nec-

essary to its growth. If it cannot flourish without an abundant supply of each one of the whole list, and if these are not resupplied by atmosphere and soil as they are removed by crops, then they must be restored in manuring or the crops will fail. But if any of them are not essential to the growth of plants we need not trouble ourselves about that one in manures.

THE ESSENTIAL INGREDIENTS OF THE FOOD OF PLANTS.

The following is a concise summary by Prof. S. W. Johnson, of the results of a vast amount of accurate and laborious experimenting on the nutrition of plants, performed for the most part in the European Experiment Stations, in order to discover what are the necessary ingredients of the food of plants.

"In regard to the food of plants, it has been settled that potash, lime, magnesia, iron, phosphoric acid, and sulphuric acid must be furnished to all agricultural plants through their roots and by the soil, in order to their growth. It has also been shown that soda, silica, and chlorine are not needful for the early growth of grain crops, but that chlorine is essential for the perfection of the seed, and that silica is probably necessary to uniform blossoming and ripening. It is further proved that water must enter crops through their roots; that carbon, which constitutes more than half their weight, is superabundantly furnished by the air; that air and water together yield the materials out of which fully ninety to ninety-eight per cent. of crops is built up; and that the soil has to give for their nourishment but the two to eight per cent. of mineral matters which remain as ashes when they are burned, and the one-half to two per cent. of nitrogen which they also contain. It is likewise definitely settled that nitrates in the soil are the chief natural source of nitrogen, while the ammonia of manures, as well as a variety of substances containing nitrogen, and found in urine or formed in the decay of dead animals, likewise supply vegetation with nitrogen."

NATURAL STRENGTH AND EXHAUSTION OF SOILS. AVAILABLE PLANT FOOD.

Crops take from the soil then, the materials needful for their growth; and these are rightly called "plant-food." Some soils yield large crops, many years in succession, without manuring. They do this because they contain large stores of the ingredients of plant-food, as potash, lime, nitrogen, etc., and because these are furnished in available forms, so that the plant can readily use them. Most of the plant-food in our soils is, so to speak, locked up in coarser or finer fragments of rocks and in partly decayed vegetable matter. In what is commonly called "weathering," these mineral and vegetable substances undergo certain chemical changes, which set free the lime and phosphoric acid and potash and other ingredients of plant-food, and change them to such forms that they may be dissolved in the water of the soil, and absorbed by the roots of the plants. There are some soils that have a very great natural strength. That is, they not only contain very large stores of plant-food, but by weathering or otherwise, new portions are made available as rapidly as the older ones are removed in cropping. The famous "black-earth" soils of Southern Russia, are of this sort, and there are lands in this country from which good crops of corn and wheat have been taken regularly for many years without manuring. But these soils are exceptions. As a rule, after cropping for some time, the point is reached where the natural re-supply of plant-food is insufficient to produce large crops. In other words, in the so-called "poor," "worn-out," or "exhausted" soils, the natural strength is insufficient for profitable production.

WHAT MATERIALS ARE LACKING IN POOR AND "WORN-OUT" SOILS?

In order to know what fertilizing materials to use on such soils, we must know what ingredients of plant-food are deficient, and what manures will best supply them. An idea of the essential ingredients of plant-food removed from the soil in cropping, may be obtained from the table below, which is copied, with slight alterations, from a lecture by Prof. S.W.

Johnson, in the report of the Connecticut Board of Agriculture for 1871. The crops are supposed to be grown upon, and removed from a given area of land, as, for instance, an acre.

TABLE 1.

Materials Removed from the Soil by Various Crops.	Sulphuric acid.	Phosphoric acid.	Lime.	Magnesia.	Potash.	Nitrogen.
TOBACCO.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Leaves, 1,800 lbs., 1,260 lbs. dry,	14	7½	73	17	71	49
Stalks, 1,100 lbs. dry,	3	15	15	2	47	33
Total,	17	22½	88	19	118	82
RYE.						
Grain, 32 bushels—1,800 lbs.,	1	15	1	3½	10	32
Straw, 3,800 lbs.,	3	7	12	5	29	9
Total,	4	22	13	8½	39	41
INDIAN CORN.						
Grain, 76 bushels—1,200 lbs.,	1	23	1½	7½	14	67
Stalks and leaves, 8,000 lbs.,	20	30½	40	21	133	38
Total,	21	53½	41½	28½	147	105
HAY.						
2¼ Tons,	2	23	43	18½	96	73
POTATOES.						
Tubers, 300 bushels,	11	32	4	7	101	58

Large quantities of Silica, and small quantities of Soda, Chlorine, and Iron are also removed from the soil by every crop. Iron is necessary to the growth of all agricultural plants, but in very minute quantity. In many cases small amounts of chlorine seem to be requisite. Silica, if needed at all, which is quite doubtful, is required only in extremely minute proportions. Soda does not appear to be an essential ingredient of plant-food. In so far as these latter are *essential* ingredients of plant-food, they are furnished in abundance by every ordinary soil.

For our present purposes, therefore, we have to consider

only the *Potash*, *Lime*, *Magnesia*, *Sulphuric acid*, and *Nitrogen*. Of this list the magnesia is commonly, though not always, supplied in sufficient quantities in even "worn-out" soils. Sometimes its presence in fertilizers may be of considerable importance to crops. Sulphuric acid and Lime are more often deficient, and hence one reason of the good effect so often observed from the application of lime and plaster. The remaining substances, the *Nitrogen*, *Phosphoric Acid*, and *Potash*, are the most important ingredients of our common commercial fertilizers, because of both their scarcity in the soil and their high cost. It is in supplying these that guano, phosphates, and bone manures are chiefly useful. It should be borne in mind however, that more or less of the good effect of fertilizers is due to their *indirect* action in rendering stores of food, already present, or otherwise supplied to the soil by the atmosphere, available to crops. This is more or less true of those just mentioned, and is especially true of lime, common salt, magnesia compounds, and plaster, which latter, it will be remembered, is composed of sulphuric acid and lime. The sulphate of lime which is formed in superphosphates by treatment of bone phosphates with sulphuric acid, is doubtless, in many cases, a most efficient, and perhaps, sometimes, the most efficient part of the fertilizer.

How much of the different ingredients of plant-food which our soils are most apt to lack, is supplied by different fertilizers, is shown by the

CHEMICAL ANALYSIS OF FERTILIZERS.

The table below, with the explanations which follow, will perhaps be useful to those who are not familiar with the ways of estimating the value of fertilizers from analyses.

The articles mentioned were all, with the exception of the English superphosphate, bought and used last spring in considerable quantities by farmers in Connecticut. The samples were, with the same exception, furnished by the officers of the Middlefield and Westfield Farmers' Club. The numbers are those attached to the specimens as they are received at the laboratory.

TABLE 2.

Ingredients Contained in 100 lbs. of Fertilizer.	NAMES OF FERTILIZERS.				
	No. 52.	No. 16.	No. 15.	No. 19.	No. 6.
	High grade English Superphosphate.	Guanape Guano.	Ammoniated Superphosphate.	Double Refined Poudrette.	"Superphosphate of bone."
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Water (Moisture),	8.5	16.6	21.7	4.2	10.1
Organic and Volatile Matters,	26.7	42.3	24.8	17.3	14.8
Phosphoric Acid,	32.0	17.5	14.0	2.2	2.6
Sulphuric Acid, Lime, and other Matters, not separately estimated,	32.8	23.6	35.9	13.2	25.3
Sand, etc.,	None.	None.	3.6	63.1	47.2
	100.00	100.00	100.0	100.0	100.0
Valuable Fertilizing Ingredients in the above.					
Nitrogen in Organic Matter,	None.	9.37	1.67	1.41	1.02
Ammonia equivalent to Nitrogen,	None.	11.38	2.03	1.71	1.23
Phosphoric Acid, soluble,	23.3	5.8	9.9	None.	None.
" insolnble,	8.7	11.7	4.1	2.2	2.6
" Total,	32.0	17.5	14.0	2.2	2.6
Bone Phosphate of Lime equivalent to total Phosphoric Acid,	69.85	38.8	30.6	4.8	5.7
Retail price per ton,	$61.00	$60.00	$42.50	$25.00	$55.00

MEANING OF THESE ANALYSES.

The Water is that which dries out on heating. No. 16 has 16.6 per cent. or 16½ lbs. in every 100 lbs. of the fertilizer. No. 19 has only 4 per cent. The percentage of water in a fertilizer is a matter of considerable consequence. The larger the amount of water the less the other matter, and vice versa.

The Organic and volatile matters are those which may be burned off after the water is removed. They are the so-called "*animal and vegetable matters*," * and contain the *Nitrogen* of these fertilizers.

* The volatile matters include, however, in some cases, water or other materials which are not removed in heating to 100–110 Centigrade.

If the ash which remains after drying and burning, be treated with strong acids, a portion will dissolve. This will include the *Phosphoric Acid*, the *Sulphuric Acid*, the *Lime*, and some other materials, as iron, alumina, and soda, whose proportions are not determined. The *Sulphuric Acid* and *Lime*, though valuable, are not sufficiently so to make them worthy of special account in analyses of high priced manures. The iron, alumina, etc., have no agricultural value.

SAND, ETC.—The residue, which resists the action of both fire and strong acids, consists of silica and other mineral matters. These possess no fertilizing value and are classified as *Sand*, etc. The Guanape Guano has practically none, while the Poudrette has 63.1 per cent., or 1262 pounds of *these worthless* matters to the ton.

PHOSPHORIC ACID SOLUBLE AND INSOLUBLE.—As has been explained, the characteristic of a superphosphate is the soluble phosphoric acid which it contains. In some super-phosphates a part of the Phosphoric which has been rendered soluble by treating the original "bone phosphate of lime" with Sulphuric Acid, undergoes a change in chemical combination by which it becomes less soluble. The terms REVERTED, reduced, and precipitated, are applied to it, when in this form. The reverted phosphoric acid ranks in solubility, and consequently in value, between the Soluble and the Insoluble. The Soluble and the Reverted are sometimes classed together, as *Available* Phosphoric Acid.

In some analyses the percentage of phosphoric acid is not stated separately, that of "bone phosphate of lime" being given in its stead. Sometimes the expression "soluble bone phosphate of lime" is met with, which is certainly a misnomer. As was explained above, the phosphoric acid occurs in the form of bone phosphate in bones and most mineral phosphates; 100 parts by weight of phosphoric acid unite with about 118 parts of lime to form 218 parts of bone phosphate; 100 parts or pounds of phosphoric acid are said therefore to be equivalent to 218 parts of bone phosphate. We lay especial stress on this point because those not familiar with chemistry are apt to be deceived in comparing analyses in some of which the term phosphoric acid, and in others the term bone

phosphate is used. It would be more accurate and clear and in every way better to discard the term bone phosphate of lime in analyses of fertilizers, and speak only of phosphoric acid.

NITROGEN, AMMONIA.

In our ordinary fertilizers, much or all of the nitrogen exists in unavailable forms. By more or less rapid processes of decay in the soil these are changed to other compounds, of which ammonia is one, and which the plant can readily use as food. Fourteen parts by weight of nitrogen unite with three parts of hydrogen to form seventeen parts of ammonia. Accordingly, 14 parts of nitrogen are said to be equivalent to 17 of ammonia, or what is the same thing, 100 parts of nitrogen are reckoned as equivalent to 121 parts of ammonia. In pure sulphate of ammonia, all of the nitrogen is in the form of ammonia. In Peruvian guano, some of the nitrogen exists as ammonia also. In our other ordinary fertilizers, there is little or no ammonia. The very common practice of reckoning nitrogen as ammonia in fertilizers which do not contain it in this form is incorrect, misleading, and therefore wrong.

The amounts of phosphoric acid and nitrogen in the above fertilizers (which contain no considerable amounts of potash,) will appear very clearly if we state, instead of the percentages, the number of pounds in the ton. No. 15 for example, with 9.94 per cent. of soluble phosphoric acid would furnish [9.94x20] 199 pounds to the ton, and so on, as below:

NAMES OF FERTILIZERS.	POUNDS OF VALUABLE INGREDIENTS IN A TON.			
	Number.	Phos. Acid Soluble.	Phos. Acid Insoluble.	Nitrogen.
English Superphosphate, - - -	53	465.6	173.4	.....
Guanape Guano, - - - - -	16	115	233.8	187.4
Ammoniated Superphosphate, - -	15	199	82.0	33.4
Double Refined Poudrette, - - -	19	.....	44.4	28.2
American Bone Fertilizer, - - -	6	.....	52.2	20.4

VALUATION OF COMMERCIAL FERTILIZERS.

The *agricultural value of a fertilizer*,—the gain which will result from its use in a given case,—is subject to such varying conditions of soil, climate, culture, and crop, as to preclude the possibility of exact estimate. The *commercial value*, being dependent upon its composition and the state of the market, admits of more nearly correct calculation.

It is customary to make estimates of the commercial values by attributing to each of the important ingredients a certain value per pound. Thus, Prof. Johnson, chemist of the State Board of Agriculture, in his last report, assumes for phosphoric acid, soluble, 15 cents; reverted, 10 cents; and insoluble, 6 cents per pound; and for nitrogen in bone, 20 cents, and in ammoniated superphosphates and guano, in which it is generally more available, 25 cents per pound. At these rates, the 199 pounds of soluble phosphoric acid in No. 15 for instance, would be worth [15 cents x 169] $29.85, and so on. Applying these figures to No. 15 we should have the following calculations for the estimated value per ton of 2000 pounds:

VALUATION OF "AMMONIATED SUPERPHOSPHATE," NO. 15.

	Per cent.	Lbs. in ton.	At cts. per lb.	Valuation.
Phos. Acid, soluble,	9.94	199.	15	$29.85
" insoluble,	4.10	82.	6	4.92
" nitrogen,	1.62	33.4	25	8.35
				$43.12

The table below gives the values as thus calculated, together with the selling prices.

NAME OF FERTILIZER.	CALCULATED VALUES AND SELLING PRICES PER TON.					
	Number.	Phosphoric Acid soluble.	Phosphoric Acid Insoluble.	Nitrogen.	Total Calculated Value.	Selling Price.
English Superphosphate, - -	53	$69.84	$10.40	.....	$81.84	$61.00
Guanape Guano, - - -	16	17.25	14.03	$46.85	78.13	70.00
Ammoniated Superphosphate, -	15	29.85	4.92	8.35	43.12	42.50
Double Refined Poudrette, -	19	.....	2.66	7.05	9.71	25.00
American Bone Fertilizer, -	6	.....	3.13	5.08	8.21	55.00

As Prof. Johnson has indicated, this method of estimating the values of fertilizers is not in all respects satisfactory. We are by no means prepared to say that in the fertilizers in the above table, six cents per pound for phosphoric acid, and twenty-five cents per pound for nitrogen, are correct valuations in Connecticut at this time. That these prices, if just for one case, can not be so for all, must be evident on a moment's reflection. The nitrogen in nitrogenous superphosphates, for instance, is derived from various materials. In some, as dried blood, it is very readily, in others, as leather scraps, it is slowly available to crops. A pound of nitrogen costs the manufacturer more, and is worth more to the farmer in dried blood than in leather. So, likewise, a pound of insoluble phosphoric acid is more valuable in Peruvian guano or in steamed and finely ground bone than in coarse, raw bone, and it is worth more in the last than in Navassa or South Carolina phosphates.

The prices here assumed are, as a whole, rather high for the present state of the market. When any farmer can obtain nitrogen at from eighteen to twenty cents per pound in Peruvian guano, and at not far from twenty-two to twenty-three cents per pound in dried blood, meat scraps, and the best nitrogenous superphosphates, twenty-five cents per pound would seem to be a high valuation. Fifteen cents per pound is likewise high for soluble phosphoric acid. It is offered in superphosphates prepared from South Carolina phosphates at 11½ cts. per lb. For insoluble phosphoric acid, six cents per pound in Peruvian guano and in steamed and finely ground bone-dust is doubtless low. For coarse raw bone, it is probably too high. For insoluble phosphoric acid in South Carolina, Navassa, and other fossil and mineral phosphates, a just valuation would probably not exceed four cents per pound.

Any scale of valuations which does not recognize the difference in value of the same ingredient in different combinations, must be imperfect from the commercial, and still more so from the agricultural, stand-point. A schedule of prices which shall recognize this difference and approach as nearly as practicable to just estimates, is a great desideratum. With our

limited experience, we do not at present feel warranted in assuming a new scale of valuations, but adhere to that already in use in the State, swerving from it only in so far as to rate insoluble phosphoric acid in fossil and mineral phosphates at four cents, for potash as sulphate eight cents, and as chloride six and one-quarter cents per pound.

Reserving the further discussion of this topic for a future occasion, allow me to call attention to another method for comparing these fertilizers one with another, and one which is open to less objections.

Assuming *ratios* of value in accordance with the scale mentioned, and applying these with the selling prices to the analytical results above, by a process analagous to what is known in arithmetic as alligation, the following figures are deduced for the actual costs of the valuable ingredients per pound.

NAMES OF FERTILIZERS.	ACTUAL COST PER POUND, IN CENTS, OF THE VALUABLE INGREDIENTS OF THESE FERTILIZERS WHEN BOUGHT AT PRICES STATED.			
	Number.	Phos. Acid Soluble.	Phos. Acid Insoluble.	Nitrogen.
		Cts.	Cts.	Cts.
English Superphosphate, - - -	53	11.5	4.6	....
Guanape Guano, - - - - -	16	12.3	5.3	22.0
Ammoniated Superphosphate, - -	15	14.8	5.9	23.8
Double Refined Poudrette, - - -	19	....	15.5	64.5
Superphosphate of Bone, - - -	6	....	40.0	167.0

HIGH AND LOW PRICED FERTILIZERS.

The above table is worthy of most careful study. The soluble phosphoric acid of No. 53 costs 11½ cents, and of No. 15, 14⅘ cents per pound. The insoluble acid varies from 4⅜ to 40 cents per pound. And while a pound of nitrogen costs 22 cents in the guano, in the poudrette it costs 64½ cents.

In the table of analyses at the end of this article, the cost of valuable ingredients in a large number of fertilizers sold in Connecticut is given as calculated upon this plan. Taking the table through, the nitrogen varies from 15 cents to $1.67 per pound. In nitrogenous superphosphates, it runs from 22¾ to 44½ cents. It is often least costly in the forms in which it is most valuable.

A curious and instructive instance of this variation is found in Nos. 120 and 102. The nitrogen in No. 120 is stated by the manufacturers, and without doubt truthfully, to be furnished in dried blood and bone. That in No. 102 is from dried blood, bone, and meat. The nitrogenous material is practically the same in both. The nitrogen in No. 120 costs 42½ cents and that of No. 102 only 21⅝ cents per pound.

Now the good, sensible farmers of Connecticut know very well whether or not to give forty-two cents a pound for coffee, when they can get an equally good article for twenty-one. No one of them will pay a given price for cloth of a given manufacture, when he can get it of another manufacture and just as good or better for a price one-half or three-fourths or seven-eighths lower. If he were obliged to take his cloth and coffee so done up in packages that he could not get access to them to judge of their quantity or quality; if he were obliged to select on the strength of general experience, or at hap-hazard, he would have to be content to take his chances with the articles as they came. But if the opportunity came to learn what the goods actually were, would it not be wise in him to accept it, and select those which were best and cheapest? And when dealers found that he and his neighbor were buying in that way, would not a competition ensue based upon goodness of quality as well as lowness of price? and would not this competition be a healthy one for all concerned?

Such a comparison as the above is fair, as far as it goes, for the better class of fertilizers, but it fails to meet so aggravated a case as that of the poudrette. Here the buyers not only paid 15½ cents for every one of the few pounds of insoluble phosphoric acid, and 64½ cents for each pound of nitro-

gen, but with every ton of the fertilizer they put on their land, they had to haul and handle 1,262 pounds of sand and the like, which neither fire will burn nor the strongest acid dissolve, and a quantity of fragments of wood and coal, and other equally worthless material besides.

There are many soils in Connecticut in which readily available nitrogen is so useful that the 1½ per cent. in the poudrette will stimulate the early growth of some crops enough to encourage farmers to use even such a fertilizer. "Just a little of it in the hill at planting time will not hurt the crop a bit and will sometimes start it off remarkably." But would it not be better to get the nitrogen at from 18 to 25 cents per pound in guano, dried blood, fish, slaughter-house refuse, sulphate of ammonia, or nitrate of soda, and soluble phosphoric at from 12 to 15 cents per pound in high grade superphosphates—and carry home as much in a couple of bags under the seat of a single wagon as would be contained in a ton of the poudrette, leaving the 1,300 pounds of sand and brick and coal and wood behind, and cost of freight and hauling with them, to compost the concentrated materials with loam, or better, good rich muck, and thus get a fertilizer which would not be strong enough to hurt the crops, yet would start them along as well as the poudrette, and would not cost half as much?

No. 6 of the table is a very good example of

FRAUDS IN FERTILIZERS.

Two samples of this have been received from farmers in this vicinity, who state that it was sold and used in considerable quantities last spring, in this and adjoining towns.* It was called the "American Bone Fertilizer," aud was represented by the agent to be a "first-class superphosphate," "equal to Peruvian guano," an excellent fertilizer for tobacco, corn, and other crops. No perceptible benefit appearing from the use, samples were brought to the station for analysis.

The two specimens, taken from lots used by two different farmers, showed essentially similar composition. The best

* Before the establishment of the Station.

superphosphates contain from 12 to over 20 per cent. of phosphoric acid, of which from 6 to 12 per cent. or more is soluble. This contained a trifle over 2½ per cent., of which no appreciable quantity was soluble. A good quality of Peruvian guano will contain 8 per cent. or more of nitrogen. This article contains 1 per cent. The best guanos and superphosphates contain from none to 8 per cent. of sand, etc. This contained 47.2 per cent. or 947 pounds to the ton. It has the appearance of salt-marsh muck mixed with sugar house scum, the latter a material of little agricultural value, which is sold in New York, as we are informed, at $5.00 or thereabouts per ton. The estimated value was $8.23 per ton. That is to say, the valuable ingredients furnished by one ton of this fertilizer could have been bought for $8.23 or less in any of the best phosphates, or bone manures, or guanos sold in the State. It was sold at $55.00 per ton, a discount being made from $60.00, "to introduce the article."

The parties furnishing the samples state that Messrs. Birchall & Chapman of Port Morris, N. Y., claim to be the manufacturers, that it was sold to them by a person named W. B. Knapp, who represented himself as a sub-agent and I. N. Leonard of Elizabeth, N. Y., as general agent, and that the latter person has also visited them in this capacity to recommend the article, and attend to the collection of the bills. The truth of these statements is amply confirmed both by the character of their authors and by documents bearing the names and signatures of the manufacturers and sellers.

We are informed that, upon receipt of the results of the analyses of the American Bone Fertilizer, the purchasers who had not paid for the article very justly refused to do so. In view of the fact that the sellers, should they appear in the State, are liable to prosecution and fine for violation of the State law which required that fertilizers offered for sale in the State shall be accompanied by a "correct analysis," a suit on their part to recover payment is hardly to be anticipated.

As has been said, all the articles mentioned in the preceding Tables except No. 53, were sold and used in considerable quantities last spring by farmers living within five miles of here.

At that time some analyses were being made at our laboratory of fertilizers bought of a prominent New York house who have always sold their wares with guarantee of composition. In reply to a suggestion that they should import some of the high grade English superphosphates, which they afterwards did, (No. 53,) they inquired whether the farmers of the State "were educated up to the point where they would give the preference to such articles."

The following brief statements will answer in part at least, some of the numerous inquiries received at the station, which have not been answered in the preceding. For composition and value of articles mentioned, see table at the end of this pamphlet.

BONE MANURES.

The fertilizing value of bone is due largely to the phosphoric acid, and, in a less degree, to the nitrogen which it contains. Bones contain besides a small quantity of WATER, two kinds of material, the so-called "ORGANIC MATTER," which contains Nitrogen, and may be burned away, and the "MINERAL MATTER," or Ash which remains after burning.

The mineral matter consists chiefly of PHOSPHATE OF LIME, a compound of PHOSPHORIC ACID and LIME, and contains also a small quantity of carbonate of lime and other compounds. Bone fertilizers, even when unadulterated, contain also more or less of materials insoluble in acids, which are classified as SAND, etc. Among materials said to be used for adulterating bone are lime, (often from oyster shells,) plaster (sulphate of lime), and salt-cake or niter-cake (an impure sulphate of soda, containing some common salt). Some manufacturers, however, make no secret of adding salt-cake to bone which has been boiled to extract the fat, it being useful to dry the fertilizer and prevent putrefaction. When plainly stated this cannot be called fraudulent. The composition of some of our bone manures is illustrated by the following table.

COMPOSITION AND VALUATION OF BONE MANURES.

TABLE 3.

INGREDIENTS.	No. 77.	No. 94.	No. 96.	No. 107.
Moisture,	9.66	7.00	16.05	12.37
Organic or Animal Matter,*	42.19	33.25	27.35	39.98
Phosphate of Lime,†	46.32	51.54	31.93	27.02
Other Mineral Matters,	1.83	8.26	24.67	20.63
	100.00	100.00	100.00	100.00
†Containing Phosphoric Acid,	21.22	23.61	14.62	12.38
*Containing Nitrogen,	3.38	3.88	2.36	3.99
Estimated Value, per ton,	$38.98	$43.85	$26.68	$30.81
Selling Price, "	‡48.00	33.00	35.00	47.50
Actual cost of Phosphoric Acid, per lb.,	7⅔ cts.	4½ cts.	7½ cts.	9½ cts.
" " Nitrogen, "	24½ cts.	15 cts.	26 cts.	30¾ cts.

No. 107 is claimed by its name "Dissolved bone," to be a superphosphate, but contains no soluble phosphoric acid, and is therefore not a "dissolved bone" at all.

Comparing 94 and 96, which are very good examples of high and low grades of ground bone, we notice that the amounts of water are very different in the two articles, No. 94 containing 7, and No. 96, 16 per cent. The greatest differences appear in the "Phosphate of Lime," 51½ per cent. in No. 94 and 32 per cent. in No. 96, and other mineral matters 8¼ and 24⅓ per cent. The percentages in 94 are very favorable, and indicate a quite pure article. But 31.2 per cent. of Phosphate of Lime in No. 96 is too little, and 24⅔ per cent. of other mineral matters is too much for a pure bone.

The values are calculated in the manner described above, page 382, insoluble phosphoric acid being assumed to be worth six cents, and nitrogen twenty cents per pound. On this basis of valuation No. 94 is worth $10.85 more, and No. 96 $8.02 less, per ton, than the selling price. The estimated value of No. 96 is only three-quarters of the price charged.

‡ In accounts received this is implied, but not definitely stated, to be the price of this article in Connecticut.

As has been stated, this method of estimating the values of fertilizers is not in all respects satisfactory. We are by no means prepared to say that six cents per pound for insoluble Phosphoric acid, and twenty cents per pound for Nitrogen in bone manures, are correct valuations in Connecticut at this time. These prices are, doubtless, not far from just. That they cannot be exactly so for all cases, is clear from a comparison of different articles. Some contain a great many coarse lumps of bone, as large as a pea or larger, the amount of really fine material being comparatively small. In others, fragments as large as a grain of wheat are rare, and much of the material is as fine as ordinary corn meal. The large lumps would lie in the ground for years before they would decompose and their phosphoric acid and nitrogen be rendered available as food to the plant. But the fine bone-dust could be more uniformly diffused throughout the soil, and quickly used by the crop, and thus bring a much speedier return for the money it costs. In rates of valuation current in Germany, where these subjects have received much more attention than with us, nitrogen in coarse raw-bone is reckoned at about 12½ cents per pound, while in a steamed, finely powdered bone dust it is rated at about 21 cents per pound.

There is a common, but erroneous impression that steamed bone is less valuable than raw bone. It is true that in the process of boiling or steaming bones to remove fats, or "grease," there is also some loss of nitrogen, but as the total weight is decreased without any considerable loss of phosphoric acid and but little loss of nitrogen, the percentages of these are found in practice not to vary greatly from those in pure bone. The steamed bone is left in a very friable condition, so that being more easily ground, it is usually much finer, and much more quickly available to plants. In brief, fine bone is much more valuable than coarse, and steamed than raw, because they are more quickly decomposed, and therefore bring a quicker return for the money invested. The effect of finely ground steamed bone may not be manifest during more than three or four years; while that of coarse fragments of raw bone will be much less marked but may

last a life time. Most of the phosphoric acid will remain in the soil until removed by plants; but much of the nitrogen will, after a time, leach out in drainage water, or escape into the air.

No. 77 is a very good example of a fine steamed bone, as No. 94 is of a rather coarse raw bone. Each is excellent of its kind, and they afford a very good illustration of the fact already referred to, that the estimated values do not represent agricultural values. Reckoning phosphoric acid at 6 cents, and nitrogen at 20 cents per pound, the fine steamed bone foots up $38.98, and the coarse raw bone, $43.85 per ton. At the same time the valuable ingredients of the steamed bone are much more available than in the other, and really worth more. No. 77 is, in fact, from the agricultural standpoint, without doubt, the most valuable specimen we have yet analyzed. If valuations current in Germany, and based upon the best European experience be correct, the farmer who wants quick returns for the money invested could as well afford to pay $48 per ton for this, as one-fourth or possibly one-third less for the very coarse grades of raw bone.

Where permanent results are desired, and slow action will suffice, the coarse raw bone may be used to advantage, particularly if obtained at prices enough lower to make up for interest on capital invested. In general the higher grades of these bone manures are the cheapest. They should contain from 20 to 23 per cent. of phosphoric acid, and 3½ to 4 per cent. of nitrogen.

We are informed that the manufacturers of No. 96 (Lister Bros., of Newark), state freely that they mix salt-cake, or niter-cake, with their ground bone. In eight samples of their bone manures examined by Prof. Johnson (Report of Conn. Board of Agriculture, 1873) the quantities of matters dissolved by water, chiefly soda-salts [salt-cake or niter-cake], were found to vary from 17 to 32 per cent. The calculated values of these samples varied from $18.76 to $32.84 per ton, ranging from $7.16 to $18.20 below the selling prices. It should be said in favor of these manures, however, that they are for the most part quite finely ground, and their mechan-

ical condition is good, while the salt-cake is doubtless not without value in rendering other materials available or aiding in their distribution through the soil. They have the appearance of having been either thoroughly boiled or steamed, and their phosphoric acid and nitrogen would doubtless be much more readily available than those of Nos. 94 and 107.* This is another of the cases in which the estimated values do not express correctly the relative agricultural values, and the estimated cost of the individual ingredients per pound, afford more just means of comparison. Still we must say of our analytical results, as Prof. Johnson does of his own, that "the figures demonstrate in the most striking manner the loose way in which the traffic in fertilizers is conducted, and show the necessity of basing transactions upon chemical analysis, if consumers expect to get the worth of their money."

This latter fact is illustrated in the most clear and decisive manner in the estimated costs of the nitrogen and phosphoric acid per pound in the manures of the table on page 384. Nos. 94 and 107 were both raw bone, the latter being the finer of the two. But the nitrogen in No. 107 costs 30¾ cents per pound, and in No. 94 only 15 cents per pound. The phosphoric acid costs also about twice as much in the 107 as in 96.

In choosing between such articles as Nos. 77, 94, and 96, the buyer should consider whether he can better afford to pay for nitrogen and phosphoric acid, respectively 25 and 7 cents per pound for those in the fine steamed bone whose action will be quicker, or 15 and 4½ cents in the coarse raw bone in which they will become available more slowly. In deciding whether he shall select such articles as No. 96 or not he has still another problem to solve; namely, whether or not the salt-cake, 150 to 300 pounds or so to the ton, by Prof. Johnson's figures, and our own, is worth enough to him to pay for its own handling and that of the extra amount of water, say from six to 12 per cent., or 120 to 240 pounds to the ton, which they contain.

* Four samples of these manures were found to contain each a small amount of soluble phosphoric acid, the percentages varying from 1 to 1⅞ per cent. not enough to be worthy of special account in the table.

FISH MANURES

are chiefly valuable as sources of nitrogen, though they contain considerable phosphoric acid also.

Several samples of fish guano, but only two of fish scrap, have been received for investigation. Analyses of a number are given in the final table.

The composition of fish scrap is quite variable, particularly in the percentages of moisture and nitrogen. No. 131 of the table was considered by farmers in this region as a fair average article, except that it was much drier than ordinary. It contained about 25 per cent. of moisture, 7½ per cent. of phosphoric acid, and 5½ per cent. of nitrogen. Taking phosphoric acid at 6 cents, and nitrogen at 20 cents per pound, the calculated value would be $30.93. The price paid for it last year was $16.00 per ton, which would make the cost of the phosphoric acid 3.1 cents, and that of nitrogen 10⅓ cents per pound. No. 103 contained 41 per cent. water, 6¼ per cent. phosphoric acid, and 5⅛ per cent. nitrogen. The estimated value is $28.79. At $16.00 per ton the nitrogen would come to 11.1 cents, and the phosphoric acid 3.3 cents per pound. At $16.00 per ton, such articles as the above would furnish nitrogen and phosphoric acid at lower rates than any other fertilizers we have examined. At the present time, however, in some parts of the state at least, they could hardly be sold at that price.

PERUVIAN GUANOS

are ordinarily ranked as nitrogenous fertilizers, though they furnish phosphoric acid in considerable, and potash in small quantities. All these ingredients are in quite available forms. Peruvian guano as sold in our markets has been somewhat variable in composition, and farmers have complained of lumpiness, which renders uniform distribution in the soil difficult or impossible. The phosphoric acid, though more available than in many of our commercial fertilizers, is only partially soluble. Very fortunately for the users of this necessary article, Messrs. Hobson, Hurtado & Co., agents of the Peruvian Government for the sale of guano, have intro-

duced into this country the "Rectified" Peruvian guano, whose value is attested by a constantly increasing use in Europe for a number of years.

In the preparation of this article, lots of varying composition are mixed, treated with sulphuric acid and pulverized. Among the advantages of the Rectified guano are, that it has a uniform composition, that nearly all the phosphoric acid is soluble, the ammonia is converted into the sulphate, in which form it is not liable to escape as in natural guano, the mechanical operations involved give a finer texture, which permits a more even distribution, and finally the price is such as to furnish the valuable ingredients at lower rates than any other fertilizer containing them in equally valuable forms, which we have examined. In answer to numerous inquiries we can simply say to those who will use Peruvian guano, that the "Rectified," as guaranteed, is to be highly commended. It is sold with a guarantee of 8⅓ per cent. nitrogen (equivalent to 10 per cent. ammonia), 10 per cent. soluble phosphoric acid, and 2 per cent. potash.

POTASH—THE "GERMAN POTASH SALTS"

from the mines at Stassfurt, are at present the most important source of potash for agriculture. There are various grades of these, characterized by the amounts of potash and other ingredients they contain. The poorest grades contain as low as 7 or 8 per cent. of potash (potassium oxide), the highest 50 per cent. or more. Unfortunately a large part of the German potash salts imported into this country are of the lower grades.

The potash salts as taken from the mines contain comparatively little potash, and a good deal of other materials. They are subjected to chemical treatment by which more or less of other constituents are removed. As prepared for the market, they contain, besides compounds of potassium, common salt, and other materials of little agricultural value, including more or less chloride of magnesium. The lower grades of the manipulated salts have, of course, considerable of these latter compounds. The same is true of the unmanufactured

kainit. The chloride of magnesium is known to be injurious to plants. How much injury it does, if any, in the amounts and way in which it is ordinarily applied in the use of the low grade German potash salts, is not definitely settled. The higher grades have little or no chloride of magnesium, little common salt, and potassium compounds corresponding to 35 to 50 per cent. or more of potash.

It will be remembered that potash, or potassa, is the compound of the metal potassium with oxygen. This combined with sulphuric acid, forms sulphate of potash. Potassium and chlorine together form chloride of potassium, or "muriate of potash," as it is called by dealers.

By adding to ordinary potash lye from ashes a proper amount of sulphuric acid and boiling the liquid down, we might, with proper care, obtain a solid substance, which would be a sulphate of potash. If we were to use hydrochloric (muriatic) acid instead of sulphuric, we should obtain a chloride of potassium or muriate of potash. In some of the German salts the potassium is present as sulphate of potash, and in others as chloride of potassium. It is customary to reckon the potassium of these salts as "actual potash." In the sulphates this term expresses the amount of potassium oxide, potassa, or potash present. In the muriates it represents the amount of potash which the potassium would make if it were combined with oxygen instead of chlorine.

100 lbs. of pure sulphate of potash contains about 54 lbs. of "actual potash." 100 lbs. of sulphate of potash are therefore said to be equivalent to 54 lbs. of actual potash, and vice versa, 54 lbs. of potash in the sulphates are reckoned as equivalent to 100 lbs. of sulphate of potash. In the "muriates" 100 lbs. of chloride of potassium are reckoned equivalent to about 63 lbs. of potash and vice versa.

Of the German salts, the sulphates are, on the whole, preferable, but the potassium in these is more costly than in the chlorides. The chlorides sometimes injure the burning quality of the leaf of tobacco, and decrease the amount of starch in potatoes, and of sugar in sugar beets, while the sulphates are always safe; but for grains, grass, and other

fodder-crops, and for wet soils, the muriates are highly recommended. The potash in all these is soluble.

The potash salts are generally most useful when applied with phosphates and nitrogenous fertilizers. It is of the greatest importance that they be uniformly distributed through the soil before the seed is put in. It is well, therefore, to mix them with earth and apply either in the fall or very early in the spring, before planting or sowing.

In Germany, where the potash salts have come into general use, quantities corresponding to 200 to 500 pounds of the higher grades, and from 300 to 600 pounds of the lower grades to the acre are recommended.

Satisfactory accounts of the German potash salts thus far analyzed would require more space than the limits of the present article will allow. Our experience, however, justifies us in joining heartily with Prof. Goessman, State Inspector of Fertilizers for Massachusetts, in recommending, for chlorides, the high grades with from 80 to 84 per cent. of potassium chloride, equivalent to 50 to 53 per cent. of potassium oxide or "actual potash," and for sulphates the highest grades, which contain from 52 to 56 per cent. of sulphate, or 28 to 30 per cent. of potassium oxide, and have the additional advantage of furnishing considerable sulphate of magnesia, which latter compound, besides being useful as plant food, facilitates the diffusion of the potash through the soil. The high grade artificial kainit which may be obtained with 30 to 32 per cent. of sulphate of potash, is also to be recommended.

These articles may be obtained at prices such as to furnish actual potash at a little over 6 cents per pound in the chloride, and at about 8 cents per pound in the sulphates; these calculations being based upon the supposition that the other materials have no value. The low grades have been sold at such prices as to bring the potash at from 9 to 30 cents or more per pound. The cost for freight and handling of a ton of the low grade salts with 200 pounds of potash, is as great as for a ton of the high grade with 600 to 1,000 pounds of potash. Unless, therefore, the farmer wants a large quantity of common salt and magnesium compounds, and is willing to

pay for them, the high grades must, on this side of the Atlantic, be decidedly the cheapest.

The primary duty of the chemist is to make analyses and experiments, and to refrain from offering practical advice until his theories have a substantial basis of known facts. At the same time it may not be out of the way to offer a few suggestions for the thoughtful consideration of Connecticut farmers.

In saying that no plant can grow, no crop can flourish without an available supply in the soil of a sufficient quantity of each one of a certain list of substances needful for its food, and that the essential use of commercial fertilizers is to supply food which plants need and soils fail to furnish, we are simply repeating universally admitted facts. It is perfectly plain, then, that those commercial fertilizers will be most economical which, in one way or another, supply these lacking materials in the needed proportions, the best forms, and at the lowest cost.

We have, therefore, two most important problems to solve. First, what materials do our soils lack? second, by what applications of fertilizers or other means will their need best be supplied?

To answer either of these questions fully and definitely, is very difficult; the first, because of the difference in soils, and both because we do not know, and do find it slow work to discover definitely, the ways in which atmosphere and soils and fertilizers supply food, and plants use it.

It is sufficiently well settled, that nitrogen, phosphoric acid, potash, sulphuric acid, lime and magnesia are the only ingredients of plant-food which need to be supplied in fertilizers. The other materials, as iron, silica, and chlorine, which plants remove from the soil, are, in so far as they are necessary for plant-food, furnished in abundance by every ordinary soil.

Generally speaking, we may accept the opinion commonly held that magnesia may sometimes be lacking, that sulphuric

acid and Lime are more, and nitrogen, phosphoric acid and potash most apt to be deficient in our ordinary soils. In one soil one, in another, several or all of these may be wanting.

It was once thought that the chemical analysis of a soil would easily reveal its deficiencies in plant food. But later experience has shown this is at best a costly and defective source of information. Different samples of soil from the same field may vary widely in composition, and, what is a still greater difficulty, the chemical tests which make known the presence of a given ingredient in the soil, do not show whether it is in a form such that the plant can use it. And there are many processes of vital importance to the sustenance of the plant which are continually going on in the soil, but which the analysis does not reveal.

Most of our artificial manures are only special fertilizers. Guanos, phosphates, fish and bone manures and the like, contain more or less nitrogen, phosphoric acid, and lime; the superphosphates contain sulphuric acid, also. With the exception of some to which German potash salts have been added, very few of them contain any appreciable quantities of magnesia or potash. They supply part but not all the materials which soils may lack.

Many farmers find that guano, fish and other special fertilizers whose action is quick and stimulating, seem to leave their soil in a more exhausted condition than before they were applied. And the complaint is not uncommon that such fertilizers do not bring the same return as formerly.

May we not at least question whether the immediate effect of these special fertilizers has not been, in many cases, to aid the plant to use the more available stores of food in the soil, until these latter have become so far exhausted as no longer to respond to the stimulating action of the special manures?

If the above supposition be correct, it is clear that what such exhausted soils need, is something to supply, not only the nitrogen and phosphoric acid of the guano, or fish, or bone, or superphosphates, or other special fertilizers, but also the potash and other materials that these latter do not furnish.

Ashes are, for many soils, a standard fertilizer. Places

where a tree or a brush-heap has been burned, often show the effects of the manuring for years. It is a trite saying, that "The land never forgets ashes." Ashes supply directly all the soil ingredients of plant-food except nitrogen. Their indirect action is also, very likely, not unimportant in rendering other materials in the soil available. Instead of wearing out soils, they strengthen them. May not this difference be due, in part at least, to the fact that they furnish the other ingredients of plant-food that the guano and fish lack?

Stable manure furnishes all the ingredients of plant-food. It is a complete fertilizer. Farmers do not complain that it helps to exhaust their land.

There are soils which, by applications of nitrogen and phosphoric acid, in the form of guano, bone or nitrogenous superphosphates, may be made to bear good crops year after year. They supply of themselves the other materials needed. They have abundant stores of magnesia and potash, and so on, and by weathering, tillage, and the action of the fertilizing materials added, these are worked over from unavailable forms into those which the plant can use.

But such is not always the case. Among the exhausted and worn-out soils of New England, there are a great many which lack more than nitrogen, phosphoric acid, sulphuric acid, and lime.

This is very strikingly illustrated in the elaborate experiments of Prof. F. H. Storer, at the Bussey Institution, at Jamaica Plain, Mass. These were made upon what Prof. Storer calls "a very good representative of the light, leachy soils that overlie gravelly drift in New England. In these experiments, which continued through a series of years, different crops were raised with different manures, the same crop being grown with the same manure, on the same plot, year after year. Those raised with fertilizers containing nitrogen and phosphoric acid only, showed very little good effect from the manuring, while the potash compounds brought the most satisfactory returns. As Prof. Storer says, the "crying want" of this land was for potash. There are doubtless many such soils in Connecticut.

WHAT FERTILIZERS TO USE. A MATTER OF EXPERIENCE AND EXPERIMENT.

Some time ago, an intelligent farmer asked the writer which were the better fertilizers, phosphates or potash salts. The reply was, and I knew no better one, "potash salts, where potash is needed, phosphates, where phosphoric acid is needed, and nitrogenous manures, where nitrogen is needed. But if you do not know what your soil lacks, and want to make sure of a crop, and enrich your land at the same time, use your nitrogenous superphosphates, and German potash salts together. The former will furnish nitrogen, phosphoric acid, sulphuric acid and lime, the latter, potash and magnesia. Thus you will have a fertilizer with all that the plant needs, a complete manure. At the same time it is well to remember that you may feed your crops, not only directly by giving them these ingredients in guano, phosphates, potash salts, and so on, but indirectly by rendering stores of plant-food, present in the soil or atmosphere, available through tillage and the use of cheaper fertilizers. A little lime or plaster may sometimes be thus more valuable than an amount of phosphates or potash salts that would cost several times as much."

Stable manure is a complete fertilizer. It contains all the ingredients of plant-food, and its organic matter improves the mechanical condition of the soil besides. It is a standard fertilizer, and useful everywhere. By what artificial fertilizers this can be most profitably supplemented, is best learned by experience and experiment.

For farmers who have not their own experience, or that of others in like circumstances, to guide them, the most sensible plan would seem to be to try experiments on a small scale, with different trustworthy fertilizers of high grade. The ones that prove most satisfactory, can then be used with confidence, in large quantities. For instance, for nitrogen, dried-blood and sulphate of ammonia, or nitrate of soda, could be employed. Phosphoric acid would be furnished in high grade superphosphates, and potash in German potash salts. By mixing two or three of these together any desired combination, as phosphoric acid and nitrogen, phosphoric acid, nitro-

gen and potash, etc., could be made. It would be well for the sake of comparison, to use lime, plaster, and stable manure also, each kind of fertilizer being applied on a separate plot. Such parallel trials, particularly when repeated in successive years, with different crops, will give the surest indication of the needs of the soil and crops, and the best means to supply them. Should the plan meet with sufficient encouragement, the Station will arrange with some of the manufacturers whose wares are sold under its supervision, to have small lots of high grade fertilizers, such as suggested, put up in small packages, and sold at low prices, for experiments. Each lot of "experimental fertilizers" will be accompanied with descriptions and directions for experiment, so that the user may, by proper care, with comparatively little expense, test the special wants of his own fields and crops.

Such experiments have, at least, this much in their favor. They are entirely rational, and they have been approved, or rather, originally proposed by the best European and American students of Agricultural Science. To make them entirely satisfactory, will require more labor, and care, than many farmers will be inclined to devote, but in the long run would this not pay? And would not the instruction they would bring, be valuable, even to those who should not carry them out completely?

As has been shown, very few of our artificial fertilizers supply all the necessary ingredients of plant-food, and they are particularly deficient in potash. It seems to be well established, that potash is deficient in many soils in New England, as well as elsewhere. Some soils have a continued resupply from the decomposition of granitic or other rocks. These are, however, of limited extent. In lack of definite knowledge it is fair to presume that our common nitrogenous and phosphatic fertilizers would often be much more beneficial if potash were substituted for some of the phosphoric acid or nitrogen, and it is a serious question whether manufacturers of fertilizers that are to be used on various soils indiscriminately will not best serve the interests of their customers by preparing fertilizers containing a more complete list of the essen-

tial ingredients of plant-food, and particularly with more potash.

Some of the fertilizers analyzed at the Station show quite fair percentages of potash. This is usually supplied in the form of German potash salts, which contain magnesia also. A nitrogenous superphosphate to which such salts have been added, furnishes all of the materials of plant-food which our ordinary soils can lack, and is, in that respect, a complete fertilizer.

For general and indiscriminate use, viewing the matter from the chemist's standpoint, such fertilizers are to be very highly recommended. They will doubtless be, in many cases, much more economical to farmers than others which furnish only part of the materials needed, though at lower rates.

From what has been said in the previous pages, it is clear that

THE WAY FOR THE FARMERS OF CONNECTICUT TO GET RELIABLE FERTILIZERS

is to,

1st. Buy only those fertilizers whose chemical composition is distinctly stated and guaranteed by the seller; and

2d. Of these, to select the ones which furnish the fertilizing ingredients their land and crops need, in the best form and at the lowest price per pound.

If they are not certain that the articles they purchase are equal to the guarantee, let them send carefully and fairly chosen samples to the Station for analysis.

In brief, let buyers and sellers know what is the composition of their fertilizers and give preference to those in which, not the whole bagfull or ton, but the valuable materials contained therein, are the cheapest. In this way, poor and fraudulent articles will be driven from the market, honest dealers will be encouraged to sell and progressive farmers to use good articles, and tens of thousands of dollars will be saved every year to them and to the State. By such means and by such means alone, can the much needed regulation of the trade in commercial fertilizers be brought about.

Some details of the steps taken by the Station to aid the farmers of Connecticut in the purchase, and at the same time

to encourage honest dealers in the sale of reliable fertilizers, may be found below.

THE CONNECTICUT FERTILIZER CONTROL SYSTEM.

The following form of agreement is the result of the deliberations of a large meeting of manufacturers, sellers, and consumers of fertilizers, held at the Station, and of consultation with the Advisory Committee and with other parties interested.

BLANK B.

..... hereby agree with the Connecticut Agricultural Experiment Station, as represented by its director, that all fertilizers offered for sale in the State of Connecticut, by ..... or by..... authorized agents, at any price above fifteen dollars ($15.00) per ton, except crude fish-scrap, shall be placed under its supervision in the following manner:

1. .....hereby agree that all fertilizers above described shall be guaranteed to contain certain minimum percentages of one or more of the following ingredients:

Nitrogen.
Phosphoric Acid (1); Soluble (2).
Phosphoric Acid; Reverted (3).
Phosphoric Acid; Insoluble (4).
Potash (5).
Sulphuric Acid. Chlorine (6).

(1). Anhydrous Phosphoric Acid or Phosphoric Oxide, P_2O_5.

(2). In any form of combination soluble in distilled water.

(3). In any form of combination soluble in a neutral solution of Ammonium Citrate at a temperature not exceeding 100 Fahrenheit.

(4). In any form of combination not soluble as above.

(5). Anhydrous Potassium Oxide K_2O, or its equivalent Potassium, in any form of combination soluble in distilled water.

(6). Anhydrous Sulphuric Oxide SO_3, Chlorine, Cl; the same being of importance in Potash Salts for distinguishing between "Sulphate" and "Chloride."

The object of these specifications (1–6) is simply to define, in chemical language, the terms "Phosphoric Acid," "Soluble," "Reverted," &c., as ordinarily employed.

2. .....also agree that the above guarantee shall be always subject to verification by analyses made at the Station.

3. .....also agree that all fertilizers above described shall be at all times open to the inspection of the Station, as represented by its Director, Chemists, or any member of its Advisory Committee.

Signed.

Date.

NOTE.—The signer or signers will insert in the proper blank spaces their names (of person, firm, or corporation), and the pronouns I or we and myself and my or ourselves and our.

As filled out, this would read, I, A. B. or we, C. D. & Co., hereby agree, &c., and would be signed, A. B., or C. D. & Co. The chemical terms used in the specifications are not very familiar to others than chemists but are put in the above form so as to define accurately the terms used, and thus leave no opportunity for perversion or mistake.

The signer of this agreement is not expected to specify in this blank the composition of the wares he sells, but he does bind himself to fulfill the requirement of the State law, by accompanying every package of fertilizer sold, with a plain statement of the analysis, using the above terms, and to guarantee the article to be equal to the analysis.

In brief, this agreement binds the signer simply to state what he sells and guarantee what he states, the verification of the statement being left to the official analysis of the Station. With the fulfillment of this guarantee the responsibility of the seller will naturally end. The Station provides that buyers who wish to determine whether the articles they purchase are equal to the guarantee, may have control analyses made at little or no expense. It is believed that no simpler or more efficient way can be devised to place the trade in fertilizers on a secure basis, insure confidence, and benefit all concerned.

It is gratifying to observe the readiness with which a majority of the more prominent manufacturers and sellers of the State, and a number of those outside the State, have expressed their willingness to sign this agreement. Indeed, one of our largest fertilizer manufacturing companies has for some years been conducting its business upon the same principles, which form the basis of our present control system, having guaran-

teed its goods on analyses made by the Chemist of the Board of Agriculture. It is worthy of note that the fertilizers made and sold by those who have been most ready to join in this arrangement are among those which appear the best in the comparison of composition and prices.

The following list includes those who have already signed the above agreement. Others have signified their intention to do so. Their names will be duly published when received.

IN CONNECTICUT.

Quinnipiac Fertilizer Co., New Haven.
Strong, Barnes, Hart & Co., "
George W. Miles, Milford.
C. L. Willard, Hartford.
Rodney Kellogg, "
F. Ellsworth, "
Leonard B. Bishop, New Haven.
Robert B. Bradley, "
John P. Barstow, Norwich.
Southmayd & Gardiner, Middletown.
W. E. Wheeler, Stratford.
D. B. Warner & Son, East Haddam.
John S. Welles, Hebron.
Peck Brothers, Northfield.
George W. Miller, Middlefield.
P. W. Bennett, "

OUTSIDE OF CONNECTICUT.

H. J. Baker & Co., New York.
Hobson, Hurtado & Co., New York.
Manhattan Blood Guano Co., "
Charles V. Mapes, New York.
Russell Coe, Linden, New Jersey.
W. H. Bowker & Co., Boston, Mass.
Matfield Fertilizer Co., Boston, Mass.
N. Jackson & Sons, Boston, Mass.
Pacific Guano Co., " "
J. A. Byrnes, Springfield, "

Directions for sending samples of fertilizers will be found in the following, which has been extensively circulated. It is of the utmost importance that in sampling and sending, these directions should be strictly followed.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

[CIRCULAR 1.]

ANALYSIS OF FERTILIZERS.

This Station, established by the last General Assembly, is prepared, in addition to scientific researches of a more abstract character, to execute analyses of fertilizers at the Chemical Laboratory of the Wesleyan University at Middletown.

As the work is paid for in large part from public funds, those analyses which are of public interest will be performed gratuitously. Preference will be given to articles furnished by Farmers' Clubs or Agricultural Societies, and to those whose novelty, importance, or extensive sale give them special interest to the farmers of the State. Where duplicates of the same brand, equally well selected and authenticated, are received, the Director will select from them for analysis at his discretion. The results of analyses will be sent directly to the party furnishing the sample. They will also, where gratuitous, be held at the service of the Station and of the State Board of Agriculture for publication and for general use. For analyses made in the interest of private individuals, the latter will be charged a moderate fee, and will entirely control the results.

It is plainly for the interest of both dealer and consumer, that fertilizers should be bought and sold upon the basis of their actual value, as determined by their composition. To further such a regulation of the trade in commercial fertilizers, arrangements will be made with those dealers who are ready to guarantee the composition of the articles they sell, and wish to place their stock under the supervision of the Station, whereby their wares will be inspected, samples taken for analysis, and results of same reported under the authority of the Director. It is hoped that all will see the advantages of this course, and encourage its adoption, and that every dealer will avail himself of the opportunity thus offered by the Station to secure for himself and his customers the benefit that must accrue therefrom.

The following directions must be *strictly followed* in order to obtain fair samples, and do justice alike to manufacturers, dealers, and consumers.

DIRECTIONS FOR TAKING SAMPLES OF FERTILIZERS FOR ANALYSIS.

FOR GUANOS, SUPERPHOSPHATES, BONE DUST, POTASH SALTS, GYPSUM, &C.

Have ready for holding the sample a *clean*, tight receptacle, preferably a closely capped glass fruit jar, of about one quart capacity. Provide also a large sheet of clean wrapping paper, or a clean newspaper. Weigh carefully three barrels, bags, or packages of the fertilizer, and carefully record the actual weight of each. Open, one after another, each of the three bags, barrels, or packages, that have been weighed. and mix well together the contents down to one-fourth, or better, down to one-half its depth, crushing very finely any lumps that may be found, Then dip out five (5) equal cupfuls (a tea-cup or bowl will answer) from different parts of the mixed portion of each package.* Pour them (15 in all) one over the other on to the paper; intermix these again thoroughly but expeditiously, to avoid loss or gain of moisture; fill the fruit jar or other receptacle from this mixture, close tightly, pack glass fruit jars in a box to prevent breakage, labelled distinctly, and send by express or otherwise, charges prepaid, to "*Agricultural Experiment Station, Middletown, Conn.*"

Each sample must be accompanied by a statement of the weights of the packages, when the article is in packages, the price per ton, &c., also by an exact copy of a specimen of any printed or written *analysis, advertisement, pamphlet,* or *statement* that accompanies it, or that is used in its sale. Also by a copy of the *brand, name,* or *trade-mark,* the name and address of the *dealer* from whom the sample is procured, and of the name and post-office address of the person or persons taking the sample. No sample will be analyzed for public use, unless the name and address of the sender, and other facts are given with sufficient accuracy and definiteness to enable the Station to verify any published statement in regard to the source of the article, &c.

Blanks are prepared for receiving these facts, and those designing to send samples are requested to apply for them at the Station.

W. O. ATWATER, *Director.*

It is of the greatest importance that samples received for analysis should be accompanied by the blank referred to—Blank A—properly filled.

When purchasers desire control analyses, to determine whether the wares they buy are as guaranteed, it is recom-

* In sampling from bags, a butter-tryer, if at hand, may be conveniently used, portions being taken from several different parts of each of several bags.

mended that the samples be taken by the buyer and seller jointly, and forwarded by them with proper specifications, and names of both parties, to the Station. Such Control Analyses will be performed gratuitously so far as public interest and the ability of the Station will warrant. Preference will be given to articles sold under supervision of the Station.

REMARKS TO TABLE ON PAGES 46–49.

From a large number of commercial fertilizers analyzed at the Station, we select the following as illustrations of the composition and value of these articles, as sold in the State.

There are a few important brands sold in the State of which, had samples been received in season, the analyses would have been given in the present report. In future reports, the attempt will be made to include at least one analysis, and, in many cases, several of each of the leading articles offered for sale in the State.

To the purchaser who may choose to use this as an aid in selecting, it is a matter of minor consequence whether any given article appears here or not. The surety of the value of the article he buys is to be found, not in any one analysis of a sample received at the Station, but rather in the composition of the special lot he buys, as guaranteed by the seller. By comparing the composition of the article as thus guaranteed, with the figures in this table, he may judge whether the valuable ingredients are furnished at fair rates.

Different samples of the same brand of fertilizer often vary considerably in composition. An article of uniform composition may give the best results in one case and fail in another. Hence the reputation of a fertilizer, from the chemical standpoint, is justly based upon the average composition of different samples as actually sold, and from the agricultural standpoint, by its effects when rightly used.

The prices are those given to us by the parties furnishing the samples, and are, unless otherwise stated, cash for lots not less than one ton. While our information as to these prices is believed to be accurate, for the special lots from which the samples were taken, it should be borne in mind that they are

subject to variations dependent upon freights, time of payment, amount purchased, etc. The prices stated here are, therefore, in no respect binding for any dealer, or any time or place.

We call especial attention to what has been explained regarding the "Estimated Commercial Values"* of fertilizers, and reiterate that these in no way express *agricultural* values; an article that "analyzes well" may give excellent results in one case, and do very poorly in another. Chemical analysis does not show what will be the effect of a fertilizer under varying conditions of moisture or drouth, warmth or frost, kind of soil, method, application, culture and crop. It does show what plant-food the fertilizer contains, and approximately, at least, what, in itself considered, it is worth. But as was illustrated in the case of the bone-manures on pages 23–26 and elsewhere, it does not always indicate the varying value of the same ingredient, in different forms. Hence the "Estimated Values" are sometimes far from just expressions of the actual values to the user. Since many persons are inclined to judge the article from these figures and from these figures alone, we feel it necessary to refer repeatedly to these facts, and to explain that the figures in the columns under "cost of valuable ingredients per pound," in the table, afford much fairer means of comparing different articles. Were it not for the pressing demand for the "estimated values," sanctioned by long usage, we should be glad to omit that column from the table.

The figures for certain brands given here, will be found to vary somewhat from those of the table in the first edition. This is due to the fact that other samples of the same brand, generally of later manufacture, have since been analyzed, and the results substituted for those of the former edition.

* See pages 16–18.

List of names of Manufacturers or Importers of Fertilizers of Table on pages 46–49, with names of Dealers by whom they were offered for Sale and of Parties by whom the samples were furnished.

Station Number.	Manufactured or Imported by	Offered for Sale by	Sample Furnished by
3.	H. J. Baker & Brother, New York,	H. J. Baker & Brother, New York,	Chester Sage,
5.	H. J. Baker & Brother,	H. J. Baker & Brother,	Chester Sage.
6.	Birchall & Chapman, Port Morris, N. Y.,	I. N. Leonard, General Agent,	E. J. Bradley.
8.	Birchall & Chapman, Port Morris, N. Y.,	H. B. Knapp, Sub. Agent,	David Hall.
9.	Manhattan Co., New York,	A. G. & R. A. Pease, Middletown,	Middlefield Farmers' Club.
11.	Geo. W. Miles, Milford, Conn.,	Southmayd & Gardiner, Middletown,	Middlefield Farmers' Club.
15.	Preston & Sons, Greenpoint, L. I.,	Southmayd & Gardiner,	Middlefield Farmers' Club.
16.	Agents for Peruvian Government,	Southmayd & Gardiner,	Middlefield Farmers' Club.
17.	Bridgeport Sulphuric Acid Co.,		Middlefield Farmers' Club.
18.	Thompson & Edwards, Chicago,	Southmayd & Gardiner,	Middlefield Farmers' Club.
19.	Lodi Manufacturing Co.,	Southmayd & Gardiner,	Middlefield Farmers' Club.
24.	G. S. Allyn & Co.,	G. S. Allyn & Co.,	Rev. W. Clift.
25.	Thompson & Edwards,		M. W. Terrill.
28.	Geo. W. Miles,	Geo. W. Miles,	M. W. Terrill.
29.		C. H. Marble & Co., Boston,	J. M. Hubbard.
30.	Riverside Phosphate Works,	J. J. H. Gregory, Marblehead, Mass.,	J. M. Hubbard.
31.	Brighton Abattoir Co.,	Jacksons & Bowker, Boston,	J. M. Hubbard.
35.		Southmayd & Gardiner,	J. M. Hubbard.
40.	Agents for Peruvian Government,	Geo. E. White, New York,	R. S. Hubbard.
43.	Joseph Lister, Chicago,	Joseph Barry, Middletown,	M. W. Wilcox.
44.	Joseph Lister,	Joseph Barry,	M. W. Wilcox.
45.	Navassa Phosphate Co.,	John Reed, New York,	M. W. Wilcox.
47.	Agents for Peruvian Government,	Southmayd & Gardiner,	M. W. Wilcox.
49.	Kearney Chemical Works, New York,	John Reed, New York,	M. W. Wilcox.
53.	H. J. Baker & Brother,	H. J. Baker & Brother,	H. J. Baker & Brother.
54.	Geo. W. Baker, New York,	Nelson Alvord, Southport,	Rev. E. L. Wells.
55.	Geo. W. Baker,	Nelson Alvord,	Rev. E. L. Wells.
56.	Bridgeport Sulphuric Acid Co.,	T. B. Wakeman,	Rev. E. L. Wells.
57.	Hobson Hurtado & Co., New York,	Hobson, Hurtado & Co.,	W. M. Habirshaw, F. C. S.
58.	Peck Brothers, Northfield,	Peck Brothers,	Mr. Peck.
60.	H. J. Baker & Brother,	H. J. Baker & Brother,	Geo. B. Forrester.
61.	H. J. Baker & Brother,	H. J. Baker & Brother,	Geo. B. Forrester.
74.	Quinnipiac Fertilizer Co., New Haven,	Quinnipiac Fertilizer Co.,	H. L. Dudley.
75.	Jas. A. Byrnes, Springfield, Mass.,	Jas. A. Byrnes,	L. F. Mellen.
77.	Jas. A. Byrnes,	Jas. A. Byrnes,	L. F. Mellen.

79.	G. W. Miles,	G. W. Miles,	G. W. Miles.
80.	G. W. Miles,	G. W. Miles,	G. W. Miles.
81.			S. M. Wells.
91.	J. Lister,		Martin Loveland.
92.	P. W. Bennett, Middlefield,	P. W. Bennett,	M. W. Terrill.
93.	Geo. W. Miller & Son, Middlefield,	G. W. Miller & Son,	M. W. Terrill.
94.	H. J. Baker & Brother,	H. J. Baker & Brother,	T. B. Wakeman.
95.	Lister Brothers, Newark, N. J.,	Lister Brothers,	Rev. E. L. Wells.
96.	Lister Brothers,	Wm. Meeker & Son,	Rev. E. L. Wells.
97.	Lister Brothers,	Wm. Meeker & Son,	Rev. E. L. Wells.
98.	Lister Brothers,	Horace Staples, Westport,	A. C. Taylor.
99.	Quinnipiac Fertilizer Co., New Haven,	Quinnipiac Fertilizer Co.,	Quinnipiac Fertilizer Co.
100.	Quinnipiac Fertilizer Co.,	Quinnipiac Fertilizer Co.,	Quinnipiac Fertilizer Co.
101.	Quinnipiac Fertilizer Co.,	Quinnipiac Fertilizer Co.,	Quinnipiac Fertilizer Co.
102.	Strong, Barnes, Hart & Co., New Haven,	Strong, Barnes, Hart & Co.,	Strong, Barnes, Hart & Co.
108.	Agents for Peruvian Government,	C. L. Willard, Hartford,	Andrews Brothers.
116.	Pacific Guano Co., Boston,		Pacific Guano Co.
117.	E. F. Coe, Williamsburgh, New York,	J. P. Barstow & Co.,	J. P. Barstow & Co.
120.	Sternfels Bone Fertilizing Co., New York,	Sternfels Bone Fertilizing Co.,	Arnold Rudd, New London.
121.	Lombard & Matthewson, Warrenville, Ct.,	Lombard & Matthewson,	John D. Gaylord.
122.	Lombard & Matthewson,	Lombard & Matthewson,	John D. Gaylord.
125.	W. H. Bowker & Co., Boston,	W. H. Bowker & Co.,	Dr. J. W. Alsop.
126.	R. H. Allen & Co., New York,		Southmayd & Gardiner.
127.	E. F. Coe,	J. P. Barstow & Co.,	J. P. Barstow & Co.
128.	Russell Coe, Linden, N. J.,	J. P. Barstow & Co.,	J. P. Barstow & Co.
129.	Lister Brothers, Newark, N. J.,	J. P. Barstow & Co.,	J. P. Barstow & Co.
130.	Thompson & Edwards,	J. A. Lewis, Willimantic,	A. B. Fuller, Columbia.
131.	Wm. Raynor, Greenpoint, L. I.,	Mr. Hurlburt, Westfield,	Dr. J. W. Alsop.
132.	J. O. & E. Smith, South Canterbury,		J. P. Barstow & Co.
133.	Rumford Chemical Works, Providence, R. I.		J. P. Barstow & Co.
139.	Thompson & Edwards,		F. Ellsworth, Hartford.

TABLE OF ANALYSES AND VALUATIONS OF COMMERCIAL FERTILIZERS SOLD IN CONNECTICUT.

[We call especial attention to the explanations in the preceding pages, and particularly to what has been said concerning the "estimated commercial values," and reiterate that these latter by no means express, and in some cases differ widely from the *agricultural* values. A more satisfactory method of comparison consists in estimating the actual costs of the valuable ingredients per pound, as in the table, and as explained on pages 19 and 20. The scale of commercial valuations is essentially the same as has been previously in use in the State, and is doubtless rather high for the present condition of the market. The prices per ton, where stated, are as given by the parties furnishing the samples. They are believed to be correct for the places where the individual specimens were obtained, though subject to variations dependent upon freights, time of payment, quantity purchased, etc. No dealer is bound by any price given here. See particularly pages 42 and 43. For names of manufacturers or importers, sellers, and parties furnishing samples, see pages 44, 45.

NAME OF FERTILIZER.	Station Number.	Moisture.	Sand, etc.	PHOSPHORIC ACID. Available. Soluble.	Available. Reverted.	Insoluble.	Total.	Bone phosphate of lime equivalent to tot'l phosphoric acid	Potash.	Nitrogen.	Ammonia equivalent to Nitrogen.	Retail price per ton.	Estimated Commercial Value.	COST OF ONE POUND, EACH, OF VALUABLE INGREDIENTS, AT PRICES STATED. Nitrogen.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Potash.
PHOSPHATIC FERTILIZERS.																		
WITHOUT NITROGEN.																		
English Superphosphate,	5	17.39	6.12	10.27	.....	3.50	13.77	30.06	.....	.....	.....	* $33.00	$35.01	.....	14.1	.....	5.6	.....
Navassa Phosphate,	45	1.41	3.65	.....	.....	.....	20.45	44.64	.....	.....	.....	.....	16.36	.....	.....	.....	.....	.....
English Superphosphate,	58	8.55	....	23.28	.....	8.67	31.95	68.85	.....	.....	.....	61.00	80.24	.....	11.5	.....	4.6	.....
" "	60	16.36	....	12.19	1.31	0.70	14.20	31.00	.....	.....	.....	.....	40.03	.....	.....	.....	.....	.....
" "	61	13.03	....	17.79	.....	1.04	18.83	41.10	.....	.....	.....	.....	54.41	.....	.....	.....	.....	.....
Caribbean Sea Guano,	125	11.90	0.51	.....	.....	.....	27.18	59.38	.....	.....	.....	.....	21.74	.....	.....	.....	.....	.....
WITH NITROGEN.																		
Bone Manures.																		
Ground Bone, J. Lister,	43	5.69	2.81	.....	.....	.....	23.55	51.41	.....	3.15	3.82	* $42.00	40.86	20.6	.....	.....	6.2	.....
Fine Bone, G. W. Baker,	54	16.78	3.40	.....	.....	.....	14.41	31.46	.....	2.46	2.99	.....	27.13	.....	.....	.....	.....	.....
Coarse Bone, " "	55	19.66	2.38	.....	.....	.....	15.53	33.90	.....	3.04	3.69	.....	30.80	.....	.....	.....	.....	.....
Ground Bone, Peck Bros.,	58	11.88	...	.....	.....	....	19.79	43.20	.....	4.03	4.89	38.00	39.87	19.	.....	.....	5.7	.....
Pure Ground Bone, J. A. Byrnes,	75	7.07	....	.....	.....	.....	19.68	42.96	.....	3.79	4.60	.....	38.77	.....	.....	.....	.....	.....

ANALYSES. VALUATIONS.

Steamed Meat and Bone, J. A. Byrnes,	77	9.66	....	....	....	....	21.22	46.32	.....	3.38	4.11	.....	38.98	.....	.....	.....	.....	.....
"Pure Bone,"	81	7.54	....	....	....	....	15.22	33.22	.....	5.46	6.62	.....	40.10	.....	.....	.....	.....	.....
Ground Bone, J. Lister,	91	4.24	....	....	....	....	22.85	49.88	.....	3.63	4.40	.....	41.94	.....	.....	.....	.....	.....
Ground Bone, P. W. Bennett,	92	7.98	....	....	....	....	22.05	48.13	.....	3.91	4.74	.....	42.10	.....	.....	.....	.....	.....
Ground Bone, G. W. Miller,	93	7.87	....	....	....	....	21.95	47.92	.....	3.88	4.71	.....	41.87	.....	.....	.....	.....	.....
Ground Bone, H. J. Baker & Bro.,	94	7.00	....	....	....	....	23.61	51.54	.....	3.88	4.71	33.00	43.85	15.0	.....	.....	4.5	.....
Bone Flour, Lister Bros.,	96	16.05	....	....	....	....	14.62	31.92	.....	2.36	2.86	35.00	26.98	26.0	.....	.....	7.8	.....
Bone Meal, Lister Bros.,	97	18.45	....	....	....	....	14.25	31.10	.....	2.37	2.87	30.00	26.58	22.6	.....	.....	6.8	.....
Celebrated Ground Bone, Lister Bros.,	98	17.09	....	....	....	....	10.70	23.36	.....	3.43	4.16	31.00	26.56	23.3	.....	.....	7.0	.....
Raw Ground Bone, Thompson & Edwards,	106	8.78	5.56	....	....	....	15.26	33.31	.....	3.90	4.73	47.50	33.91	23.0	.....	.....	8.4	.....
"Dissolved Bone," Thompson & Edwards,	107	12.37	....	....	....	....	12.38	27.02	.....	3.99	4.84		30.81	.....	.....	.....	.....	.....
Fine Bone, Lombard & Matthewson,	121	8.23	....	....	....	....	26.72	58.33	.....	3.40	4.12	45.00	45.66	19.7	.....	.....	5.9	.....
Ground Bone, R. H. Allen & Co.,	126	10.12	6.45	....	....	....	22.94	50.07	.....	3.57	4.33	.....	41.81	.....	.....	.....	.....	.....
Ground Bone, Lister Bros.,	129	14.71	3.74	....	....	....	12.98	28.33	.....	2.84	3.44	38.00	26.94	28.1	.....	.....	8.5	.....
Raw Ground Bone, Thompson & Edwards,	130	12.08	0.89	....	....	....	22.67	49.50	.....	2.63	3.19	* 40.00	37.73	21.2	.....	.....	6.4	.....
NITROGENOUS PHOSPHATES AND SUPERPHOSPHATES.																		
Phosphatic Blood Guano, Manhattan Co.,	9	21.83	0.93	7.83	1.75	2.08	11.66	25.45	1.20	2.90	3.52	.....	45.90	.....	.....	.....	.....	.....
Ammoniated Superphosphate, G. W. Miles,	11	19.87	2.60	9.91	0.16	0.80	10.87	23.69	.....	2.75	3.38	* 48.00	44.76	26.8	16.0	10.7	6.4	.....
Superphosphate, Preston & Sons,	15	21.75	3.60	9.94	.....	4.10	14.04	30.65	.....	1.67	1.96	* 42.50	43.12	23.8	14.8	.....	5.9	.....
Steamed Bone, "Dissolved," Thompson & Edwards,	25	8.71	....	0.43	.....	12.34	12.77	27.88	.....	4.25	5.15	* 48.00	37.35	32.2	19.3	.....	7.7	.....
Ammoniated Bone Phosphate, Thompson & Edwards,	26	14.84	....	0.95	.....	12.33	13.78	30.08	.....	4.16	5.05	* 48.00	39.04	30.8	18.5	.....	7.4	.....
Riverside Phosphate, J. J. H. Gregory,	30	20.16	....	.....	.....	.....	20.44	44.62	.....	4.18	5.07	* 45.00	45.43	24.8	.....	.....	5.9	.....
Animal Fertilizer, Acidulated, Brighton Abattoir,	31	17.59	...	6.37	.....	1.11	7.48	16.32	1.73	5.33	6.47	.....	47.65	.....	.....	.....	.....	.....
Superphosphate, Bridgeport Sulphuric Acid Co.,	56	9.37	8.41	3.67	.....	7.43	11.10	24.23	.....	1.14	1.88	.....	25.62	.....	.....	.....	.....	.....
Ammoniated Bone Superphosphate, G. W. Miles,	79	24.15	3.40	9.28	2.61	0.91	12.84	28.03	.....	2.57	3.12	45.00	47.00	23.7	14.2	9.5	5.7	.....
Superphosphate, Lister Bros.,	95	19.09	....	10.29	2.12	1.38	13.79	30.10	.....	2.60	3.21	45.00	49.99	22.5	13¼	9.	5½	.....
Soluble Nitrogenous Phosphate, Quinnipiac,	101	19.27	....	7.24	.....	0.46	7.71	16.81	.....	4.41	5.36	40.00	44.34	22.7	13.6	.....	5.4	.....
Soluble Pacific Guano,	116	10.29	....	5.06	1.50	7.23	13.79	30.10	4.62	2.42	2.93	.....	†	.....	.....	.....	.....	.....
Ammoniated Superphosphate, E. F. Coe,	117	19.16	1.25	10.22	2.80	1.66	14.68	32.04	.....	2.54	3.08	42.00	50.95	21.	12.5	8.4	5.1	.....
Ammoniated Dissolved Bone, Sternfel's	120	16.83	5.83	2.64	2.30	0.44	5.39	11.76	.....	2.09	2.53	40.00	23.49	42.5	25.5	17.0	10.2	.....

TABLE OF ANALYSES AND VALUATIONS OF COMMERCIAL FERTILIZERS SOLD IN CONNECTICUT—CONTINUED.

NAME OF FERTILIZER.	Station Number.	Moisture.	Sand, etc.	Phosphoric Acid. Available. Soluble.	Phosphoric Acid. Available. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total.	Bone phosphate of lime equivalent to tot'l phosphoric acid	Potash.	Nitrogen.	Ammonia equivalent to Nitrogen.	Retail price per ton.	Estimated commercial value.	Cost of one pound, each, of valuable ingredients, at prices stated. Nitrogen.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Potash.
Superphosphate, Lombard & Matthewson,	122	4.29	4.78	5.75	6.38	2.89	15.02	32.79	.....	2.92	3.54	$50.00	$48.08	25.9	15.6	10.4	6.2	.....
Abattoir Guano, E. F. Coe,	127	17.61	.....	8.91	1.69	1.23	11.83	25.82	3.99	3.39	4.11	50.00	54.92	22.7	13.6	9.1	5.5	7.3
Ammoniated Bone Phosphate of Lime, Russell Coe,	128	21.01	.....	11.67	0.92	0.20	12.79	27.82	.....	2.24	2.71	40.00	48.29	21.0	12.5	8.3	5.0	.....
Superphosphate, Wilson's,	133	19.70	2.62	5.84	1.19	1.04	8.07	17.61	.....	2.39	2.90	40.00	33.09	30.0	18.0	12.0	7.2	.....
Ammoniated Bone Superphosphate, Thompson & Edwards,	139	19.31	2.27	1.70	8.60	3.22	13.53	29.53	.....	2.39	3.62	50.00	41.11	30.4	18.2	12.1	7.3	.....
NITROGENOUS FERTILIZERS.																		
WITH CONSIDERABLE PHOSPHORIC ACID. *Peruvian Guanos.*																		
Guanape,	16	16.60	.....	5.75	.....	11.69	17.44	38.07	.....	9.37	11.37	* 70.00	78.12	21.7	13.0	.....	5.2	.....
Guanape,	40	20.66	0.47	9.18	.....	8.15	17.33	37.83	1.20	7.35	8.92	* 60.00	75.99	19.6	11.7	.....	4.7	6.3
Guanape,	47	11.40	2.10	.....	.....	.....	15.37	33.55	.....	11.33	13.75	60.00	72.89	20.0	.....	.....	4.8	.....
Rectified Peruvian,	57	12.61	.....	10.67	.....	1.62	12.59	27.48	2.43	9.15	11.10	60.00	83.58	17.9	10.7	.....	4.3	5.7
No. 1. Peruvian (Guanape),	108	21.57	.....	.....	.....	.....	17.90	39.07	.....	8.56	10.39	.....	64.28	.....	.....	.....	.....	.....
WITH LITTLE OR NO PHOSPHORIC ACID. *Fish Manures.*																		
Allyn's Fertilizer,	24	.....	.....	.....	.....	.....	6.17	13.48	.....	8.80	10.68	.....	51.42	.....	.....	.....	.....	.....
Fish Guano, G. W. Miles,	28	21.96	.....	.....	.....	.....	8.66	18.90	.....	6.07	7.37	* 40.00	40.74	24.5	.....	.....	5.8	.....
C. Island Guano, G. W. Miles,	80	8.63	1.43	.....	.....	.....	7.74	16.90	.....	8.84	10.73	.....	43.48	.....	.....	.....	.....	.....
Pine Island Guano, Quinnipiac,	99	15.93	.....	4.95	2.32	1.93	9.20	20.11	.....	5.64	6.84	45.00	50.03	22.5	13.5	9.0	5.4	.....
Dry Ground Fish Guano, Quinnipiac,	100	14.64	.....	.....	.....	.....	6.67	14.59	.....	7.50	9.11	45.00	45.50	24.6	.....	.....	5.9	.....
Fish Scrap,	103	40.95	.....	.....	.....	.....	6.23	13.60	.....	5.33	6.47	$ 16.00	28.79	11.1	.....	.....	3.3	.....

Fish Scrap,	131	25.10	2.42				7.49	16.35		5.49	6.66	* 16.00	30.93	10.3			3.1	
Animal Refuse. Not Superphosphated.																		
Animal Dust,	29	14.45		0.26		5.80	6.06	13.22		7.32	8.89	[2] 50.00	44.34	28.2	16.9		6.7	
Azotin,	49	12.56					6.92	15.10		7.33	8.89	50.00	44.95	27.7			6.6	
Dried Blood, Meat Scrap and Bone. Strong, Barnes, Hart & Co.,	102	12.26					5.20	11.35		8.08	9.80	40.00	46.64	21.6			5.1	
Azotin,	118									11.71	14.21		58.55					
Dried Blood,	119									10.87	13.19		54.35					
Sulphate of Ammonia,	3									20.53	24.92	* 97.50	102.60	23.7				
Castor Pomace,	35	6.83					2.11	4.60		4.80	5.83	40.00	26.53	37.7			9.05	
Castor Pomace,	59	7.21	1.36				1.91	4.16		4.72	5.73		25.89					
Castor Pomace,	105	19.13	0.88				2.42	5.31		5.29	6.42		29.35					
MISCELLANEOUS.																		
American Bone Fertilizer,	6	10.10	47.15				2.61	5.71		1.02	1.23	* 55.00	8.23	167.1			40.1	
American Bone Fertilizer,	8	13.07	41.46				2.80	6.11		1.03	1.24	* 55.00	8.48	158.8			38.1	
Lodi Double Refined Poudrette,	19	4.20	63.07				2.22	4.84		1.41	1.71	25.00	9.71	64.4			15.4	
HOME-MADE SUPERPHOSPHATES.																		
Made by adding Sulphuric Acid to Ground Bone, No. 43,	44	1.39		1.27		17.73	19.00	41.47		2.70	3.27	[4] 42.00	38.59	27.2	16.3		6.5	
Made by adding Sulphuric Acid to Navassa Phosphate, No. 45,	46	15.85		7.96		11.56	19.52	42.61				[4] 28.00	37.75		11.1		4.4	
Made by adding Sulphuric Acid to Guanape Guano, No. 47,	48	16.01		9.05		3.77	12.82	27.98		7.69	9.33	[4] 57.40	70.12	20.4	12.2		4.9	

* Price in 1875, when sample was taken. † See pages 23–26 for remarks on bone manures. The fine steamed bone is worth relatively more, and the coarse raw bone relatively less than the estimated commercial values indicate. [1] (No. 43) in car-load lots. (?) [2] (Nos. 29 and 31) two dollars and fifty cents per cwt. No. 29 probably less, and 31 probably $40, by the ton. [3] (No. 130) in car-load lots. [4] Nos. 44–46–48, superphosphated by purchasers. No. 46 was too moist for convenient use; 48, rather lumpy. The cost of materials, but not of labor, was taken into account. [5] No. 103. Assumed price, see page 27. [6] (No. 116). At 6 cents per lb. for insoluble Phosphoric Acid, the calculated value of this fertilizer would be $46.35. At 4 cents for insoluble phosphoric acid (which is probably a more just valuation for fossil and mineral phosphates), it would be $43.45. See page 17.

The figures for certain brands given here, will be found to vary somewhat from those of the table in the first edition. This is due to the fact that other samples of the same brand, generally of later manufacture, have since been analyzed, and the results substituted for those of the former edition.

☞ The figures of this table, taken alone, without study of the preceding text, give a very inadequate idea of the articles.