J. De Lancey Verplanck

ESSAYS

ON

PEAT, MUCK,

AND

COMMERCIAL MANURES,

BY SAMUEL W. JOHNSON,

CHEMIST TO THE CONNECTICUT STATE AGRICULTURAL SOCIETY AND PROFESSOR OF ANALYTICAL AND AGRICULTURAL CHEMISTRY IN YALE COLLEGE.

HARTFORD:

PUBLISHED BY BROWN & GROSS.

1859.

PRESS
OF
WILLIAMS & WILEY.

PREFACE.

In 1856 the writer attempted to turn his chemical knowledge to the use of Agriculture, by examining the commercial fertilizers then offered for sale in the markets of Connecticut and New York.

In a business having such prospects of extension as lay before the trade in manures, in a region where convenient markets largely counterbalance the disadvantages of poor and worn-out soils, it was to be anticipated that frauds would arise, especially since it is so difficult or even in many cases impossible, to judge accurately of the quality of a fertilizer from its external characters.

Chemistry which has done so much for all the practical arts during the last 50 years, and which has made possible the extensive use of artificial fertilizers, fortunately offers the farmer complete protection against every attempt to defraud him by worthless mixtures, sold under high-sounding names and forged certificates; and although there is no scientific merit in analyzing manures, there is great practical use in saving the hard-toiling farmer from profitless and ruinous expenditures.

In the year just mentioned, the writer published in the *Homestead* a series of papers on the principal fertilizers then on sale in Connecticut. These articles excited much interest among the readers of that Journal, and at the Annual Meeting of the Connecticut State Agricultural Society, in Jan. 1857, the writer was invited to address that body upon "Frauds in Commercial Manures." It was then shown that gross deceit had actually been practised by parties soliciting the patronage of the farmers of this State, and the great facilities for perpetrating further frauds were made the subject of a lengthened exposition. At that time the writer was commissioned on behalf of the State Agricultural Society to make chemical analyses of all commercial manures offered for sale in the State, and to report upon them through the columns of the *Homestead.* At the annual meeting of the Society in 1858, he presented his First Annual Report as Chemist to the Society, comprising the analysis and valuation of forty-three samples of commercial manures, with an introduction giving some general considerations on the nature and use of manures, and followed by a preliminary notice of an extended investigation into the agricultural merits of Peat and Muck, which was undertaken at the suggestion of Henry A. Dyer, Esq., the able Secretary of the Society.

At the Executive Meeting of the State Society in 1859, a Second Annual Report was offered, which contained the completed investigation of Peat and Muck, together with analyses of such fertilizers as had been found in market during the previous year.

This volume embodies these two Reports,* and consists of a series of disconnected essays, retaining nearly the form in which they were originally presented to the Society.

The analyses of commercial fertilizers have been duplicated in most instances, in order to ensure entire accuracy, and the statement of results has been accompanied with such explanations as appear adapted to facilitate their use.

The methods of analysis are indicated in appendices, so that those versed in such matters may judge of the reliability of the analytical examinations.

The writer has had the gratification of finding his labors appreciated, not only by the State Society, which continues to appropriate the fund requisite for their prosecution; but also by practical farmers, who point with satisfaction to instances in which they have been saved from loss by the contents of these pages.

By demonstrating the immediate practical and pecuniary advantage which the Agriculturist may derive from Chemisttry, the writer hopes to excite more interest in this noble science, among those whom it is especially adapted to benefit; being confident that it has but just begun to reveal its power, and if properly encouraged will in time become a most useful aid to the farmer in nearly every step of his yearly routine.

SAMUEL W. JOHNSON,

Analytical Laboratory of Yale College, New Haven, Ct., Aug. 18, 1859.

* The first 58 pages are occupied with the Reports made in the year 1857, (presented complete in January, 1858), and now revised, and are referred to in the table of contents on page 5. The remainder of the book comprises investigations made in 1858, and has a separate table of contents on page 59.

ESSAYS ON MANURES.

1857.

CONTENTS,

FOR ESSAYS IN 1857.

INTRODUCTORY.

GENERAL CONSIDERATIONS ON MANURES.

1. *What are manures.*

Manures are substances which are incorporated with the soil for the purpose of supplying some deficiency in the latter. However numerous and different may be the materials which assist the growth of plants, judging them by their origin, external characters and names, chemistry has in late years demonstrated that they all consist of only about a dozen forms of matter, which will be specified below.

2. *How manures act.*

Manures may act in three distinct ways.

I. *They may enter the plant as direct nutriment.* Carbonic acid, water, ammonia or nitric acid, sulphuric acid, phosphoric acid, silica, oxyd of iron, chlorine, lime, magnesia, potash and soda, are the elements of vegetable nutrition—the essential plant-food.

In a fertile soil all these materials are accessible to the plant. If one of them be absent, the soil is barren; if a substance that contains the missing body be applied to the soil, it makes the latter fertile.

II. *Manures may act partly as solvents, or absorbents,* and thus indirectly supply food to the plant, e. g., lime, gypsum, salts of ammonia, &c.

Soils are infertile not only from the absence or deficiency of some one or more of the above-named forms of plant food, but also for other reasons. The food of the plant must be soluble in water, so as thus to be transmitted into the plant as rapidly as needed. Soils are often unproductive because the stores of plant-food they contain are locked up in insoluble forms. Lime, guano, the products of the decay of vegetable matters, often fertilize a field merely by their solvent action on the soil. Gypsum acts as an absorber or fixer of ammonia.

III. *Manures improve the physical character of the soil*, i. e., make it warmer, lighter or heavier, more or less retentive of moisture, &c. Such are some manures that are often applied in large quantity, as lime, marl and muck.

A soil is often barren, not because it has no supplies of nutriment for the plant, neither for the reason that those supplies are insoluble; but because the soil itself is so wet or dry, so tenacious and impenetrable, or so light and shifting, that vegetation fails to find the physical conditions of its growth and perfection.

Almost all our ordinary fertilizers exercise to a greater or less degree all these effects. Thus lime, on a clay soil, may, 1st., mechanically destroy the coherence and tenacity of the clay, and give it the friability of a loam; 2d., chemically decompose the clay, making potash, soda, ammonia, &c., soluble, and, 3d, be directly absorbed and appropriated by the plant.

3. *Exhaustion of the soil by cropping, and renovation by weathering.*

Under cultivation there is removed from the soil by each crop, a greater or less quantity of plant-food. The stores of nutriment in the soil thus continually become smaller and smaller.

By the action of the atmosphere (weathering,) assisted by pulverization of the soil (tillage,) the insoluble matters of the soil are gradually made soluble and available to vegetation.

There is thus constantly going on in the soil an exhausting, and as constantly, a renovating process. In most soils under ordinary cultivation, the exhaustion, or removal of plant-food, proceeds more rapidly than the supply by weathering. Such soils therefore tend to become unproductive. In a few cases, the solution of the materials of the soil itself goes on so rapidly that there is always present in them an excess of all the matters requisite to nourish vegetation. These soils are inexhaustible.

To assist in maintaining the first class of soils in a state of productiveness, manures are employed.

4. *Comparative agricultural value of different fertilizers.*

It is obvious from the foregoing considerations that manures are required to exercise very different functions in different cases, according to the character of the soil, as determined by its origin and by its previous treatment. The soil itself is constantly changing under culture, so that what is useful on my neighbor's soil that has been tilled and cropped for twenty years, may be quite valueless on mine which is just reclaimed from the forest. What benefits my soil this year may be of no perceptible advantage next year.

In how far manure is needed for the special purpose of supplying the soil with food for vegetation, it is often difficult to decide. If a new and good soil is repeatedly cropped until it ceases to yield remunerative returns, it may be that addition of some *one* substance, lime, or potash, or sulphuric acid, will restore its fertility. It more often happens that *several* bodies are deficient; but *what* is deficient can only be certainly learned by actual trial. In any special case that substance is most valuable as a manure, (in so far as the *direct* nutrition of the plant is concerned,) which is most deficient in the soil in accessible form.

As regards the indirect action of manures, in virtue of their absorbent or solvent powers, and as regards their effects in meliorating the texture and other physical characters of the soil, practical men have established certain rules, founded on extended experience, which it is not needful to recapitulate here.

Thus much is certain: that one fertilizing agent has no absolute and invariable superiority over another, for all are equally indispensable. The superiorty that any one manure may be reputed to possess, depends upon circumstances. Circumstances are exceedingly various and continually changing. The reputation and local value of manures is equally various and changing.

In some regions, as in certain districts of Pennsylvania, *lime* is considered the best manure. In numerous localities, *plaster* (sulphuric acid and lime,) is chiefly depended upon. In some districts, superphosphate of lime; in others, Peruvian guano is almost exclusively used.

Among the substances essential to vegetation, there are some which almost never fail from the soil. Thus, oxyd of iron and silica are present in every soil. Lime and sulphuric acid may often be wanting. Potash and soda are not unfrequently deficient. Available ammonia and phosphoric acid are likewise often liable to exhaustion.

Ammonia and phosphoric acid, which possess the highest commercial value among fertilizers, have been considered by some whose opinions are of weight in the agricultural world, to possess also a decidedly greater *agricultural* value than other manures. It is asserted that in the growth of certain crops, and in fact those crops which best remunerate the farmer, these substances are most rapidly exhausted from the soil. Now it is undoubtedly true that on the soils of certain districts, and in certain courses of cropping, the application of ammoniacal and phosphatic manures produces the most striking results; yet it is by no means proved, or even probable, that on the whole, all soils and all systems of cropping included, these bodies are oftener lacking, or oftener and more permanently useful, than some of the other fertilizing substances.

5. *What manures are most often and most generally useful?*

While we can not accord to any simple manure, or to any single ingredient of a manure, a universal fertilizing superiority, it is true that some manures are more useful than others, on account of their compound nature. The more ingredients a manure can supply to vegetation the more useful it is. Stable manure is the universal and best fertilizer, because it contains everything which can feed the plant. Swamp muck, straw, and vegetable refuse generally, are of similar character. Fertilizers, like lime, plaster, salt, &c., which contain but a few ingredients, can not in general be depended upon for continuously maintaining the fertility of the soil.

6. *Uses of special or partial manures.*

Special manures, i. e., manures which contain some one or few ingredients, are of use, very rarely as the farmer's chief reliance, but often as adjuncts to stable manure. Several special manures may often be so combined as to make an effectual substitute for stable manure. In high-farming, and in market gardening, and generally where circumstances admit of raising the most exhausting crops without fallow, laying down to grass, or rotation of any sort, special manures are most advantageously employed. In ordinary mixed farming they are useful in assisting to reclaim or improve poor lands; but in the best practice they play as yet a very subordinate part, unless peculiar circumstances make them extraordinarily cheap.

7. *Comparative commercial value of manures.*

The commercial value of a manure is measured by its price, and may be quite independent of its real agricultural value, though it usually depends considerably on its *reputed* agricultural value. The scarcity of a substance, the cost of preparation and transportation, the demand for it on account of other than agricultural uses—all these considerations of course influence its price. It is commercially worth what the dealer can get for it, so much per bushel or ton.

8. *Valuation of manures.—What substances are to be regarded as commercially important in costly manures.*

In any fertilizer which is sold as high or higher than half a cent a pound, there are but three ingredients that deserve to be taken account of in estimating its value. These are ammonia, phosphoric acid, and potash. Every thing else that has a fertilizing value may be more cheaply obtained under its proper name. If the farmer needs sulphuric acid he purchases gypsum; if he needs soda, common salt supplies him. Every thing but these three substances may be procured so cheaply, that the farmer is cheated if he pays ten dollars per ton for a manure, unless it contains or yields one or all of these three substances in considerable proportion.

9. *Mechanical condition of Manures.*

Nothing is so important to the rapid and economical action of a manure as its existing in a finely pulverized or divided state. All costly fertilizers ought to exist chiefly as fine, nearly impalpable powders, and the coarser portions, if any, should be capable of passing through a sieve of say eight or ten holes to the linear inch. The same immediate benefits are derived from two bushels of bones rendered impalpably fine by treatment with oil-of-vitriol, ten bushels of bone-dust, and one hundred bushels of whole bones. Fineness facilitates distribution, and economizes capital.

10. *Chemical condition of manures— State of solubility, &c.—Ammonia, potential and actual—Phosphoric acid, soluble and insoluble.*

The solubility of a manure is a serious question to be considered in its valuation. We are accustomed to speak of ammonia as existing in two states, viz: *actual* and *potential.* By actual ammonia, we mean ready-formed ammonia; by potential ammonia, that which will result by decomposition or decay—"that which exists in possibility, not in act." Now the former is almost invariably soluble with ease in water, and is thus readily and immediately available to plants; while the latter must first become "actual" by decay, before it can assist in supporting vegetation.

In Peruvian guano, we have about half of the ammonia ready formed, and easily soluble in water, the remainder exists in the form of uric acid, which yields ammonia by decay in the soil, but may require weeks or months to complete the change. In leather shavings or woolen rags the ammonia is all potential, and as these bodies decay slowly, they are of less value than guano as sources of ammonia. Oil-cake, (linseed and cotton seed,) contains much potential ammonia, and in a form that very speedily yields actual ammonia.

We do not know with what precise results the process of the decay of ammonia-yielding bodies is accomplished in the soil. Out of the soil such bodies do not give quite all their nitrogen in the form of ammonia: a portion escapes in the uncombined state, and thus becomes unavailable.

Phosphoric acid may occur in two different states of solubility; one readily soluble, the other slowly and slightly soluble in water. The former we specify as soluble, the latter as insoluble phosphoric acid. In Peruvian guano we find 3.5 per cent. of soluble phosphoric acid, existing there as phosphates of ammonia and potash. The remaining 10 to 12 per cent. is insoluble, being combined with lime and magnesia. In most other manures, genuine superphosphates excepted, the phosphoric acid is insoluble.

Among those phosphates which are here ranked as insoluble, there exist great differences in their availability, resulting from their mechanical condition. The ashes of bones, and the porous rock-guano when finely ground, exert immediate effect on crops, while the dense, glassy, or crystallized phosphorite of Hurdstown, N. J., and the fossil bones (so-called coprolite of England,) are almost or quite inert unless subjected to treatment with oil-of-vitriol, (see page 31.)

11. *The reasonable price of phosphoric acid, ammonia, and potash.*

I. *Insoluble phosphoric acid.*—There are several substances now in market, which, as fertilizers, are valuable exclusively on account of their content of phosphoric acid; which, moreover, are at present the cheapest sources of this substance that possess the degree of fineness proper to an active fertilizer. These substances are the phosphatic guanos, (Columbian and American guano,) and the refuse bone-black of the sugar refineries. From them we can easily calculate the present lowest commercial value of phosphoric acid. If we divide the price per ton of Columbian guano, $35, by the number of pounds of phosphoric acid in a ton, which, at 40 per cent., amounts to 800 pounds, then we have the price of one pound as nearly 4⅜ cents.

Refuse bone-black may be had for $30 per ton; it usually contains 32 per cent. of phosphoric acid. The same division as above gives us 4⅝ cents as the cost of phosphoric acid per pound.

In this report I shall adopt the average of these figures, viz.: 4½ cents, as the reasonable price of insoluble phosphoric acid.

Phosphoric acid is much cheaper in crushed bones; but this material is not in a suitable state of division to serve as the basis of a fair estimate.

II. *Soluble phosphoric acid.*—This is nearly always the result of a manufacturing process. Professor Way, chemist to the Royal Agricultural Society of England, estimates its worth at 10½ cents per pound. Dr. Voelker, of the Royal Agricultural College of England, and Dr. Stoeckhardt, the distinguished Saxon Agricultural Chemist, reckon it at 12½ cents per pound. They have deduced these prices from that of the best commercial superphosphates. In this report the price will also be assumed at 12½ cents. This, I believe, is considerably more than it is really worth, but is probably the lowest rate at which it can now be purchased.

III. *Actual ammonia.*—The cheapest commercial source of this body is Peruvian guano. Although it contains several per cents. of potential ammonia, yet the latter is so readily converted into actual ammonia, that the whole effect of the manure is produced in one season, and therefore we may justly consider the whole as of equal value with actual ammonia.

Good Peruvian guano contains:

2 per cent., or 40 pounds per ton of potash.
3 " " " 60 " " " soluble phosphoric acid.
12 " " " 240 " " " insoluble " "
and yields
16 " " " 320 " " " ammonia.

If we add together the values of the potash, (see next page,) and of the phosphoric acid, soluble and insoluble, and subtract the same from the price of guano we shall arrive at the worth of the ammonia—as follows:

40×4=$1.60; 60×12½=$7.50; and 240×4½=$10.80; total $19.90.

$65.00—$19.90=$45.10 the value of 320 pounds of ammonia.

$45.10÷320=14 cents nearly, the value of one pound.

This price, 14 cents per pound, will be employed in this report.

IV. *Potential ammonia.* The value of this varies so greatly; being, for example, as uric acid in guano, not inferior to actual ammonia, while in woolen rags it is not worth more than one-half as much, that we can fix no uniform price, but must decide what it shall be, in each special case, separately.

V. *Potash.* The value of potash is difficult to estimate, because it may vary exceedingly according to circumstances. Wood ashes are its chief sources; these are poor or rich in potash according to the kind of tree that yields them, and the soil on which it has grown. It may vary from five to twenty per cent. Stoeckhardt, who estimates the value of ammonia at twenty cents, makes potash worth four cents per pound. The price of potashes can not serve as a guide, for they are never used for agricultural purposes. Four cents is certainly high enough for this country if it is correct for Germany.

12. *Potash may be usually neglected.*

Most concentrated manures contain very little or no potash. In guano it rarely exceeds three per cent. Superphosphate of lime can contain none of consequence. Potash can not be economically added to manufactured manures, because nearly pure potash, or even the raw material from which it is extracted, viz.: wood-ashes, has a higher commercial value for technical than for agricultural purposes. Besides, potash is not *generally* deficient in soils, and therefore farmers do not wish to pay for it as an ingredient of costly manures. It is only when a manure is professedly sold as containing much potash, that this ingredient deserves to be taken account of in its valuation.

13. *Computing the money-value of concentrated manures.*

In what immediately precedes, is contained the data for calculating *approximatively* the price that can be afforded for a high-priced manure, if we have before us the results of a reliable analysis. The actual calculation is very easy, and has been illustrated already in deducing the value of ammonia from Peruvian guano. We give here a *resume* of the prices adopted in this report, viz.:

Potash, per pound, - - - - -	4 cents.
Insoluble phosphoric acid, per pound, - -	4½ "
Soluble " " " - -	12½ "
Actual, and some forms of potential ammonia,	14 "

As a further example of the calculation, here may follow the details of the valuation of a superphosphate of lime. Analysis gave the following percentages:

Actual ammonia, - - - - -	2.39,	say 2.4
Potential " - - - - -	1.06,	" 1.0
Soluble phosporic acid, - -	2.56,	" 2.6
Insoluble " " - -	22.98,	" 23.0

Multiplying the percentage of each ingredient by its estimated price, and adding together the products thus obtained, gives the value of one hundred pounds; this taken twenty times, gives us the worth of a ton of two thousand pounds.

In the case before us, the quantity of potential ammonia is so small that we may reckon it with the actual ammonia without materially influencing the result. Thus,

$2.4+1.0=3.4$; $3.4\times14 = .48$, value of ammonia in 100 lbs.

$2.6\times12\frac{1}{2}= .33$, value of soluble phos. acid in 100 pounds.

$23\times.04\frac{1}{2}=\$1.03$, value of insol. phosphoric acid in 100 lbs.

$1.84, total value of 100 lbs.
20

$36.80, value of one ton.

It is not claimed that this method of valuation is more than rough and approximate. Usually the price demanded is more than that obtained by calculation. In case of the superphosphate just mentioned, the selling price is $45. There is no doubt that it ought to be better for that money. The farmer must decide for himself whether he can get the same fertilizing materials more cheaply. If he cannot he may purchase such a superphosphate. For *comparing the worth of different fertilizers* this method of computation is of great value, as will be seen further on, where will be found tables giving the calculated values of all the high-priced manures that have come into my hands officially, during the last two years.

It is but just to mention here, that this method of estimating the value of fertilizers was first proposed nine years ago by Dr. J. A. STOECKHARDT, Professor of Agricultural Chemistry in the Royal Academy of Agriculture and Forestry, at Tharand, near Dresden, in Saxony, and has been adopted in principle by the chemists of the agricultural societies in Great Britain.

The estimates I made in 1856 were much lower than those now given. The price of manures has advanced since that time, (Peruvian guanos ten dollars per ton,) and the prices I then proposed for phosphoric acid were too small. All the estimated values in this report are founded on the prices just given.

14. *Estimation of the value of cheap manures.*

The method of valuation above described is not applicable to cheap manures, which contain but little ammonia or phosphoric acid. Their value often depends more upon the mechanical and chemical condition of their ingredients, than upon the quantity of any one. The few manufactured manures of this sort, may best be compared with some similar fertilizer of standard commercial value, viz.: stable manure, leached ashes, &c. Under the head Poudrette, examples will be given.

EXAMINATION OF COMMERCIAL MANURES.

GUANO.

1. *Peruvian Guano.*—The manner in which the importation

and sale of this standard fertilizer has been hitherto conducted, is such as to afford a sufficient guarantee of its genuineness. But four samples have been analyzed. All were good, as shown by the following results:

ANALYSES OF PERUVIAN GUANO.

	I.		II.		III.		IV.
Water, ...	66.32	65.18	12.63	12.70	68.00	68.70	59.46
Organic Matter, ...			52.27	51.46			
Ammonia potenial, ...	5.82	5.95	16.03	15.98	17.86	18.85	16.32
" actual, ...	8.93	9.08					
Phosphoric acid, sol. in water, .	4.69	3.64	15.19	14.08			
" " insol. "	10.05	10.50					
Sand, &c., insoluble in acids,	1.69	1.52	2.45	2.66			
Phosphate of lime equivalent to total phosphoric acid, av.	21.28		31.69				

I. Came from the store of Wm. Kellogg, Hartford, 1856.
II. " " " Wm. B. Johnson, New Haven, 1857.
III. " " " Backus & Barstow, Norwich, 1857.
IV. " " " C. Leonard, Norwalk, 1857.

A Peruvian guano is genuine and good, when it contains 15 per cent. of ammonia, and the same amount of phosphoric acid. The first analyses were made more complete than is necessary for judging of the quality of this manure. It is sufficient, as in the last two analyses, to ascertain the amount of loss, (water and organic matter,) by burning, and the amount of ammonia.

I believe the fact that guano may rapidly depreciate in quality by keeping, is not sufficiently thought of. In a note by Dr. Krocker, in a recent German Agricultural paper, it is stated that the loss in guano may amount to one-fifth or even one-fourth of the whole ammonia originally present, *during a single winter, especially when access of moist air is allowed.* If guano is kept dry and away from the air the loss is trifling. The ammonia of a genuine guano, although to a considerable extent "existing in possibility not in act," passes so readily into actual ammonia that it must be reckoned as such. The phosphoric acid also, in a Peruvian guano, is all in a readily soluble state, and it is not fair to make so great a distinction between the portions soluble and insoluble in water, as would be right in case of a manure which has been reduced to powder by mechanical means.

2. *Pacific Ocean Guano.*

ANALYSES.

	I.		II.	
Water,	36.24	36.10	21.70	21.44
Organic matter,			32.35	32.33
Ammonia potential,	.75	.68	.71	.58
" actual,	1.96	1.84		
Phosphoric acid, soluble in water,	2.27	2.77	23.27	24.60
" " insoluble in water,	23.68	20.91		
Sand, &c., insoluble in acid,	2.75	2.10	.51	.57
Phosphate of lime equivalent to total phosphoric acid, average,	53.76		51.86	
Dealer's price per ton,	$50.00			
Calculated value per ton,	$34.00		$30.00	

I. From a sample sent by the importers to a dealer in Hartford, 1856.

II. From a sample sent by the dealers in New York to the agricultural store of Wm. B. Johnson, taken from the bags by this gentleman in my presence.

The sample 1. when sent into this State was advertised as nearly if not quite equal to Peruvian guano. In support of this statement the following certificate was given: "I have analyzed a sample of guano for Willet & Co., and find it to contain the following:

Phosphate of lime,	42.48
Carbonate "	2.26
Urate of Ammonia, Phosphate " &c., Carbonate "	20.54
Chloride of Sodium, " Potassium, Sulphate of Soda, &c.,	14.46
Undecomposed organic matter, feathers, &c.,	3.26
Silicious matter,	5.10
Water and loss,	12.00
	100.00

JAMES CHILTON, M. D., Chemist."

New York, October 4th, 1854.

The above analysis has a very elaborate appearance, but does not instruct us as to the value of the sample analyzed by Dr.

Chilton. In fact, it is eminently adapted to deceive; it gives the impression that the substance in question contains 20.5 per cent. of ammonia salts, yet without actually asserting that it contains even 1 per cent. of ammonia. Calculation shows that so far from being "nearly if not quite equal to Peruvian guano," it is not worth so much by $31 per ton, and that $16 was charged for it above its real value.

The second sample analyzed last summer, is still poorer. In calculating its value, I have admitted it to contain the same amount of soluble phosphoric acid that was found in I. This ingredient was not determined and is probably less than thus admitted.

3. *Ichaboe Guano.* I quote the analysis and history of this manure from my investigations made in 1856, in order to show what sort of impositions have vanished from the State of Connecticut since a chemical scrutiny has been exercised over our fertilizers. Ten years ago a very good guano was obtained from the Ichaboe islands, containing 7 per cent. of ammonia, and 15 per cent. of phosphoric acid; worth therefore now, about $35 per ton. In 1851 the deposits were exhausted. In 1856 it was announced that there was a new arrival of this superior guano, and it was offered in New York at $40 per ton. An authentic sample was procured at the store of the agent, A. Longett, in New York City, and subjected to analysis.

It had a very unpromising appearance, and contained some feathers, together with much coarse sand and gravel. Several pounds were rubbed in a mortar to break down any soft lumps, and then were shaken on a sieve of sixteen holes to the linear inch.

89.1	per cent.	passed the sieve.
9.4	"	coarse sand and gravel.
1.5	"	feathers remained.
100.0		

This fine portion was analyzed as usual. The results were calculated on the whole, including the 9.4 per cent. of sand and gravel, under the item "sand and insoluble matters," and the feathers under "organic matter." To the potential ammonia found in the fine guano, was added 0.2 per cent. as the greatest amount that could be yielded by the feathers.

Analysis of Ichaboe Guano.

Water and organic matter, . . .	17.43	18.52
Ammonia potential, . . .	1.37	1.41
" actual, ...	1.53	1.51
Phosphoric acid, ...	6.97	7.64
Sand and matter insoluble in acid, . .	65.72	63.87
Phosphate of lime equivalent to total phosphoric acid, average, ...	15.82	
Dealer's price, $40.		
Calculated value, $15.		

This is the only manure I have examined that contained 65 per cent. of sand and gravel.

4. *Baker's Island or American Guano.*—The specimen of this guano furnished me by Mr. Secretary Dyer, is of excellent mechanical condition, and gave results essentially agreeing with those of Dr. Higgins and Dr. Gale, viz:

Water, organic and vegetable matters, .	11.97	11.70
Insoluble matters, sand, . . .	.10	.17
Phosphoric acid, ...	38.16	38.63
Ammonia, ...	.68	
Phosphate of lime equivalent to phos. acid,	83.36	
Calculated value, $34.50		

It thus appears that the above is an excellent quality of phosphatic guano. So finely divided is the phosphate of lime that it must be dissolved with sufficient rapidity, in any moderately retentive soil, and if it can be had at $35 per ton, I should not hesitate to use it in preference to any superphosphate or other phosphatic manure now in our market. It can not, however, produce the remarkable effects of Peruvian guano, or of other ammoniacal manures, whose efficacy depends greatly on their ammonia.*

* Analyses made during the present year demonstrate that what is now sold in this State as American Guano, is a very inferior article containing but 7.9 per cent. of phosphoric acid, and chiefly consisting of sulphate of lime.

S. W. J., 1859.

SUPERPHOSPHATES.

The manufacture of manures bearing the general designation of *Superphosphate of Lime*, first begun in this country about five years ago, and has rapidly extended. As was to be expected, they have proved highly useful in very numerous instances, and when well prepared are to be looked to as the best means of supplying phosphoric acid to crops. There is, however, no other fertilizer which so easily admits of adulteration or fraud, as this, and none whose real value is so difficult to determine. Simple inspection or any other means short of a thorough and costly analysis, furnishes not the slightest clue to its genuineness and excellence.

There is so much confusion with regard to the different phosphates of lime, arising mainly from the great variety of names that have been applied to them, that perhaps it will be a service to many of the readers of this report, to set forth the chemistry of this subject in a few words. For this purpose I copy from my published articles.

Chemistry of the Phosphates of Lime.

The reader will please bear in mind, that phosphate of lime is in chemical language a *salt:* which means—in a chemical sense be it remembered—a compound of two classes of bodies, the one called *acids*, the other *bases.*

These bodies follow the universal natural laws of *combination in definite proportions*, and the numbers expressing these proportions, are termed *equivalents.*

We can best illustrate this with a body like sulphate of lime, (plaster of Paris, gypsum,) which is a salt consisting of but one acid, and one base, and but one equivalent of each.

The acid is *sulphuric acid*, its equivalent is	40
The base is *lime*, its equivalent is	28
The salt is *sulphate of lime*, its equivalent is	68

The above becomes intelligible when it is considered that in every specimen of pure gypsum that has ever been examined, the lime and sulphuric acid are present in exactly the proportions indicated by the numbers 40 and 28, and it has been proved a hundred times, that when lime and sulphuric acid are brought together in such circumstances that they can unite, they always do unite in the above proportions. This is what is meant by the law of definite proportions.

The word equivalent simply means that 28 parts by weight, grains, pounds, &c., of lime, are equal to, or go as far, in making a salt, as 40 grains, pounds, &c., of sulphuric acid.

Unlike sulphuric acid, (one equivalent of which usually combines with but one equivalent of a base,) one equivalent of phosphoric acid usually unites with *three* equivalents of base; and these three equivalents may be all of one base, or two of one base and one of another, or, finally, may be all of different bases. What is most remarkable is, that *water* may act as a base; but it is not customary to allow the water to figure in the name of the compound; and in this way, the three phosphates that contain lime and water as the basic ingredients, are all called phosphates of lime. They are distinguished from each other by a variety of prefixes, unfortunately numerous, and none of which are strictly in accordance with the general principles that regulate chemical name-making.

The constitution of these three phosphates of lime may be represented as follows:

The first is phosphoric acid (72), lime (28), lime (28), lime (28).
The second is phosphoric acid (72), lime (28), lime (28), water (9.)
The third is phosphoric acid (72), lime (28), water (9), water (9.)

The equivalents are given with each ingredient, and by adding them together we find the equivalent of each phosphate.

The 1st,	72	of acid,	and 84	of base.	is 156.
The 2d,	72	" "	and 65	" "	is 137.
The 3d,	72	" "	and 46	" "	is 118.

What is the use of these equivalents? may be asked. In 156 parts (ozs. or lbs.) of the 1st are 75 parts, (ozs. or lbs.) of phosphoric acid: in 137 parts of the 2d, and in 118 parts of the 3d, is the same quantity. A simple operation of "rule of three," will reduce these quantities to *percents*, and thus we may more readily compare their composition.

Percent composition of the phosphates of lime.

	1	2	3
Phosphoric acid, -	46.15	52.55	61.02
Lime, - -	53.85	40.88	23.73
Water, - - -		6.57	15.25
	100.00	100.00	100.00

With regard to the names of these phosphates, I have already hinted that much confusion exists.

To No. 1 have been applied the names, neutral, basic, ordinary, tri-, and bone-phosphate. To No. 2, bi-, di-, and neutral phosphate. To No. 3, mono-, bi-, acid, and superphosphate.

No. 1, we may designate as *bone-phosphate of lime*, because it is the chief earthy ingredient of bones, or at any rate it remains when boues are burned, and constitutes the larger share of bone-ashes. It is almost absolutely insoluble in pure water; but dissolves perceptibly in water eontaining in solution salts of ammonia, or common salt, or carbonic acid. It is also the principal ingredient of the so-called mineral phosphates,—of *Apatite*, that occurs abundantly in the iron mines of northern New York, of the *Eupyrchroite* of Crown Point, and the *Phosphorite* of Estramadura in Spain, and of Hurdstown, New Jersey. In the fossil bones, the so-called *Coprolites* of certain districts in England, and in the phosphatic nodules of the silurian rocks of Canada, a variable quantity of bone-phosphate of lime is contained. The phosphoric acid of all the genuine guanos exists mostly in combination with lime as bone-phosphate.

No. 2, most commonly called the *neutral phosphate of lime*, deserves notice as occurring mixed with bone phosphate in the Columbian guano, and in the similar phosphatic guanos recently imported by the Philadelphia Guano Company. It will be noticed further on.

The agricultural value of phosphoric acid, and of the phosphates of lime is sufficiently understood. To them, bones mainly owe their efficacy as a fertilizer. It is well known that, although bones are highly useful when applied to the soil in a coarsely-broken state, they are far more valuable if reduced to small fragments, or better still, if ground to dust. This is because nothing can enter the plant in a solid form. All that a crop absorbs through its roots must be dissolved in the water of the soil. The bone-phosphate of lime is only slightly soluble in water, and is of course very slowly presented to the plant. The more finely it is divided or pulverized, the more surface it exposes to the action of water and the more rapidly it dissolves. By grinding it is only possible to reduce bones to a gritty dust, fine perhaps to the unaided eye, but still coarse, when seen under the microscope. Chemistry furnishes a cheap means of extending the division to an astonishing degree, and enables us to make bone-manure perfect both in its mechanical and chemical qualities.

This brings us to No. 3, or *superphosphate of lime*, which is the characteristic ingredient of the genuine commercial article known by that name, in which, however, it is largely mixed with other substances. Its peculiarity is, ready solubility in water. It may be prepared from either No. 1, or No., 2, by adding to these phosphoric acid, or by removing lime, in presence of water. In practice lime is removed.

If to 156 parts (one equivalent) of bone phosphate of lime, we add 80 parts (two equivalents) of sulphuric acid,* with sufficient water to admit of an intimate and perfect mixture, then the 80 parts of sulphuric acid take 56 parts (two equivalents) of lime and form sulphate of lime, while the phosphoric acid retains 28 parts (one equivalent) of lime, and 18 parts (two equivalents) of water replace the lime removed by the sulphuric acid, so that there results 136 parts of sulphate of lime, and 118 parts of superphosphate.

The manufacture of good superphosphate of lime, consists essentially in subjecting some form of bone-phosphate of lime—it may be fresh or burned bones, mineral-phosphates or phosphatic guanos—to the action of sulphuric acid. The product of such treatment contains sulphate of lime, superphosphate of lime, and still a greater or less share of undecomposed bone-phosphate, together with some free snlphuric acid, because the materials can not be brought into such thorough contact as to ensure complete action.

---

* *Oil of Vitriol* is a compound of about 75 per cent. of sulphuric acid, with 25 per cent. of water.

The reader can easily perform a simple experiment that illustrates the change which superphosphate of lime, or any soluble phosphate, always undergoes when brought into the soil. Stir a spoonful of superphosphate in a tumbler of water; let it settle and then pour off the clear liquid into another tumbler, (if no superphosphate is at hand, use instead of the liquid just mentioned, strong vinegar in which some bits of bones have stood for a few days.) Now stir a few lumps of salæratus or soda, in water, and pour it gradually into the first liquid. Immediately a white cloud, or *precipitate*, as the chemist calls it, is formed; at the same time the liquid will foam like soda water, from the escape of carbonic acid gas.

This white cloud is *precipitated bone-phosphate of lime*, and does not essentially differ from the original bone-phosphate, except that it is inconceivably finer than can be obtained by any mechanical means. The particles of the finest bone-dust will not average smaller than one hundredth of an inch, while those of this precipitated phosphate are not more than one twenty-thouandth of an inch in diameter.*

Since the particles of the precipitated phosphate are so very much smaller than those of the finest bone-dust, we can understand that their action as a manure would be correspondingly more rapid.

In fact, the application of superphosphate to the soil, is always speedily followed by the formation of this precipitated phosphate; the iron, lime, potash, &c., of the soil, having the same effect as that produced by the salæratus or soda in the above experiments.

The advantage of dissolving, or rather acting upon bones with sulphuric acid, is then, not to furnish the plant with a new food; but to present an old dish in a new shape, more readily accessible to the plant. In addition to the advantage of *sub-division* thus presented, another not less important is secured; viz: *distribution.* This may be illustrated as follows: If one part of a quantity of superphosphate be mixed with chalk, lime, or ashes before use, while another portion is directly applied, in both cases precipitated phosphate will be furnished to the soil. The

* Prof. Ogden N. Rood, of the Troy University, has had the kindness to measure them under the microscope at my request.

sub-division will be equal, but the *distribution* will be unlike. In the first case, the ready-formed phosphate is very imperfectly mixed with the soil, by the mechanical operations of tillage. In the latter instance, if the superphosphate be scattered on the surface, it is unaffected until a rain falls upon it. Then the superphosphate dissolves, and trickles or soaks down into the soil, meeting here with a particle of lime or potash, and depositing a particle of bone-phosphate, traveling on a little way, and depositing another, and so filling the whole soil to a certain depth with the precious fertilizer.

It seems then that it is important not only that the superphosphate be *made*, but that it *remain* such, until strewn on the soil.

I would suggest that the simplest, and for agricultural purposes, the most accurate way of designating the phosphates of lime, and all other phosphates, is to divide them into two classes, *soluble* and *insoluble*, and always to base calculations on the *phosphoric acid* they contain, because it, and not lime or water, is the valuable ingredient of them all. Accordingly, in all my analyses, I have invariably stated separately the amount of phosphoric acid soluble in water and the quantity insoluble in that vehicle of vegetable nutriment.

For the sake of comparison with the common standards, the quantity of bone phosphate equivalent or corresponding to the phosphoric acid, has been included in the analytical tables. The amount of bone phosphate of lime is obtained by multiplying the phosphoric acid by 13 and dividing the product by 6.

What ought to be accepted as the standard of composition in a commercial superphosphate?

The answer to this question is: as good an article as can be manufactured on the large scale.

There are two classes of good superphosphates. One is represented by the following analysis made by me in 1852, on what then was Mapes' improved superphosphate:

Ammonia, - - - -	2.78
Soluble phosphoric acid, - -	10.65
Insoluble " " -	10.17

Here we have 21 per cent. of phosphoric acid, one-half of which is soluble in water. The proportion of soluble phosphoric acid is sufficiently large for a quick and energetic action, while the still insoluble phosphoric acid renders its effect more lasting. The 3 per cent. of ammonia is a constituent which makes the manure more generally useful than it would be otherwise. Such a manure is worth as follows:

Ammonia	3 per cent × 14	=$0.42	× 20=	$8.40
Soluble phos. acid,	11 " " × 12½=	1.37½	× 20=	$27.50
Insoluble "	10 " " × 4½=	0.45	× 20=	$9.00
Total value,				$44.90

This sample is the only one of its class that has hitherto fallen into my hands.

The other kind is, strictly speaking, a superphosphate, containing but little insoluble phosphoric acid, and no ammonia. It is precisely what it is called, and is intended to be an adjunct to other fertilizers. The following statement of composition and worth—the average of four best English samples, according to Prof. Way's analyses—gives an idea of this manure:

Soluble phosphoric acid,	13.23,	worth per ton,	$33.20
Insoluble " "	3.07,	" "	$2.80
Total value, - - - - - - -			$36.00

The only specimen of such a superphosphate that I have analyzed, is that made by B. M. Rhodes & Co., of Baltimore, Maryland.

Besides these two classes of superphosphates, there is another, which indeed includes many good manures, but they hardly deserve to be called superphosphates, as they contain but two or three per cent. of soluble phosphoric acid. They *are*, however, called superphosphates, but we cannot admit that they are any thing better than second-rate articles.

In stating the composition and value of the superphosphates I have examined, I shall class together those coming from the same manufacturer, or otherwise such as most nearly agree in composition. This plan will enable us to trace the improvement of deterioration in the manufacture, when numerous samples have been examined, and, otherwise, will facilitate comparison.

Mapes' Superphosphate—Newark, New Jersey.

The best superphosphate that has ever come under my examination, was the one that is first given in the table below. The sample analyzed in 1856 had but half the value of the first; and in 1857 the three specimens analyzed are worth but one-third as much. It is clear that this is a brand not to be depended upon, and the material that has come into Connecticut the past year is hardly worth a long transportation.

	Mapes' Improved.		Mapes' Nitrogenized.				
	I.	II.	III.			IV.	V.
	1852.	1857.	1856.			1857.	1857.
Water,	4.54	7.90	43.24 (Water and organic matter together)	42.72	41.68	11.15	21.61
Organic and vol. matter,	22.96	15.04				18.65	26.29
Sand and matters insol. in acids.	1.48	13.90	6.20	6.57	7.76	16.91	4.18
Lime,		28.08				23.55	
Sulphuric acid,							
Carbonic acid,	none	6.54		none		7.52	2.38
Phos. acid soluble,	10.65	none	1.12	1.07	0.58	none	none
" " insoluble,	10.17	13.56–13.20	9.18	9.11	10.12	10,19–9.60	9.85
Ammonia actual,	2.78	1.16	1.54		1.48	2.28	1.16
" potential,			2.11		2.16		
Phos. lime equivalent to phos. acid,	45.11	28.99	av. 22.44			21.43	21.34
Calculated value,	$44.	$15	$21.			$14.50	$12.50

I. Furnished by Edwin Hoyt, Esq., New Canaan, Ct.

II. From store of Backus & Barstow, Norwich, Ct.

III. From a Hartford dealer.

IV. From store of Backus & Barstow, Norwich, Ct., average from many bags.

V. From C. Leonard's store, Norwalk, Ct.

Mechanical state mostly good.

Deburg's Superphosphate—Williamsburg, Brooklyn, L. I.

The sample analyzed in 1856 was of a very fair quality. The last year it is seen, however, that there is a serious falling off.

	Deburg's Superphosphate.				
	I. 1852.		II. 1856.		III. 1857.
Water, organic and volatile matters,	27.65	26.24	24.57	21.23	25.20
Sand and matters insoluble in acids,	8.45	8.80	6.89	7.37	
Phosphoric acid soluble in water,	5.96		2.56	2.46	.51
" " insoluble "	14.37	15.78	22.98	22.53	17.61
Ammonia actual,	1.38		2.39	2.25	1.44
" potential,			1.06	1.24	
Phosphate of lime equiv. to phosphoric acid,	av. 45.56		54.74		39.26
Calculated value,	$32.		$36.25		$21.50

I. From the agricultural store, New Haven, Ct.

II. From the factory—taken from a heap in my presence.

III. From Messrs Backus & Barstow, Norwich—sample made up by taking a spoonful from each bag of a large lot.

Mechanical condition, good.

Coe's Superphosphate—Middletown, Ct.

This fertilizer, manufactured in Connecticut, has been subjected to pretty severe scrutiny, and has maintained a good degree of uniformity in composition. The variations are perhaps not greater than are necessarily incidental to the manufacture.

COE'S SUPERPHOSPHATE.

	I. 1854.		II. 1856.		III. 1856.		IV. 1856.		V. 1857.	VI. 1857.		VII. 1857.	
Water, organic and volatile matters,	32.70	31.67	35.36	35.19	40.27	40.37	37.53	38.02	37.55	34.90	35.30	29.50	29.33
Sand and matters insoluble in acids,	5.97	6.31	2.94	2.60	3.36	2.94	3.15	3.37		4.50		3.77	3.62
Phosphoric acid soluble in water,	3.37	3.47	3.90	4.19	4.35	3.75	3.59	3.84	2.91	2.53	2.69	2.17	2.19
" " insoluble in water,	16.29	16.80	19.06	18.42	16.22	16.33	17.59	17.84	18.08	16.83	16.48	21.11	20.77
Ammonia, actual,	2.12	2.07	1.57	1.77	1.65	1.66	1.50	1.66	3.30	2.69	2.89	3.08	3.14
" potential,	1.47	1.52	1.58	1.60	1.28	.95	1.55	1.38					
Phosphate of lime equivalent to phosphoric acid,	av. 44.33		49.35		44.35		46.47		45.48	41.73		50.09	
Calculated value,	$33.75		$36.25		$33		$41		$33	$35		$33.25	

I., II., III., IV. From the agricultural stores of New Haven and Hartford.

V. From store of Backus and Barstow, Norwich, Ct.

VI. and VII. From Henry Hull, Esq., Naugatuck, Ct.

Mechanical condition uniformly good.

Coe & Company's Superphosphate—Boston, Mass.

This manure, furnished by Henry Hull, Esq., of Naugatuck, Ct., is of a grayish white color, and is in good mechanical condition. Its analysis resulted as follows:

Water, organic and volatile matters,	26.70	26.19
Sand and insoluble matter,	7.15	6.79
Soluble phosphoric acid,	none	
Insoluble " "	19.98	20.27
Potential ammonia,	3.06	
Phosphate of lime equivalent to phos. acid, av.,	43.59	

Calculated value, $26.50.

This manure is wrongly named.* It is a good bone-manure at $30 per ton.

L'loyd's Superphosphate—Providence, R. I.

This fertilizer I believe enjoys a good reputation as compared with other similar manures. Its texture is fine. It is apparently made from unburned bones. Its composition is as follows:

Water, organic and volatile matters	42.15	42.48
Sand and insoluble "	7.00	5.20
Lime,	20.61	19.50
Sulphuric acid,	11.80	
Soluble phosphoric acid,	5.53	15.50
Insoluble " "	11.41	
Potential ammonia,	2.48	2.55
Phosphate of lime, equivalent to phos. acid, av.,	35.14	

Calculated value, $31.

The proportion of soluble phosphoric acid is considerably above the average. The total amount is however small.

* I have since learned that this sample was mis-labelled. Messrs. Coe & Co., sell it as "Steamed Bone." S. W. J.

Rhodes' Superphosphate—Baltimore, Md.

In my address before the State Agricultural Society a year ago, I made mention of Rhodes' superphosphate to illustrate a common fault in the analysis of commercial manures, viz: calculating or inferring a result from insufficient grounds, instead of actually deciding the matter experimentally. An analysis of this manure was quoted from the proprietor's circular, wherein the total amount of phosphoric acid is estimated, and from the quantity of sulphuric acid present is *inferred* the proportion of soluble phosphoric acid. I stated that doubtless a fuller analysis would demonstrate that the amount of the soluble phosphoric acid was considerably smaller than represented.

The sample with which I have been furnished by Mr. Dyer gave the following results in three analyses:

				Average.
Water, organic and volatile matters,	27.60	27.73	26.60	27.31
Insoluble matters, sand, &c.,	3.22	2.47	10.05	5.24
Lime,	20.13	20.25		20.19
Soluble phosphoric acid,	12.13	11.65	11.03	11.60
Insoluble " "	3.91	3.77	3.94	3.87
Total " "	16.04	15.42	14.97	15.47
Potential ammonia,	.24	.24		.24
Phosphate of lime equivalent to phosphoric acid,				38.80
Calculated value, $32.25.				

The variation in the analytical results is due to the difficulty of averaging the manure. When rubbed in a mortar it becomes slightly pasty and can not be very thoroughly intermixed.

The mechanical condition of this superphosphate is unexceptionable.

In a new edition of their circular, Messrs. Rhodes & Co. publish analyses and report made by Drs. Higgins and Bickell, according to which this superphosphate contained, in four samples respectively, the following amounts of phosphoric acid:

	1	2	3	4	5
Soluble phosphoric acid,	14.32	16.01	17.73	17.56	11.60
Insoluble " "	none.	1.49	none.	1.22	3.87
Total,	14.32	17.49	17.73	18.78	15.47

4 Is the statement made in their circular which I read last year before this Society. 5 Is the average result of my own ac-

tual determinations. It is seen that the statement in my address is confirmed, in case of the sample I analyzed. At the same time. the difference is not seriously great.

In the analyses of Messrs. Higgins and Bickell, several per cent of soda are given. I have not taken the trouble to estimate this ingredient, which has no significance in case of an expensive fertilizer.

Other Superphosphates.

	Wallingford, Ct. I. 1857.		Buck's bone superphosphate, Hartford, Ct. II. 1857.	
Water, organic and volatile matters,	48.30	48.05	51.59	51.46
Sand and insoluble "	8.98	8.78	.60	.98
Lime,			20.53	20.36
Sulphuric acid,	10.67			
Soluble phosphoric acid,	2.02	12.00	14.25	14.17
Insoluble " "	9.72			
Potential Ammonia,	7.35	6.92	2.50	2.54
Phosphate of lime, equivalent to phosphoric acid,	21.34		30.79	
Calculated value,	$34.50		$31.00	

I. This was furnished me by Mr. Parmelee of New Haven. It contains much potential ammonia in the form of gelatine, but the material is so poorly pulverized, consisting of coarsely-crushed bones, that its action must be slow. A large reduction must therefore be made from the calculated price.

II. Is in good form. The sample furnished was small, so that I was unable to determine the soluble phosphoric acid.

COLUMBIAN OR ROCK GUANO.

This substance, which has also been called a native superphosphate of lime, is reported to come from certain islands in the Caribbean Sea. It occurs in hard stony masses, which vary much in structure, color and composition. The rock that is richest in phosphoric acid is concretionary in structure. Externally its color is gray or white, internally brown or black. This rock, though quite tough under the hammer, may be readily reduced to a fine powder, having a yellowish or brownish-gray color, and in this form it now appears in the market. It has been supposed that this guano is formed from the excrements of gulls, pelicans, and cormorants, which are the sole inhabitants of the islands where it is found. These islands are a hundred or more in number, and it is said that the guano exists there in enormous quantities. The rock guano consists essentially of phosphates, but is more or less intermixed with other mineral matters. It contains but a trifling amount of ammonia, or of ammonia-yielding substances.

The composition is seen from the following table:

ANALYSES OF COLUMBIAN GUANO.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
Water and organic matter,	8.74	8.62	8.65	11.75	18.09	13.03		22.87	12.17	10.75
Sand and matter insoluble in acid,	5.86	5.93	6.51	9.05	2.66	0.55		13.18	52.07	0.02
Lime,	36.04	36.00	35.95	28.85	none.	40.60	39.34	2.66	0.37	39.01
Magnesia,	1.84	1.82	1.83			2.93	1.64		0.27	0.22
Potash,	1.57	1.19	1.38							
Soda,	.09	.36	.23			3.23				
Oxyd of iron,	1.36	1.36	1.36		much.			12.41	1.55	0.11
Alumina,					much.			16.24	13.03	
Sulphuric acid,	4.06	4.13	4.10			1.93	4.00	1.07		7.08
Phosphoric acid,	40.09	39.45	40.40	33.50	34.69	37.15	42.98	31.66	19.47	43.50
Carbonic "										
Chlorine,						.44				
	99.65	98.86	100.41							100.69
Ammonia,	.28	.28								
Phosphoric acid soluble in water,	.85	.70	*2.67			.85	.81			
Phosphate of lime equivaleut to phosphoric acid,	86.86	85.47	87.53	72.68	75.18	80.49	93.16	68.59	42.18	94.25
Calculated value,	$36.00	$36.00	$36.00	$30.00	$31.00	$33.50	$38.70	$28.50	$17.50	$39.00

* Dissolved by long-continued washing with het water.

I. and II., ground guano, sent to editors of Homestead, by the proprietors of the guano.

III., unground guano, sent to editors of Homestead, by the proprietors of the guano.

IV., from a gentleman—a purchaser—near Philadelphia, Pennsylvania.

V., from the store of C. Leonard, Norwalk.

The above five analyses were made under my direction.

VI., VII., VIII. and IX., are quoted from a paper by Wm. F. Taylor, of Philadelphia, in the Proceedings of the *Philadelphia Academy of Natural Sciences*, March, 1857. The specimens were rock-samples, furnished by Dr. D. Luther, President of the Philadelphia Guano Company.

X., ground commercial sample; analysis by Drs. Higgins & Bickell.

Richness in phosphoric acid.—This, the only important ingredient, ranges in the majority of the above analyses at about forty per cent. In analyses V., IV., and VIII., it falls 5, 6, and 8 per cent. lower. In case of IX., we have but 20 per cent. of phosphoric acid. Analysis VIII. and IX., were made on a material quite different in external appearance from the rock furnishing the other samples. The Philadelphia Guano Company sent me specimens of these inferior kinds a year or more ago. They appear to be, and actually are, largely intermixed with sand, though when pulverised they can scarcely be distinguished by the eye from the best sorts. I had begun analyses of the specimens put into my possession, but their completion was rendered unnecessary by the appearance of Mr. Taylor's extended investigation. They contain little or no lime, and the phosphoric acid is combined with oxyd of iron or alumina.

The best qualities of Columbian guano form the richest known source of large quantities of phosphoric acid, if, indeed, there are large quantities of the best quality. But the above analyses show that even the commercial article found in the agricultural stores, varies considerably in value, while some of the rock samples are worth but half as much as the best qualities; and, therefore, bone-black, or bone-ash, is equal in this respect to the *average* of the best samples hitherto analyzed.

Solubility of the phosphoric acid.—The circulars of the Philadelphia Guano Company give an analysis of this guano, by Dr. Chilton of New York, according to which it contains 13.14 per cent. of *soluble phosphate of lime.* J. C. Booth reports therein, that Columbian guano contains 6.05 per cent. of *free phosphoric acid*, or 32.27 per cent. of *soluble phosphate of lime.* Dr. David Stewart, chemist to the State Agricultural Society of Maryland, in an analysis he furnishes, makes it to contain 5.23 per cent. of soluble phosphoric acid. Dr. A. A. Hayes of Boston, in his analyses, states that it contains 11.4 per cent. of phosphoric acid more than is requisite to form bone-phosphate of lime. He says it is in fact a kind of natural *bi-phosphate of lime.* J. C. Booth, in analyzing another sample, found 9.6 *per cent.* of *free* phosphoric acid. On the strength of these statements, the Columbian guano has been called a *native superphosphate of lime.* It is easy to understand how some of the gentlemen above-named have committed the inadvertency of asserting that the substance in question contains free phosphoric acid, or superphosphate of lime. The error is more to be attributed to the looseness of language than to any other cause.

The fact is, that some of these specimens of Columbian guano contain, in addition to the ordinary *bone-phosphate of lime*, the composition of which is—

phosphoric acid, lime, lime, lime—

more or less of the generally called *neutral phosphate*, which is—

phosphoric acid, lime, lime, water.

There is in it, however, no *superphosphate of lime*, which is—

phosphoric acid, lime, water, water.*

This *neutral phosphate* is slightly soluble in water, and is slowly decomposed by boiling water. Thus, in analyses I., II., VI. and VII., about 0.8 per cent. of phosporic acid was dissolved; and in III., by long continued washing with hot water, 2.67 per cent was made soluble. This neutral phosphate is decomposed by carbonic acid, and hence is doubtless readily available to vegetation.

* See that part of this report relative to superphosphate of lime.

As concerns the value of those varieties which consist chiefly of phosphates of iron, and alumina, V., VIII. and IX., I am unable to state whether or not they are capable of readily yielding their phosphoric acid to vegetation. As artificially prepared, these phosphates are totally insoluble in pure water, and are not easily decomposable. In fact, nearly all the knowledge we have of these compounds, leads to the idea that they are unadapted to feed the growing plant. Some writers have not hesitated to declare them quite valueless for agricultural purposes. The only satisfactory evidence, however, must be brought from direct trials with them in the soil, for bodies are soluble there, which ordinarily are accepted as the types of insolubility.

The PRINCE SALM HORSTMAR, of Germany, who has devoted much time and means, to studies having a direct bearing on agriculture, found, indeed, that phosphate of iron is actually assimilated by vegetation; but we do not yet know whether it may be appropriated with such ease as to adapt it for a fertilizer.

I had hoped to institute some experiments with a view to determine this point, but have not found the opportunity.*

POUDRETTE.

Since chemistry has explained in such a beautiful manner the action of manures, and made evident what enormous quantities of fertilizing material are daily lost to agriculture, the question of economizing the effete matters which accumulate in large towns, has excited deep interest.

The subject is not merely one of agricultural importance, but has extensive bearings upon the health of densely populated countries. Those substances which most easily pass into putrefaction, and then become in the highest degree disagreeable and dangerous to the inhabitants of cities, possess, as fertilizers, the greatest value to the farmer.

Not many years since it was common to find large cities filled with filth, which had accumulated during generations, with no other means of removal than the natural agencies of decay, or

* Investigations that have recently come to my knowledge, prove that the phosphates of iron and alumina are available as food to plants.

S. W. J., 1859.

rains might furnish. Not a few of the fearful plagues that in former centuries have ravaged the capitals of the old world, trace their origin most unequivocally, to the disgusting negligence in these matters, then prevalent.

It is therefore fortunate for a people, when the refuse of the town, instead of poisoning the atmosphere and generating terrible pestilences, can be transported to the fields of the country, and under the wonderful transmutations of agriculture be converted into healthful food.

Numerous efforts have been made with a view to produce a good manure from the night-soil of cities, but so far as I can learn, with very limited success, if the quality of the product hitherto brought into market is a proper criterion for judgment.

Practice and science concur in attributing to human excrements, very high fertilizing properties. It is well-known that the richness of manure depends upon the richness of the food that supports the animal producing the manure. It is equally well-known that, on the whole, no animal is so well fed as man.

Notwithstanding these facts the manures that have been prepared from night-soil, and brought into commerce under the names *Poudrette*, *Ta-Feu*, *&c.*, are not remarkable for their value. It is true that good manures are made, but they are by no means so concentrated as reasonably to command a high price, or warrant much outlay for their transportation.

Some of the causes that conspire to this result, become evident from the following considerations:

The night-soil as usually collected has already lost the chief part of its original value. Unless special arrangements are made to prevent the escape of urine from the vaults of privies, the greater part of it soaks away directly into the adjoining ground and is lost. Now the value of the urine voided by an adult man during one year, for example, is much greater than that of the corresponding solid excrements. It contains, according to Stoeckhardt, (Chem. Field Lectures, page 72):

Double the quantity of phosphoric acid.

Four times as much nitrogen.

Six times as much alkalies.

Not only is the urine itself lost to a considerable degree, but in the usual construction of privies it falls upon the solid excrements and washes away a considerable share of their soluble and active matters, so that the contents of a vault, even though quite fresh, are of very inferior value.

Again, the vaults are only emptied at considerable intervals, between which, especially in warm weather, a rapid putrefaction of their contents takes place, by which a good share of the nitrogen that remains after the urine has leached out the mass, escapes into the air in the shape of ammonia compounds, and is lost. After the night-soil has passed these two stages of deterioration, it is usually no longer suitable for the preparation of a concentrated manure, even supposing it free from foreign matters.

But again, considerable quantities of worthless matter, coal-ashes, &c., find their way into the vaults, which are, indeed, often an *omnium gatherum* for all sorts of refuse. Often the slops of the kitchen run into them, and the rains flow through them on their way to the deeper earth, washing in sand and dirt, and washing out the valuable ingredients.

From these facts, it is seen that the raw material used in making poudrette and tafeu, must be of variable, and for the most part, of inferior value.

The process of manufacturing ought to consist merely in converting the night-soil into a shape convenient for transportation, and if possible concentrating the valuable ingredients. The manure is made of the *best quality* by treating the night-soil with sulphuric acid and then rapidly drying by artificial heat. The acid prevents the loss of ammonia, while the drying removes the worthless water, and brings the mass into a suitable state for handling. The manure is manufactured *most cheaply* by mixing it with some drying or absorbent material, as peat, or swamp muck, or the charcoal of the same, and drying by exposure to the air. The first method is expensive and raises the cost of the product far above its value, unless the raw material is of unusually good quality. The second process dilutes the night-soil with matters which are indeed very useful, but must be sold very cheaply.

According to Nesbit's careful calculation, fresh human excrements, solid and liquid together, when dried completely, yield a material having the following per centage composition in round numbers:

Ammonia, (a considerable share not actual but potential,) - - - -	20
Other organic matters, - - -	62
Phosphoric acid, - - - - - -	3
Other inorganic matters, - - - - -	25
	100

The value of this, estimated by the prices adopted in the present report, is $60, and it therefore approaches Peruvian guano in commercial worth.

How effectually the causes I have enumerated deteriorate the value of night-soil before it is converted into a portable manure, is seen by the following analyses:

ANALYZED BY	Poudrette.	Poudrette. from Montfau-con.	Poudrette. from De. Bercy.	Saxon Guano, Dresden.		Poudrette. Liebig Man. Co.		Poudrette. Lodi Manufacturing Company. New York City.			Yard-Manure well rotted and dried.	Box Manure, mixed dung, and litter, fresh.	Yard-Manure, mixed dung of horses, bullocks, and pigs.	Horse-Manure well, rotted.
						East	Hartford, Ct.	New Haven ag. store.	Norwich. Backus & Barstow.	Norwalk, C. T. Leonard.				
	Sullivan.	Souberain.	Souberain.	Muller,	Scheven.	Seely.		Twining.	Twining.	Twining.	Dr. Voelcker,	Prof. Way.	Boussingault.	Richardson.
	I.	II.	III.	IV.	V.	VI.		VII.	VIII.	IX.	X.	XI.	XII.	XIII.
Water,	28.41	28.00	13.60	19.5	18.42	39.97	60.01	32.52	15.60	25.62				
Organic and volatile matter,	64.08	29.00	24.10	20.8	11.25	20.57		14.88	18.40	14.80	67.24			
Sand, &c., insoluble in acids,	.36	28.00	43.20	43.0	56.08	29.95	30.37	42.64			4.11			
Oxyd of iron,				5.6				2.43			2.74			
Alumina,								3.25						
Lime,				2.7				1.05			8.09			
Magnesia,				0.7				trace.			.56			
Phosphoric acid,				2.5		.87	1.05	1.06	1.19	1.36	1.83	.30	.20	.81
Sulphuric acid,				3.1				.79			.53			
Potash and Soda,				1.5				1.38			2.35			
Soluble silica,											6.82			
Carbonic acid,				0.6							5.73			
								100.00			100.00			
Ammonia from organic matters,	1.54	1.78	1.98	2.6	1.64	1.23	1.39	1.15	1.19	1.15	3.00	.56	.48	.75

The analyses I.–V. are quoted from foreign journals. Analyses VI.–IX. were made in the Yale Laboratory. I. represents the composition of a mixture of two parts of turf-coal, with one part of night soil, and shows how poor an article is procured when it is known what is the process of making. It will be seen that although no dirt or sand was mixed with the night soil, yet the amount of fertilizing matter is very small. The further details of the original analysis show that besides the ingredients stated above, there was but 5.3 per cent. of valuable matter in the pondrette, and this was mostly sulphate of lime.

II. and III. are analyses of poudrette made in France, the country where this manufacture originated, and from whose language the name is derived. There is every reason to suppose that these specimens were prepared in the best manner; blood and butchers' offal were employed in the latter.

IV. and V. show the composition of a poudrette made at Dresden in Saxony, the addition to which of some sulphate of ammonia, is claimed by *Dr. Abendroth*, the chemist who superintends its manufacture, to entitle it to the name of a guano. It does not differ materially in value from the French poudrette. I have before me a pamphlet setting forth the principles that, it is professed, guide the production of this manure, and have full faith that the business is managed as well as can be. The price of the article is about $1.00 per cwt. Dr. Mueller, chemist to the Agricultural Experiment Station at Chemnitz, in Saxony, the author of one of the above analyses, remarks concerning it, as follows: "In an experimental trial made last year (1855) at the Chemnitz Agricultural Experiment Station, with the purpose of testing the effect of various manures, the *same amount of money* being invested in each application, it resulted that the Saxon guano had the least effect of all. This led me to make the accompanying analysis. A glance at the figures is enough, without any actual trial, to show that no great effect can be expected from such a manure. From the *quantity* of valuable matters present, six *cwt.* of this might be considered equivalent to one *cwt.* of Peruvian guano; but when the form is taken into account—nearly one-half of the ammonia being inert, and the phosphoric acid existing as almost insoluble phosphate of iron—

its value must be estimated lower. The other ingredients are of less importance, and, at any rate, may be procured more cheaply from other sources."

VI. represents the composition of a poudrette manufactured by the so-called *Liebig Manufacturing Co.*, at East Hartford, Ct. It does not claim to be a concentrated fertilizer, its price being but $1.50 per barrel when sold in quantity. It is not just then to estimate its value from the ammonia and phosphoric acid alone, for the cheaper a manure is, the more must its less valuable ingredients figure in estimating its worth.

These have not been separately estimated, for the reason that no calculation of any permanent value, could be founded on one analysis of a material that is so likely to vary in these ingredients, especially where it is sold by bulk. This being a kind of manure that is applied in large quantity, and the ingredients being in proportions more nearly approaching the demands of the growing plant, than is the case with concentrated fertilizers, whose true function is to make up special deficiencies in the soil, we must appeal to practice for precise information as to its worth. Again, it has but a local value, for being bulky, it can not repay much expense in transportation, and therefore should not be judged by the general principles that commend or condemn a superphosphate or guano; but by the particular wants of the soil in the neighborhood where it is sold, and the local circumstances that there affect the price of other cheap fertilizers.

VII., VIII. and IX. are analyses of the *Lodi Co's. Poudrette*, prepared from the night soil of New York city. The extravagant and persistent claims that have been set up in favor of this manure, led to a complete investigation of its merits. To insure a fair examination, general analyses were made on three samples, and one of them was submitted to a full and minute analysis. The samples differed much in their degree of dryness. VII. fresh from New York, was quite moist, almost wet. VIII. was moist, but still powdery. IX. was dry to the feel.

In all these commercial poudrettes we observe a very large proportion of valueless *water* and *sand*, viz: 60 to 75 per cent.

The quantity of organic matters averages at about 20 per cent. This yields but 1.2 per cent of ammonia. There remains but 4.5 per cent. of other fertilizing substances. The analyses, X.–XIII. enable us to compare these poudrettes with common stable or yard manure. Analysis X. represents the composition of *dried* yard manure. Fresh yard manure contains from 65 to 75 per cent. of water, so that we must take but one-third to one-fourth of the numbers there given. *We see then that the best of these poudrettes does not exceed dried yard manure in value, or is worth but three to four times as much as its weight of common yard manure*, if we judge alone from chemical composition.

But the question of manurial value is by no means a purely chemical one. As already insisted upon, the *form* as well as the kind and quality of matter, must be duly considered. In a concentrated fertilizer the assumption that the ingredients are in a state to be readily available to the plant, is the indispensable basis of calculations founded on composition. In discussing the value of cheap manures, this matter becomes of paramount importance. In these respects the Liebig Manufacturing Co's. Poudrette is unexceptionable. It is free from coarse refuse, and having undergone fermentation, it would seem able to produce an immediate and rapid effect. It can be applied with seeds by a drill, does not impregnate the soil with the germs of noxious weeds, and has other obvious advantages over barn-yard or stable manure. From a chemical point of view we may assume it to be worth as much as three times its weight of stable manure. Farmers must decide for themselves whether it is economical for their use. For some it will not be; for many others who command city prices for their produce, and are obliged to transport all their manure some miles, it can hardly fail to be highly valuable. Its modest price is certainly in its favor, and I am credibly informed that it is in good repute among those who have used it.

The Lodi Co's. Poudrette can not be recommended. The organic matter of the East Hartford Poudrette is a fermented peat or muck, is highly divided and absorbent of moisture and ammonia. The Lodi poudrette contains nearly as much organic matter, but it mostly consists of sticks and the dust of hard coal. In fact all manner of city refuse, old nails, apple-seeds, &c., &c., are found in it. It is coarse and lumpy in texture. Its selling price is $1.50 per bbl. of about 200 lbs. So long as the farmer can procure 400 lbs. of good stable manure for $1.50, so long it is cheaper than this poudrette.

In this connection the question occurs—can not the night soil of cities be profitably secured for agricultural purposes without losing any of its original value. Undoubtedly it can be, and it is a subject worthy of the most careful consideration of the parties concerned in such an undertaking, viz: those on whose premises it is inevitably produced, those who may find profitable employment in making it portable, and finally, those who are in perpetual need of just such a material for increasing the yield of their farms.

Nesbit has estimated the total amount of dry matter annually excreted by an adult, well but not highly fed, at 90 lbs., containing 16.85 lbs. of ammonia, and 2.75 of phosphoric acid, the former at 14 cents per lb.=$2.36; the latter at 4½ cts.=12 cts. Both amount to $2.48. If this estimate be correct, a city of 30,000 inhabitants, like New Haven, furnishes yearly $75,000 worth of the most valuable fertilizing material, which now is not only lost, but is a nuisance. Could a little prejudice be overcome, undoubtedly the whole of this might be economized in a most profitable manner. The raw material, if collected fresh, is rich enough to warrant the outlay of considerable money in preparing it for use.

DEBURG'S BONE MEAL.

This substance sent me by Messrs. Backus & Barstow, of Norwich, had the appearance of *bone-ash* or the residue of burnt bones, and proved to be such on analysis.

Water,	3.04
Organic and volatile matters, mostly charcoal,	2.07
Sand and insoluble matters,	11.19
Lime,	42.17
Phosphoric acid,	34.06—35.42
Carbonic "	1.23
Magnesia, sulphuric acid, with undetermined matters,	4.88
	100.00

Bone Meal is a term that has long been in use in England, to signify finely ground bones, and it is a departure from good usage to apply the name to bone-ash. This is a good phosphatic fertilizer, and comes very near in composition to the average samples of Columbian guano. The calculated value is $31.75.

IVORY DUST AND TURNINGS.

The examination of these substances from the comb factory at Meriden, has led to the following analytical results:

	Dust.	Turnings.
Water - -	11.20	10.92
Organic matter, - - -	33.70	37.94
Lime, - -	27.09	25.80
Phosphoric acid, - -	23.22	22.11
Ammonia yielded by organic matter,	6.00	6.46

The above is nearly the composition of the bones of domestic animals, and it is obvious that this material must be a valuable fertilizer, though the quantity that can be procured is small.

BEEF SCRAPS.

This material is a residue of the soap-boiling processes. It occurs in the form of cakes, which having been very strongly pressed, are so hard as to withstand any attempts at pulverization. In composition it is almost pure muscular fibre or cellular tissue. It contains 97.42 per cent. of organic matter, and yields 13 per cent. of ammonia on decay. It must be exceedingly valuable to manufacturers as a source of ammonia, but from its hardness can not be directly useful, except it is reduced by some solvent, or is softened by soaking with water. I understand it now commands a good price from the manufacturers of super-phosphates.

ON THE COMPOSITION AND AGRICULTURAL VALUE OF COTTON-SEED CAKE.

Recently a process has been patented for removing the hulls from cotton-seed, so that this material may be expressed for its oil. This new industry is now prosecuted in Providence, R. I., and so enormous are the quantities of cotton-seed that hitherto have been nearly useless refuse, which may thus be profitably economized, that this manufacture will doubtless be a permanent and extended one. The important agricultural uses to which the cake remaining after the expresssion of flax, rape and other oily seeds, have been applied, makes it important to study what are the properties of the cotton-seed cake. I have examined specimens from the Providence mills, and find that its composition is not inferior to that of the best flax-seed cake, and in some points its agricultural value surpasses that of any other kind of oil-cake of which I have knowledge; as will appear from the following statement of its composition compared with that of linseed cake.

	I.	II.	III.	IV.	V.
Water,	6.82		11.19	9.23	16.94
Oil,	16.47		9.08	12.96	
Albuminous bodies,	44.41	48.82	25.16	28.28	10.69
Mucilaginous and saccharine matters,	12.74		}	34.22	40.11
Fibre,	11.76		48.93	9.00	27.16
Ash,	7.80	8.96	5.64	6.21	5.04
	100.00		100.00	100.00	100.00
Nitrogen,	7.05	7.75	3.95	4.47	
Phosphoric acid in ash,	2.36	2.45			
Sand,	.94		1.32		

No. I. is the cake from Providence.

No. II. gives some of the results of an analysis made by Dr. C. T. Jackson, on cake prepared by himself from hulled cotton-seed. (Patent Office Report for 1855, agricultural part.)

No. III., analysis of Dr. Anderson on cotton-cake, made at Edinburgh, Scotland.

No. IV., average composition of eight samples of American linseed cake. (Journal of Highland and Ag. Soc. of Scotland, July, 1855, p. 51.)

No. V., Meadow Hay, Saxony, Dr. Wolff.

The two points of interest before us are, the *nutritive* and *manurial* value of this cake. With reference to both, chemistry and practical results agree in their conclusions. The great value of linseed cake, as an adjunct to hay for fat cattle and milch cows, has long been recognized; and is undeniably traceable in the main, to three ingredients of the seeds of the oil-yielding plants. The value of food depends upon the quantity of matters it contains which may be appropriated by the animal which consumes the food. Now, it is proved that the fat of animals is derivable from the *starch*, *gum* and *sugar*, and more directly and easily from the *oil* of the food. These four substances, are, then, the *fat-formers*. The muscles, nerves and tendons of animals, the fibrine of their blood, and the curd of their milk, are almost identical in composition, and strongly similar in many of their properties, with matters found in all vegetables, but chiefly in such as form the most concentrated food. These *blood-* (and *muscle-*) *formers* are characterized by containing about 15½ per cent. of nitrogen; and hence are called *nitrogenous substances*. Since albumin (white of egg) is the type of these bodies, they are also often designated as the *albuminous bodies*.

The bony frame-work of the animal owes its solidity to *phosphate of lime*, and this substance must be furnished by the food. A perfect food must supply the animal with these three classes of bodies, and in proper proportions. What proportions are the proper ones, we have at present no means of knowing with accuracy. The ordinary kinds of food for cattle, contain a large quantity of vegetable fibre or woody matter, which is more or less indigestible, but which is indispensable to the welfare of the herbivorous animals, as their digestive organs are adapted to a bulky and rough food. (See analysis V.) The addition of a small quautity of a food rich in oil and albuminous substances, to the ordinary kinds of feed, has been found highly advantageous in practice. Neither hay alone, nor concentrated food alone, gives the best results. A certain combination of the two presents the most advantages.

For fattening animals, and for increasing the yield and quality of milk, linseed cake has long been held in high estimation. This is to be expected from its composition. The muscle of flesh and the curd of milk are increased in quantity, because the albuminous substances of the linseed constitute an abundant and ready source of them; the fat of the animal and the butter of the milk are increased by the presence in the food of so much oil and mucilaginous matters.

A year or two since, Mr. M'Lagan of Scotland, reported in the

Journal of the Highland Society, some trials on the value, as food, of linseed cake, cotton-seed cake, and bean meal. Analysis III. represents the composition of the cotton cake; IV. that of the linseed cake. The bean meal has 25 per cent. of albuminous matters, but 1½ per cent of oil, and correspondingly more of the bodies that have the same nutrient function as the mucilaginous and saccharine matters. Six animals of nearly equal size and quality were fed during three months in Winter, with all the turnips and straw they would eat, and in addition, two of them received daily, four pounds of linseed cake, two, four pounds of cotton-seed cake, and two, four pounds of bean meal. The animals thrived as well on the cotton-seed cake as on the other kinds of food—as shown by their appearance, and by their weight when slaughtered.

When linseed cake is fed in too large quantity it purges the animal. The quality of beef is excellent when the daily dose of oil-cake does not exceed six pounds for an animal of 700 pounds. Cases are on record when more than this quantity has spoiled the beef, giving it a *taste like tallow.*

Probably like results would follow excessive feeding with cotton-seed cake. In the best cotton districts of India, the cotton-seed bears a high value as food for fat cattle. I know of no experiments with it on milch cows, but it is to be expected that here also it will have the same effects as linseed cake.

A Bavarian farmer has recently announced that heifers fed for three months before calving with a little linseed cake in addition to their other fodder, acquire a larger development of the milk vessels, and yield more milk afterward, than similar animals fed as usual. If this be a fact, cotton-seed cake must have an equally good effect.

Some of those who have used cotton-seed cake have found difficulty in inducing cattle to eat it. By giving it at first in small doses, mixed with other palatable food, they soon learn to eat it with relish.

On comparing the analyses II. and I., with the average composition of linseed cake, IV., it will be seen that the cotton-seed cake is much richer in oil and albuminous matters than the linseed cake. A correspondingly less quantity will therefore be required. Three pounds of this cotton-seed cake are equivalent to four of linseed cake of average quality.

The value of the article in question as a manure, is obviously very considerable. The dung of cattle, etc., fed upon it, will be greatly richer both in nitrogen and phosphates, than that of animals fed on hay alone. Where stock is kept, probably the best manner of using this cake as a fertilizer, is to feed it to the cattle, and carefully apply the manure they furnish. In this way, whatever is not economized as fat or flesh, will be available as manure.

In England and on the continent of Europe, linseed-and rape-cake have been used directly as a dressing for the soil, and with results fully equal to what is indicated by their composition. These kinds of cake decompose readily, and their effect is usually finished in one season. 500 or 600 pounds per acre is considered a good application; more is liable to be injurious. It is found that when applied with the seed, these kinds of cake prevent germination to a considerable degree; but if applied a week or so previous to sowing, this detriment is not encountered.

The cotton-seed is often employed in the Southern States, with good effects, as a manure for Indian corn, &c. I do not know whether like rape and linseed cake, it destroys the seed. For manuring purposes it is about one-third richer than linseed cake. Its effects are mostly due to the nitrogen it contains, and therefore are similar to those of guano. It is best used in conjunction with other fertilizers. I should judge that a mixture of 400 pounds of this cotton-seed cake with 50 bushels of leached wood-ashes per acre, would make an excellent application for most crops. It is highly important that the cake be uniformly distributed, and thoroughly intermixed with the soil.

This cotton-seed cake is doubtless an excellent material for composts, owing to its ready decomposability.

Its commercial value as a manure, if calculated from the prices adopted in this Report, is $21.60. The market price is $25.00. Therefore, next to Peruvian guano, this is a substance which, if its composition proves uniform, is most nearly worth what it costs.

NOTE. In making the analyses which are included in this

Report, I have been greatly assisted by the following gentlemen, students in the Yale Analytical Laboratory, viz: Messrs. A. D. Willson, A. P. Rockwell, M. Watson, and G. F. Barker. I am especially indebted also to my skillful professional assistants, Messrs. Henry M. Seely and Edward H. Twining, who have each made numerous analyses.

PEAT AND MUCK—PRELIMINARY NOTICE.

The investigation of the Peats and Mucks sent in to me from various parts of the State, last summer, has been prosecuted as far as has been possible. Seventeen specimens have been submitted to analysis, and in them have been made the following determinations, viz:

Water.
Organic matter.
Ash.
Portion soluble in water.
" insoluble in water.
" soluble in carbonate of soda.
" insoluble in " " "
Total nitrogen or potential ammonia.

In two cases, complete analyses of the ash have been carried out. In all of them, the ash has been more or less analyzed, where the quantity of it has allowed.

This labor has occupied my able assistant, Edward H. Twining, nearly the whole of four months. Some of the analytical processes consumed a great deal of time, and the consequence is, that now, when I must present my report, many interesting points remain uninvestigated. I therefore prefer not to enter into the details of the results already obtained, but to reserve this most important subject for further and more extended studies, if such be the pleasure of the Society. The analytical results as far as finished, serve to indicate the direction in which new researches may be undertaken with most promise of usefulness.

I may mention in brief, some of the more important facts that have transpired in this research. Very great differences exist between different specimens. Some are but slightly advanced in the peaty decomposition, and yield but a few per cent. of matter soluble in alkalies; others consist almost entirely of soluble peaty substance, the so-called humic, ulmic and geic acids. An important question, yet very undecided, so far as my knowledge extends, is, how do these differences stand connected with the readiness of decomposition which is essential to the fertilizing applications of peat? This is a branch of inquiry that deserves to be studied experimentally, both in the laboratory and on the farm. Hereafter I shall attempt to offer some suggestions for a practical study of this subject, which may lead to a better knowledge of the best methods of composting, &c. Some of the peats examined, have dissolved in water to the extent of only three-fourths of a per cent. Others have yielded to water, five, six, and one as much as twelve per cent., viz: five per cent. of mineral, and seven per cent. of vegetable matter. The precise nature of the matters thus dissolved has not been accurately studied in any one case. It is shown, however, that the character of the portion soluble in water varies very widely; for example, in the specimen yielding twelve per cent., it is chiefly compounds of the peaty acids with oxyd of iron, that are extracted by water. In other cases much lime and little iron is dissolved. These particulars deserve the most minute study, because the matters soluble in water are those which are immediately serviceable to vegetation. Very likely some of these peats may be at first injurious from the quantities of soluble salts of iron they contain.

That part of the investigation relating to the estimation of nitrogen, has furnished the most interesting results. No specimen of peat that I have examined, though all have been merely air-dried, and contain from ten to thirty per cent. of water, has yielded less than one per cent. of potential ammonia, while the average yield is two per cent., and one specimen gave three and one-half per cent., which is one-fifth as much as is found in the best Peruvian guano.

Mr. Daniel Buck, of Poquonock, has long employed peat as fuel, and some time ago brought to the notice of Messrs. Dyer and Weld the fact that the peat he employs, exhales a strong odor of ammonia when burning. This observation has been made in my laboratory with other samples.

In the two specimens of peat-ashes, one furnished by Mr. Buck, and coming from the peat just mentioned, the other by Mr. Stanwood, of Colebrook, were found, besides large quantities of carbonate of lime, considerable sulphate of lime and magnesia, also nearly one per cent. of phosphoric acid and the same amount of alkalies.

The gentlemen who have furnished these peats, namely: Messrs. T. S. Gold, Nathan Hart, Titus L. Hart of West Cornwall, Lewis M. Norton of Goshen, Messrs. Pond and Miles of Milford, Messrs. Russell Peck of Berlin, B. F. Northrop of Griswold, J. H. Stanwood of Colebrook, S. Loveland of North Granby, Daniel Buck of Poquonock, Adams White, Philip Scarborough, Perrin Scarborough, and the Messrs. Dyer of Brooklyn, have communicated to me a large amount of valuable imformation respecting the character and value of the deposits, which would be most appropriately embodied in a future report, should I be permitted to complete this investigation.

Practical men have already abundantly proved that many peats are of exceeding agricultural value. This is no discovery of mine, or of those who have already subjected these substances to a chemical examination. Mr. Daniel Buck of Poquonock, has used his peat without any preparation, as a top-dressing on grass, and has experienced the most decided results from its use in this simple manner. He estimates his raw peat as equal to cow-dung in fertilizing value.

What may be expected from a thorough chemical investigation of these deposits is this: We shall be able to decide which are valuable, and which are indifferent for fertilizing purposes. We shall excite throughout the State and the whole country, in fact, an interest in these deposits, that will lead to their extended and systematic use. We shall thus acquire a full practical knowledge of their merits, and of the best methods for converting them into grain and flesh and milk.

Unquestionably, the greatest service we can render to our farming interests is to develop our internal resources. The importation of foreign fertilizers is enriching foreign merchants, and withdrawing cash from the pockets of our farmers. Their use is extremely liable to run to excess, and makes our agriculture unsteady and improvident. We need, not only to live and make money from our soils, but to constantly improve the soil, and thus extend our agricultural capital. The enlightened economy of the enormous masses of muck and peat which Connecticut contains, which probably exceed in extent those of any other State, can not fail to exercise the most beneficent influence on our material prosperity. We shall thus at once fertilize those fields that are already arable, and reclaim from waste a large area of land that is now all but useless.

I doubt not that the peat beds of our State are destined to be of immense value for other than merely agricultural purposes. As *fuel*, they have already been employed to some extent. In Europe a vast deal of ingenuity has been bestowed upon the means of preparing peat-fuel, so as to adapt it to transportation and advantageous use. In Bristol of this State, the Copper Company have for some time employed a furnace in connection with their steam engine, which receives the peat as it comes dripping wet from the swamp, and consumes it with the greatest economy, even the water it contains being made to contribute to its heating effect.

In Germany, a method has been invented for converting the porous, bulky, and friable peat, into dense hard cakes, or bricks, which contain little of the coarse impurities of the peat, and may be transported without loss or pulverization, and burn with a great degree of freedom. All this is accomplished without any pressure, by simply diffusing the peat in water, allowing the latter to settle, and drying the deposit.

Again, in Ireland and Germany, peat is consumed in large quantities in an entirely new industry, which has originated and grown to a good deal of vigor within the last five to six years. The peat is distilled, either over a free fire, or by over-heated steam, and a large number of useful products are thus obtained, quite analogous to those now prepared to some extent in this country from bituminous coals.

As an example of the kind and quantity of these products, the following statement may be adduced:

From a turf or peat excavated in Hanover, Germany, and worked in the air-dry state, were obtained:

2	per cent.	of a	clear, colorless, light-turf-oil or photogene.
2	"	"	dark, heavy "
$1\frac{1}{2}$	"	"	asphalt.
35	"	"	peat coal or coke.
15	"	"	illuminating gas.
$\frac{3}{10}$	"	"	paraffin.
4	"	"	kreosote.
40	"	"	water containing 1—3 per cent. ammonia.

These products are all susceptible of useful applications for purposes of illumination, lubrication, heating, preservation of wood, manufacture of lamp-black, varnish, and even of perfumery.

If I should be authorized to continue my labors, I shall communicate to the Society a full account of all these various technical applications of peat, in so far as they promise to be of service to the industrial interests of this State.

I have taken measures to provide myself with means of information on all these topics, as furnished by the scientific and technical journals and publications of Great Britain, Germany and France. I also wish to examine personally, the more important of our peat-beds, so as to be able to compare their physical with their chemical characters, and thus to establish rules by which practical men may be guided in the economy of the different varieties.

APPENDIX.—Methods of Analysis.

The general method of analysis for guanos, superphosphates, &c., whose commercial value lies almost exclusively in ammonia and phosphoric acid, is as follows:

1. Of the well averaged and pulverized sample, a quantity of 2 grams is weighed off and dried at a temperature of 212 deg. until it ceases to lose weight; the loss is water. If loss of ammonia is feared, a known quantity of oxalic acid is added before drying.

2. The dried residue of 1, is gradually heated to low redness in a porcelain cup, and maintained at such a heat, until all organic matter is burned off. The loss is organic and volatile matter. Usually the substance is directly heated to redness without separately estimating the water.

3. The residue of 2, is pulverized if need be, and digested for some time with moderately concentrated hydrochloric acid. The diluted solution is filtered off and washed, the residue weighed as sand and insoluble matters.

4. The solution 3, is brought to the bulk of three or four liquid ounces, mixed with rather more than its volume of strong alcohol and enough sulphuric acid to unite with all the lime which is thereby completely separated as sulphate. The liquid is filtered off, the sulphate of lime is washed with dilute alcohol, dried and weighed; from it is calculated the amount of lime.

5. The solution 4, is evaporated until the alcohol is removed, then without filtration, to it is added an excess of a liquid made by dissolving in 2 quarts of water, 30 grams of sulphate of magnesia, 41 grams of chlorid of ammonium, 37½ grams of tartaric acid, and 40 grams of carbonate of ammonia, (see W. Mayer, in Liebig's Annalen, Vol. 101, p. 168,) and finally excess of ammonia. After five to six hours, the precipitate of ammonia-phosphate of magnesia, usually mixed with some brown organic matters, is collected in a filter and washed three or four times with ammonia water; it is then dissolved from the filter by dilute hydrochloric acid, and again thrown down by ammonia,

after addition of a little tartaric acid. It is now pure, and is finally washed and weighed as usual for the estimation of phosphoric acid.

6. 1 gram of the manure is burned in the usual way, with soda lime. The resulting ammonia is collected in 20 cubic centimeters of a fifth-solution of oxalic acid, (12.6 grams of pure oxalic acid to a liter of water,) and estimated by titrition with a dilute potash solution.

7. The soluble phosphoric acid of a manure is estimated by washing 2 grams of it with several ounces of water and treating the solution as in 4 and 5.

8. To determine actual ammonia, one or two grams are mixed in a flask, with a pint of water; a piece of caustic potash is added, and three-fourths of the water slowly distilled off through a Liebig's condenser into a standard oxalic acid. The ammonia is then estimated by titrition.

In complete ash-analysis of manures, or in examining organic bodies, e. g., cotton-seed cake, the usual and approved methods are employed.

ESSAYS ON MANURES.

1858.

CONTENTS,

FOR ESSAYS IN 1858.

PEAT AND MUCK.

ESSAY ON THEIR NATURE AND AGRICULTURAL USES.

---

1. *What is Peat?*

By the general term Peat we understand the vegetable soil of salt-marshes, beaver-meadows, bogs and swamps.

It consists of vegetable matters resulting from the decay of many generations of aquatic or marsh plants, as mosses, sedges, coarse grasses, and a great variety of shrubby plants, mixed with more or less mineral substances, partly derived from these plants, and partly washed in from the surrounding lands.

2. *The conditions under which Peat is formed.*

The production of Peat from fallen and decaying plants, depends upon the presence of so much water as to cover or saturate the vegetable matters, and thereby hinder the full access of air. Saturation with water also has the effect to maintain the decaying matters at a low temperature, and by these two causes in combination, the process of decay is made to proceed with great slowness, and the final products of such slow decay, are compounds that themselves resist decay, and hence they accumulate.

In New England there appears to be nothing like the extensive *moors* that abound in Ireland, Scotland, the north of England, North Germany, Holland, and the elevated plains of Bavaria, which are mostly level or gently sloping tracts of country covered with peat or turf to a depth often of 20 feet. In this country it is only in low places, where streams become obstructed and form swamps, or in bays and inlets on salt water, where the ebb and flow of the tide keeps the soil constantly wet, that our peat-beds occur.

In the countries above named the weather is more uniform than here, especially are the summers cooler, and rain falls are more frequent. Such is the greater humidity of the atmosphere that some species of mosses,—the so-called *sphagnums*,—which have a wonderful avidity for moisture, (hence used for packing plants which require to be kept moist on journeys,) are able to keep fresh and in growth during the entire summer. These mosses decay below and throw out new vegetation above, and thus produce a bog wherever the earth is springy. It is in this way that in those countries, the moors and peat-bogs actually grow, increasing in depth and area, from year to year, and raise themselves above the level of the surrounding country.

There the reclamation of a moor is usually an expensive operation, for which not only much draining, but actual cutting out and burning of the compact peat is necessary.

The warmth of our summers and the dryness of our atmosphere prevent the accumulation of peat above the highest level of the standing water of our marshes, and so soon as the marshes are well drained, the peat ceases to form, and in most cases the swamp may be easily converted into good meadow land.

Springy hill-sides, which in cooler, moister climates would become moors, here dry up in summer to such an extent that no peat can be formed upon them.

3. *The different kinds of Peat.*

Very great differences in the characters of the deposits in our peat beds are observable. These differences are partly of color, some peats being gray, others red, others again black, the majority when dry possess a brown-red or snuff color. They also vary remarkably in weight and consistency. Some are compact, destitute of fibres or other traces of the vegetation from which they have been derived, and on drying shrink greatly and yield tough dense masses which burn readily, and are employed as fuel. Others again are light and porous, and remain so on drying; these contain much intermixed vegetable matter that is but little advanced in the peaty decomposition. Some peats are almost entirely free from mineral matters, and on burning leave but a few *per cent.* of ash, others contain considerable quantities of lime or iron, in chemical combination, or of sand and clay that have been washed in from the hills adjoining the swamps.

The peat of some swamps is mostly derived from mosses, that of others from grasses, some contain much decayed wood and leaves, others again are free from these.

In the same swamp we usually observe more or less of all these differences. We find the surface peat is light and full of partly decayed vegetation, while below the deposits are more compact. We commonly can trace distinct strata or layers of peat, which are often very unlike each other in appearance and quality, and in some cases the light and compact layers alternate so that the former are found below the latter.

The light and porous kinds of peat appear in general to be formed in shallow swamps or on the surface of bogs, where there is considerable access of air to the decaying matters, while the compacter peats are found at a depth, and seem to have been formed beneath the low-water mark, in more complete exclusion of the atmosphere.

The nature of the vegetation that flourishes in a bog, no doubt has some effect on the character of the peat. The peats chiefly derived from mosses that have grown in the full sunlight, have a red color, especially in their upper layers, while those produced principally from grasses are often grayish in appearance, or are full of silvery fibres—the skeletons of the blades of grasses and sedges.

The accidental admixtures of soil often greatly affect the appearance and value of a peat, but on the whole it would appear that its quality is most influenced by the nature and degree of decomposition it has been subjected to.

The term *muck* is chiefly used among us to designate what is more correctly called peat. In proper usage, muck is a general term for manure of any sort, and if applied to peat should be qualified as swamp-muck.

Some intelligent farmers call the surface layers of their swamps, which are loose and light in texture, *swamp-muck*, and to the bottom layers, which are more compact and often serviceable as fuel, they apply the term peat. This distinction is not very definite, but is convenient in many cases, and will be employed in this Report as far as practicable; although according to usage it is often necessary to use the words peat and muck synonymously.

4. *The Chemical Composition of Peat.*

Pure peat is derived from the decay of woody-fibre, which constitutes the organic basis of nearly all plants, and is essentially the same thing whether found in true wood or in grasses and mosses.

Like the vegetation from which it is formed, it is for the most part combustible, and if free from accidental admixtures of earthy matters, leaves but a few per cent. of ash when burned.

(*a*) *The organic or combustible part of peat* varies exceedingly in composition. It is in fact an indefinite mixture of several or perhaps of many bodies whose precise nature is little known. These bodies have received the collective names *humus* and *geine.* In order to understand the general characters of Humus, as we shall designate the organie matters of peat, it is necessary to remind ourselves of the nature of the processes of decay, by which it is produced.

In a chemical sense, decay is strongly similar to combustion or burning. It is in fact a burning at low temperatures, a combustion going on so slowly that there is no accumulation of heat, and no exhibition of light. To go back one step further, both these processes are cases of oxydation. A piece of wood whether consumed in the fire, or allowed to decay in the soil, is finally brought to the same result. Its organic portion is dissipated in the form of invisible gases, its mineral matters remain behind as ashes or earth. It is the vital principle of the atmosphere—oxygen gas, which is consumed in these changes, and which if it be supplied in sufficient quantity, burns, i. e., unites with the carbon and the hydrogen of the wood, and converts them into carbonic acid and water.

When wood instead of being burned with full access of air is heated in close vessels or in coal-pits, with imperfect supply of oxygen, then its most easily combustible parts—those portions which give flame—are burnt off, and charcoal is left—a substance that burns without flame.

When wood or vegetable matters generally, instead of being permitted to moulder away in the free atmosphere, with just enough moisture and sufficient warmth to promote complete decay, are kept under water and thus nearly shut off from the action of oxygen,* a similar burning out of the more combustible (oxydable) matters of the wood takes place, and peat results, a substance, which like charcoal, burns without or with little flame, is highly indestructible, and is richer in carbon than the wood from which it was formed.

In the formation of peat this removal of the more combustible parts of the wood cannot go on nearly to the degree it does in the preparation of charcoal, on account of the lower temperature, and the far smaller supply of air. With the changes in temperature, and with the variable access of air, are connected the differences in the nature and relative quantity of the ingredients of peat. The larger share of the organic matters that may be separated from peat, possesses *acid* characters.

If peat be agitated, or better, boiled a short time with water, it is partly dissolved. The quantity taken up by water varies from 1 to 17 per cent., and of this a variable portion is organic acids. The extract or solution in water has generally an amber or pale brown color, like the water of swamps or of forest streams, and the acids it contains are two in number, and have received the names *crenic* and *apocrenic* acids.

In the water extract these acids are in general partly uncombined and partly united to various bases, as lime, magnesia, oxyd of iron and alumina.

The great mass of the peat remaining after the treatment with water, consists of one or several acids which are soluble in solutions of an alkali, and may thus be removed from the remaining ingredients. To exhibit these acids, the so-called *humic* acids,—we boil the peat with a solution of carbonate of soda; a dark brown liquid is shortly obtained which contains the humic acids united with soda.

If now, any strong acid as sulphuric acid, is added in excess to the solution of humate of soda, the soda is taken by the sul-

---

* Not entirely, for water dissolves a certain quantity of oxygen which supports the respiration of fishes.

phuric acid, and the humic acids are separated, and subside as a black or brown sediment.

In most peats, after the extraction with water and carbonate of soda, there still remains a black residue which is insoluble in alkalies and has been termed humine. This substance is usually mixed with more or less undecomposed vegetable matter or fibre, from which we know no means of separating it. It is not an acid, else it would combine with alkalies. Its composition, however, does not differ much from that of the humic acids just mentioned.

Besides the bodies above named, a small amount of resinous matters exists in some, perhaps in all peats; occasionally too, a bituminous or pitchy matter has been found in them, but these substances are doubtless of no agricultural significance whatever.

Such is a concise sketch of the organic or combustible ingredients of peat, and it is of sufficient fullness and accuracy for our present purpose.*

(*b*) *The mineral part of peat which remains as ashes* when the organic matters are burned away is variable in quantity and composition. Usually a quantity of sand or soil is found in it, and not unfrequently constitutes its larger portion. Some peats leave on burning much carbonate of lime, the ash of others again is mostly oxyd of iron; silicic, sulphuric and phosphoric acids, magnesia, potash, soda, alumina and chlorine, also occur in small quantities in the ash of all peats.

In some rare instances peats are found which are so impregnated with soluble sulphates of iron and alumina as to yield these salts to water in large quantity, and sulphate of iron (green vitriol,) has actually been manufactured from such peats, which have in consequence been characterized as vitriol peats.

(*c*) *The nitrogen or potential ammonia* of peats is an important ingredient, which is never absent, though its quantity varies from 1 to 5 *per cent.*

---

* The varieties of humic and ulmic acids, of humine and ulmine, described by Mulder and Herrmann are not noticed here, for the reasons that these chemists disagree as to their properties and existence, and they are of no agricultural importance.

5. After this general statement of the composition of peat, we may proceed to notice: *The characters that adapt it for agricultural uses.*

These characters are conveniently discussed under two heads, viz:

(*A.*) Those which render it useful in improving the texture and other physical characters of the soil, and indirectly contribute to the nourishment of crops,—characters which constitute it an *amendment* to use the language of French agricultural writers; and,

(*B.*) Those which make it a direct fertilizer.

(*A.*) Considered as an amendment, the value of peat depends upon

I. *Its remarkable power of absorbing and retaining water, both as a liquid and as vapor:*

II. *Its power of absorbing ammonia:*

III. *Its action in modifying the decay of organic (animal and vegetable) bodies:*

IV. *Its effect in promoting the disintegration and solution of mineral matters, (the stony matters of the soil): and*

V. *Its influence on the temperature of the soil.*

The agricultural importance of these properties of peat is best illustrated by considering the faults of a certain class of soils.

Throughout Connecticut are found abundant examples of light, leachy, hungry soils, which consist of coarse sand or fine gravel; are surface-dry in a few hours after the heaviest rains, and in the summer drouths, are as dry as an ash-heap to a depth of several or many feet.

These soils are easy to work, are ready for the plow early in the spring, and if well manured give moderate crops in wet seasons. In a dry summer, however, they yield poorly, and at the best they require constant and very heavy manuring to keep them in heart.

Crops fail on these soils from two causes, viz.: want of moisture and want of food. Cultivated plants demand as an indispensable condition of their growth and perfection, to be kept within certain limits of wetness. Buckwheat will flourish best on dry soils, while cranberries and rice grow in swamps. The crops that are most profitable to us, wheat, oats, etc., require a medium degree of moisture, and in all cases it is desirable that the soil be equally protected from excess of water and from drouth. Soils must be thus situated either naturally, or as the result of improvement, before any steadily good results can be obtained in their cultivation.

In wet seasons these light soils are tolerably productive if well manured. It is then plain that if we could add anything to them which would retain the moisture of dews and rains in spite of the summer-heats, our crops would be uniformly fair, provided the supply of manure be kept up.

But why is it that light soils need more manure than loamy or heavy lands? We answer—because, in the first place, the rains which quickly descend through the open soil, wash down out of the reach of vegetation the soluble fertilizing matters, and in the second place, from the porosity of the soil the air has too great access, so that the vegetable and animal matters of manures decay too rapidly, their volatile portions, ammonia and carbonic acid, escape into the atmosphere, and are in measure lost to the crops. From these combined causes we find that a heavy dressing of well-rotted stable manure almost, if not quite entirely, disappears from such soils in one season, so that another year the field requires a renewed application; while on loamy soils the same amount of manure would have lasted several years, and produced each year a better effect.

We want then to amend light soils by incorporating with them something that prevents the rains from leaching through them too rapidly, and, that at the same time, renders them less open to the air, or absorbs and retains for the use of crops the volatile products of the decay of manures.

Now for these purposes vegetable matter of some sort, is the best and almost the only amendment that can be economically employed. In many cases a good peat or muck is the best form of this material, that lies at the farmer's command.

I. *Its absorbent power for liquid water* is well known to every farmer who has thrown it up in a pile to season for use. It holds the water like a sponge, and after exposure for a whole summer is still distinctly moist to the feel.

Its absorbent power for vapor of water is so great that more than once it has happened in Germany, that barns or close sheds filled with dried peat, such as is used for fuel, have been burst by the swelling of the peat in damp weather, occasioned by the absorption of moisture from the air. This power is further shown by the fact that when peat has been kept all summer long in a dry room, thinly spread out to the air, and has become like dry snuff to the feel, it still contains 10, 20, 30, and in some of the specimens I have examined, even 40 per cent. of water. To dry a peat thoroughly, it requires to be exposed for some time to the temperature of boiling water. It is thus plain that no summer heats can dry up a soil which has had a good dressing of this material, for on the one hand, it soaks up and holds the rains that fall upon it, and on the other, it absorbs the vapor of water out of the atmosphere whenever it is moist, as at night and in cloudy weather.

II. *Absorbent power for ammonia.*

All soils that deserve to be called fertile, have the property of absorbing and retaining ammonia and the volatile matters which escape from fermenting manures, but light and coarse soils may be deficient in this power. Here again in respect to its absorptive power for ammonia, peat comes to our aid.

We may easily show by direct experiment that peat absorbs and combines with ammonia.

I took for example a weighed quantity of the peat No. 29 from the New Haven Beaver Pond, the specimen furnished me by Chauncey Goodyear Esq., and poured upon it a known quantity of dilute solution of ammonia, and agitated the two together for 48 hours. I then distilled off at a boiling heat the unabsorbed ammonia and determined its quantity. This amount subtracted from that of the ammonia originally employed, gave the quantity of ammonia absorbed and retained by the peat at the temperature of boiling water.

The peat retained ammonia to the amount of .95 of one per cent.

I made another trial with carbonate of ammonia, adding excess of solution of this salt to a quantity of peat, and exposing it to the heat of boiling water, until no smell of ammonia was perceptible. The entire ammonia in the peat was then determined, and it was found that the dry peat which originally gave 2.4 per cent. of ammonia (potential,) now gave 3.7 per cent. The absorbed quantity was thus 1.3 per cent.

This last experiment most nearly represents the true power of absorption, because in fermenting manures ammonia mostly occurs in the form of carbonate, and this is more largely retained than free ammonia, on account of its power of decomposing the humate of lime, forming with it carbonate of lime and humate of ammonia.

The absorbent power of peat for ammonia is beautifully shown by the analyses of three specimens sent me by Edwin Hoyt, Esq., of New Canaan. The first of these (No. 22,) is the swamp muck he employs. It contains in the dry state but .58 per cent. of ammonia (potential.) The second sample (No. 23,) is the same muck that has lain under the flooring of the horse stables, and has been in this way partially saturated with urine. It contains 1.15 per cent. of ammonia. The third sample is, finally, the same muck composted with white-fish. It contains 1.31 per cent. of ammonia.

The quantities of ammonia thus absorbed, both in the laboratory and field experiments is small—from .7 to 1.3 per cent. The absorption is without doubt almost entirely due to the organic matter of the peats, and in all the specimens on which these trials were made, the per centage of inorganic matter is large. The results therefore become a better expression of the power of *peat* in general to absorb ammonia, if we reckon them on the organic matter alone. Calculated in this way, the organic matter of the Beaver Pond peat (which constitutes but 68 per cent. of the dry peat) absorbs 1.4 per cent. of free ammonia and 1.9 per cent. of ammonia out of the carbonate of ammonia. In the same manner we find that the organic matter of Hoyt's muck has absorbed 2.35 per cent. of ammonia.

We observe that the peat which is, naturally, richest in ammonia, absorbs less, relatively, than that which is poor in this substance.

When we consider how small an ingredient of most manures ammonia is, viz.: less than one per cent. in case of stable manure, and how little of it in the shape of guano for instance is usually applied to crops—not more than 40 to 60 lbs. to the acre. (The usual dressings with guano are from 250 to 400 lbs. per acre, and ammonia averages but 15 per cent. of the guano) we at once perceive that an absorptive power of two or even one per cent. is adequate for every agricultural purpose.

III. *The influence of peat in modifying the decay of organic matters deserves notice.*

Peat itself in its native bed or more properly the water which impregnates it and is charged with its soluble principles has a remarkable anti-septic or preservative power. Many instances are on record of the bodies of animals being found in a quite fresh and well-preserved state in peat bogs, but when peat is removed from the swamp, and so far dried as to be convenient for agricultural use, it does not appear to exert this preservative quality to the same degree or even in the same kind.

Buried in a peat bog or immersed in peat water, animal matters are absolutely prevented from decay, or decay only with extreme slowness; but if covered with peat that is no longer quite saturated with water, their decay is indeed checked in rapidity, and the noisome odors evolved from putrifying animal substances are not perceived, still decay does go on, and in warm weather, no very long time is needed to complete the process.

The effect of peat in modifying decay is analogous to that of charcoal, and is probably connected with its extreme porosity. If a piece of flesh be exposed to the air during summer weather it shortly putrifies and acquires an intolerable odor. If it be now repeatedly rubbed with charcoal dust, and kept in it for some time, the taint which only resides on the surface, may be completely removed, and the sweetness of the meat restored, or if the fresh meat be surrounded with a layer of charcoal powder of a certain thickness, it will pass the hottest weather without manifesting the usual odor of putrefying bodies.

It does however waste away, and in time, completely disappears. It decays, but does not putrefy, it exhales, not the disgusting gases which reveal the neighborhood of carrion, but the pungent odor of hartshorn. The gases which escape are the same that would result if the flesh were perfectly burnt up in a full supply of air, viz.: vapor of water, carbonic acid and *ammonia.*

If we attend carefully to the nature of decay thus modified by charcoal dust, we find that it is complete, rapid but regular, and unaccompanied by unhealthful or disagreeable exhalations.

Peat has all the effects of charcoal with this advantage, that it permanently retains the ammonia formed in decay, which contrary to the generally received opinion charcoal does not.

From its absorptive power for water, it maintains a lower temperature under the sun's heat than dry charcoal or a light soil, and this circumstance protracts and regulates the process of decay in a highly beneficial manner, so that if a muck-dressed soil receive an application of stable manure, fish, or guano,—in the first place, the ammonia and other volatile matters cannot be formed so rapidly as in the undressed soil, because the soil is moister and decay is thereby hindered,—and in the second place, when formed they cannot escape from the soil, but are fixed in it by the peculiar absorptive power of the vegetable acids of muck.

These properties of peat will be again recurred to, when we come to discuss its uses in composting.

IV. *Peat promotes the disintegration of the soil.*

Every soil is a storehouse of food for crops; but the stores it contains are only partly available for immediate use. In fact, by far the larger share is locked up, as it were, in insoluble combinations, and by a very slow and gradual change does it become accessible to the plant. This change is chiefly brought about by the united action of water and carbonic acid gas, or rather of water holding this gas in solution. Nearly all the rocks and minerals out of which fertile soils are formed,—which therefore contain those inorganic matters that are essential to vegetable growth,—though very slowly acted on by pure water, are decomposed and dissolved to a much greater extent, to an extent, indeed, commensurate with the wants of vegetation, by water charged with carbonic acid gas.

The only abundant source of carbonic acid in the soil, is decaying vegetable matter.

Hungry, leachy soils, from their deficiency of vegetable matter and of moisture do not adequately yield their own native resources to the support of crops, because the conditions for converting their fixed into floating capital are wanting. Such soils dressed with peat or green manured, at once acquire the power of retaining water, and keep that water overcharged with carbonic acid, thus not only the extraneous manures which the farmer applies are fully economized; but the soil becomes more productive from its own stores of fertility which now begin to be unlocked and available.

It is probable, nay almost certain, that the acids of peat, exert a powerful decomposing, and ultimately solvent effect on the minerals of the soil; but on this point we have no precise information, and must therefore be content merely to allude to the probability, which is sustained by the fact that the acids crenic, apocrenic and humic, though often partly uncombined, are never wholly so, but usually occur united in part to various bases, viz.: lime, magnesia, ammonia, potash, alumina and oxyd of iron.

V. *The influence of peat on the temperature* of light soils dressed with it may often be of considerable practical importance. A light dry soil is subject to great variations of temperature, and rapidly follows the changes of the atmosphere from cold to hot, and from hot to cold. In the summer noon a sandy soil becomes so warm as to be hardly endurable to the feel, and again it is on such soils that the earliest frosts take effect. If a soil thus subject to extremes of temperature have a dressing of peat, it will on the one hand not become so warm in the hot day, and on the other hand it will not cool so rapidly, nor so much in the night; its temperature will be rendered more uniform, and on the whole more conducive to the welfare of vegetation. This regulative effect on temperature is partly due to the stores of water held by peat. In a hot day this water is constantly evaporating, and this, as all know is a cooling process. At night the peat absorbs vapor of water from the air, and condenses it within its pores, this condensation is again accompanied with the evolution of heat.

It appears to be a general, though not invariable fact that dark colored soils, other things being equal, are constantly the warmest, or at any rate maintain the temperature most favorable to vegetation. It has been repeatedly observed that on light-colored soils plants mature more rapidly if the soil be thinly covered with a coating of some black substance. Thus Lampadius, Professor in the School of Mines at Friberg a town situated in a mountainous part of Saxony, found that he could ripen melons, even in the coolest summers, by strewing a coating of coal-dust an inch deep over the surface of the soil. In some of the vineyards of the Rhine, the powder of a black slate is employed to hasten the ripening of the grape.

Girardin, an eminent French agriculturist in a series of experiments on the cultivation of potatoes found that the time of their ripening varied eight to fourteen days, according to the character of the soil. He found, on the 25th of August, in a very dark soil made so by the presence of much humus or decaying vegetable matter, twenty-six varieties ripe; in sandy soil but twenty, in clay nineteen, and in a white lime soil only sixteen.

It cannot be doubted then, that the effect of dressing a light sandy or gravelly soil with peat, or otherwise enriching it in vegetable matter, is to render it warmer, in the sense in which that word is usually applied to soils. The upward range of the thermometer may not be increased, but the uniform warmth so salutary to our most valued crops is thereby secured.

(*B.*) The ingredients and qualities of peat which make it *a direct fertilizer* next come under discussion. We shall notice:

I. *The organic matters, including nitrogen or ammonia.*

II. *The inorganic or mineral ingredients; and*

III. *Institute a comparison between peat and stable manure.*

In division I. we have to consider:

1st. The organic matters as direct food to plants.

Twenty years ago, when Chemistry and Vegetable-Physiology began to be applied to Agriculture, the opinion was firmly held among scientific men, that the organic parts of humus—by which we understand decayed vegetable matter, such as is found to a greater or less extent in all good soils, and *abounds* in many fertile ones, such as constitutes the leaf-mould of forests, such as is produced in the fermenting of stable manure, and that forms the principal part of swamp-muck and peat,—are the true nourishment of vegetation, at any rate of the higher orders of plants, those which supply food to man and to domestic animals.

In 1840, Liebig, in his celebrated and admirable treatise on the "Applications of Chemistry to Agriculture and Physiology," gave as his opinion that these organic bodies do not nourish vegetation except by the products of their decay. He asserted that they cannot enter the plant directly, but that the water, carbonic acid and ammonia resulting from their decay, are the substances actually imbibed by plants, and from these alone is built up the organic or combustible part of vegetation.

To this day there is a division of opinion among scientific men on this subject, some adopting the views of Liebig, others adhering essentially to the old doctrines. Many experiments and trials have been made with a view to settling this question, but such are the difficulties of a direct solution that scarcely definite results either way have been obtained.

On the one hand, Liebig and those who adopt his doctrines, have demonstrated that these organic matters are not at all essential to the growth of agricultural plants, and have shown that they can constitute but a small part of the actual food of vegetation taken in the aggregate.

On the other hand, there is no satisfactory evidence that the soluble organic matters of the soil and of peat, are not actually appropriated by, and, so far as they go, are not directly serviceable as food to plants.

Be this as it may, practice has abundantly demonstrated the value of humus as an ingredient of the soil, and if not directly, yet indirectly, it furnishes the material out of which plants build up their parts.

2d. The organic matters of peat as indirect food to plants. Very nearly one-half by weight of our common crops when perfectly dry, consists of *carbon*. The substance which supplies this element to plants is the gas, carbonic acid. Plants derive this gas mostly from the atmosphere absorbing it by means of their leaves. But the free atmosphere, at only a little space above the soil, contains but 1–25,000th of its bulk of this gas, whereas plants flourish in air containing a larger quantity, and in fact their other wants being supplied, they grow better as the quantity is increased to 1–12th the bulk of the air. These considerations make sufficiently obvious how important it is that the soil have in itself a constant and abundant source of carbonic acid gas. As before said, organic matter in a state of decay, is the single material which the farmer can incorporate with his soil in order to make it a supply of this most indispensable form of plant-food.

The *nitrogen* of crops, an ingredient that characterizes those vegetable substances which have the highest value as food for man, is naturally supplied to plants in the form of ammonia, and we are sufficiently aware of the great fertilizing value of this substance and of its commercial worth, in the shape of guano, &c., &c., for agricultural purposes, a worth depending upon the fact of its comparative scarcity.

It has long been known that peat contains a considerable quantity of nitrogen, and the average amount in the 33 specimens I have submitted to analysis, including peats and swamp mucks of all grades of quality, is equivalent to 1¾ *per cent.* of ammonia on the air-dried substance, or more than twice as much as exists in the best stable or yard manure. In several peats the amount is as high as 3 *per cent.*, and in one case 3½ per cent. were found.

There is a difference of opinion among chemists as to the state in which this nitrogen exists in peat and humus. Some assume it to be ammonia held in a peculiar state of combination with the humic and other acids, so that the ordinary means fail to separate it, and this is the most commonly received view. Certain it is that we cannot get much actual ammonia from a peat by a treatment which will displace this body perfectly from a guano or other ordinary manure. In two trials but about 1 per cent. was obtained.

In order then to estimate the availability of the nitrogen of peat, we must fall back on general principles, and practical experience.

We know from the exact demonstrations of chemical science that when organic bodies decay their elements enter into new and more stable combinations and that their nitrogen appears in the form of ammonia. If bodies very rich in nitrogen undergo a rapid putrefactive decay, a portion of the nitrogen separates as such and escapes combination, it is probable however that highly porous substances containing but a few per cent. of nitrogen, yield all or nearly all their nitrogen in the shape of ammonia, or, what has the same agricultural significance, in that of nitric acid.

The conclusion then is entirely warranted that the nitrogen of peat becomes almost completely available, as the peat decays in the soil. This conclusion is supported by the fact attested by practical men, that certain varieties of swamp-muck are equal to stable manure in their fertilizing effects, although inferior to the latter in respect to the quantity of substances usually held to be active fertilizers which they contain, ammonia (nitrogen) alone excepted.

3d. The decay of peat itself offers some peculiarities that are worthy of notice in this connection. It is more gradual and regular in decay than the vegetable matters of stable dung, or than that furnished by turning under sod or green crops. It is thus a more steady and lasting benefit, especially in light soils, out of which ordinary vegetable manures disappear too rapidly. The decay of peat appears to proceed through a regular series of steps. In the soil, especially in contact with soluble alkaline bodies as ammonia and lime, there is a progressive conversion of the insoluble or *less soluble* into soluble compounds. Thus the inert matters that resist the immediate solvent power of alkalies, absorb oxygen from the air and form the humic acid soluble in alkalies; the humic acids also undergo an analogous change, and pass into crenic acid, and this body is converted into apocrenic acid. The two latter are soluble in water, and, in the porous soil, they are rapidly brought to the end-result of decay, viz.: water, carbonic acid and ammonia.

Great differences must be observed, however, in the rapidity with which these changes take place. Doubtless they go on most slowly in case of the black compact peats, and perhaps many of the lighter and more porous samples of swamp-muck I have examined would decay nearly as fast as unaltered vegetable matter.

It might appear from the above statement that the effect of exposing peat to the air as is done when it is incorporated with the soil, would be to increase relatively the amount of soluble organic matters; but the fact is, that they are actually diminished and so because the oxydation and consequent removal of these soluble matters (crenic and apocrenic acids) proceed more rapidly than they can be produced from the less soluble humic acid of the peat.

II. With regard to the inorganic matters of peat considered as food to plants, it is obvious that leaving out of the account for the present, some exceptional cases, they are useful as far as they go.

In the ashes of peats, we almost always find small quanties of sulphate of lime, magnesia and phosphoric acid. Potash and soda too, are often present though never to any considerable amount. Carbonate and sulphate of lime are large ingredients of the ashes of about one-half the peats I have examined. The ashes of the other half are largely mixed with sand and soil, but in most cases also contain considerable sulphate and often carbonate of lime and magnesia.

In one swamp-muck, No. 4, from Messrs. Pond and Miles, Milford, there was found but two per cent. of ash, at least one half of which was sand, and the remainder sulphate of lime, (gypsum). In other samples 20, 30, 50 and even 60 per cent. remained after burning off the organic matter. In these cases the ash is chiefly sand. The amount of ash found in those peats which were most free from sand ranges from 4 to 9 per cent. Probably the average per centage of true ash, viz.: that derived from the organic matters themselves not including sand and accidental ingredients, is not far from 5 per cent.

I regret that time has not allowed me to make more complete examinations of the ashes of all the peats that have come under analysis. What I have been able to do is with two exceptions simply to ascertain the presence, and in a rough way the comparative abundance of lime, magnesia, iron, sulphuric and carbonic acids. I am not entirely satisfied with the accuracy of the inferences which I have been obliged to draw from the necessarily superficial ash-examinations. But to carry out full quantitative analyses of the ashes of 34 peats and mucks, is an immense amount of labor, and could not be hoped to prove practically remunerative; because it must be with the analyses of peats as it is with that of soils, they may be useful to establish a general fact, but cannot be relied upon implicitly in individual cases unless they are strongly marked and peculiar.

I give here a statement of the composition of the ash of two peats, the only ones I have had time to examine fully. They doubtless give a fair idea of the inorganic ingredients of the majority of the peats submitted to trial, sand not being taken into account.

Analysis of Peat ashes.

	I.	II.
Potash,	.69	.80
Soda,	.58	
Lime,	40.52	35.59
Magnesia,	6.06	4.92
Oxyd of iron and alumina,	5.17	9.08
Phosphoric acid,	.50	.77
Sulphuric acid,	5.52	10.41
Chlorine,	.15	.43
Soluble silica,	8.23	1.40
Carbonic acid,	19.60	22.28
Sand and charcoal,	12.11	15.04
	99.13	100.74

I. was furnished me by Mr. Daniel Buck, Jr., of Poquonock, and comes from a peat, (No. 12,) which he employs as fuel. For the elaborate analysis I am indebted to Mr. Geo. F. Barker of Charleston, Mass., a graduate of the Yale Scientific School.

II. (from peat No. 9,) was sent me by Mr. J. H. Stanwood of Colebrook. Mr. O. C. Sparrow of Colchester, Ct., a graduate of the Yale Scientific School, executed the analysis.

The fertilizing constituents of both these ashes consist almost entirely of carbonate and sulphate of lime, and carbonate of magnesia. Phosphoric acid and potash are present, but in small quantity. Nevertheless, as will be shown presently, the ingredients of these ashes must be considered as largely contributing to the fertilizing effect of the peats from which they were derived.

In a few instances, there is an almost entire want of useful ash ingredients, for example, in Virgin's mucks, Nos. 18, 19 and 20; and Hoyt's muck, No. 22. In these samples, besides sand and oxyd of iron, there are only very minute quantities of lime and magnesia to be found.

III. *Comparison of Peat with Stable Manure.*

The fertilizing value of peat is best understood by comparing it with some standard manure. Stable manure is obviously that fertilizer whose effects are most universally observed and appreciated, and by setting analyses of the two side by side, we may see at a glance, what are the excellencies and what the deficiencies of peat. In order rightly to estimate the worth of those ingredients which occur in but small per centage in peat, we must remember that it like stable manure, may be, and usually should be applied in large doses, so that in fact the smallest ingredients come upon an acre in considerable quantity.

In making our comparison we will take the analysis of Peat No. 12, (Mr. Buck's,) and one executed by Dr. Voelcker of the Royal Agricultural College of England, on wellf-ermented farm yard manure of best quality, from the mixed dung of horses, cows and sheep.

The peat is understood to be simply air dried, yet perhaps dryer than it would become if dug and left heaped over one summer; while the yard manure is moist from the heap, and of the usual average dryness.

No. I, is the complete analysis of Peat; No. II, of well rotted stable manure:

		I.	II.
Water expelled at 212 deg.		18.050	75.420
Org. matter.	Soluble in dilute solution of carbonate of soda—soluble geine,	27.190	16.530
	Insoluble in solution of carbonate of soda,	48.840	
Potash,		.041	.491
Soda,		.035	.080
Lime,		2.431	1.990
Magnesia,		.364	.138
Oxyd of iron and alumina,		.310	.673
Phosphoric acid,		.030	.450
Sulphuric acid,		.331	.121
Chlorine,		.009	.018
Soluble silica,		.494	1.678
Carbonic acid,		1.175	1.401
Sand and charcoal,		.700	1.010
		100.000	100.000
Potential ammonia,		2.920	.735
Matters soluble in water,		1.800	5.180

In studying the above analyses we observe 1st, that this peat contains *five times as much organic matter*, and *four times as much potential ammonia* as the yard-manure. 2d. It contains more lime, magnesia and sulphuric acid than yard-manure. 3d. It is *deficient* in potash and phosphoric acid. We see thus that peat and yard-manure are excellently adapted to go together; each supplies the deficiencies of the other.

We see also from this *that peat requires the addition of phosphates*, (in the shape of bone-dust, or phosphatic guano,) *and of potash*, (as unleached wood ashes,) *in order to make it precisely equal in composition to stable manure.*

But there are some other questions to be discussed, for two manures may reveal to the chemist the same composition and yet be very unlike in their fertilizing effects, because their conditions are unlike, because they differ in their degrees of solubility or availability.

Now, as before insisted upon, it is true in general, that peat is much more slow of decomposition than yard-manure, and this fact which is an advantage in an amendment is a disadvantage in a fertilizer. Though there may be some peats, or rather mucks, which are energetic and rapid in their action, it seems that the most of them need to be applied in larger quantities than stable manure in order to produce equal fertilizing effects.

Another matter that may be noticed here is the apparent contradiction between Chemistry, which says that peat is not equal to stable manure as a fertilizer, and practice, which in many cases affirms that it is equal to our standard manure.

In the first place, the chemical conclusion is a general one and does not apply to individual peats, which in a few instances may be superior to yard-manure. If I mistake not, the practical judgment also is, that in general yard-manure is the best.

To go to the individual cases, 2d, a peat in which ammonia exists, to 3 or 4 times the amount found in stable or yard manure, may for a few seasons produce better results than the latter, merely on account of the presence of this one ingredient, it may in fact, for the soil and crop to which it is applied, *be* a better fertilizer than yard manure, because the substance ammonia is most needed in that soil, and yet for the generality of soils, or in the long run, it may prove to be an inferior fertilizer.

Again, 3d, the melioration of the physical qualities of a soil, the amendment of its dryness and excessive porosity, by means of peat may be more effective for agricultural purposes, than the application of tenfold as much fertilizing, i. e. plant-feeding materials; in the same way that the mere draining of an over-moist soil often makes it more productive than do the heaviest manurings.

6. *On the characters of Peat that are detrimental, or that may sometimes need correction before it is agriculturally useful.*

1st. *Bad effects on heavy soils.*

We have laid much stress on the amending qualities of peat, when applied to dry and leachy soils, which by its use are rendered more retentive of moisture and manure. Now these properties which it would seem are just adapted to renovate very light land, under certain circumstances may become disadvantageous on heavier soils. On clays no application is needed to retain moisture. They are already too wet as a general thing. Unless a soil be open, some varieties of muck, (the denser peat-like kinds) are too slow in decay, and therefore do not yield up their stores of plant-food with sufficient rapidity.

Put into the soil it lasts much longer than stubble, or green crops plowed in, or than long manure. If buried too deeply, or put into a heavy soil, especially if in large quantity, it does not decay, but remains wet, and tends to make a bog of the field itself.

In soils that are rather heavy, it is therefore best to compost the muck with some rapidly fermenting manure. We thus get a compound which is quicker than muck, and slower than stable manure, etc., and is therefore better adapted to the wants of the soil than either of these would be alone.

Here it will be seen that much depends on the character of the muck itself. If light, spongy, brown or gray in color, and easily dried, it may be used alone with advantage on loamy soils, whereas if dense, black, and coherent like some of the Irish peats, a block of which when dry, will make a voyage across the Atlantic in the boiler of a steamship without losing its form—it would most likely be a poor amendment on a soil which has much tendency to become compact, and therefore does not readily free itself from excess of water.

A clay soil if *thorough-drained and deeply plowed*, may be wonderfully improved by even a heavy dressing of muck, as then, the water being let off, the muck can exert no detrimental action, but operates as effectually to loosen a too heavy soil as in case of sand it makes an over-porous soil compact or retentive. A clay may be made friable if well drained by incorporating with it any substance as lime, sand, long manure or muck which interposing itself between, the clayey particles, prevents their adhering together.

2d. *Noxious ingredients.*

(*a*) *Vitriol peat.* Occasionally a peat is met with which is injurious if applied in the fresh state to crops, from its containing some substance which exerts a poisonous action on vegetation. So far as I can decide from my inquiries, the only detrimental ingredient that occurs in peat is sulphate of protoxyd of iron, the same body that is popularly known under the names copperas and green-vitriol. This body is usually formed from sulphuret of iron, which is thus indirectly noxious.

I have found this substance ready-formed in large quantity in but one of the peats that I have examined, viz.: that sent me by Mr. Perrin Scarborough* of Brooklyn, Ct., (No. 17.) This remarkable peat dissolves in water to the extent of 15 per cent., and this soluble portion although containing some organic matter and sulphate of lime, consists in great part of green-vitriol.

Green-vitriol in minute doses is not hurtful, but rather beneficial to vegetation, but in larger quantity it is fatally destructive.

In the salt marsh mud sent me by the Rev. Wm. Clift of Stonington, (No. 33,) there is likewise sulphate of protoxyd of iron in considerable quantity.

This noxious substance likewise occurs in small amount in swamp muck (No. 22,) from E. Hoyt, Esq., New Canaan, and in hardly appreciable quantity in several others.

In a sample of the peat from the farm of Albert Day, Esq., Brooklyn, which is reputed detrimental, I have not been able to find any traces of this substance.

Besides green-vitriol, it is possible that certain organic salts of protoxyd of iron, may be deleterious, but there is not much evidence to support this idea.

(*b*) *The acidity of Peats.* Many writers have asserted that peat and muck possess a hurtful "acidity" which must be corrected before they can be usefully employed. It is indeed a fact that peat consists largely of acids, but, except perhaps in the vitriol peats, (those containing copperas,) they are so insoluble, or if soluble, are so quickly modified by the absorption of oxygen, that they do not exhibit any "acidity" that can be deleterious to vegetation. It is advised to neutralize this supposed acidity by lime or some other alkali before using peat as a fertilizer or amendment, and there is great use in such mixtures of peat with alkaline matters, as we shall presently notice under the head of com-

* Erroneously said to be from Mr. Philip Scarborough, in an article in the *Homestead*, Vol. 3, p. 540.

posts, but I know of no single fact, which warrants the idea that the organic matters of any peat have any acidity that is hurtful to vegetation.

(c) *Resinous matters* are mentioned by various writers as injurious ingredients of peat, but I find no evidence that this notion is well-founded. The peat or muck formed from the decay of resinous wood and leaves does not appear to be injurious, and the amount of resin in peat is exceedingly small.

3d. *Deficient Ingredients.* This topic has been alluded to already, and we need only mention here that potash and phosphoric acid are in general the bodies which must be added to peat to make a durably efficient fertilizer. Sometimes, too, lime is wanting. To supply these ingredients; for potash, unleached wood ashes or New Jersey Green Sand may be employed; for phosphoric acid, bone-dust or phosphatic guano; for lime, marl or leached ashes.

7. *The Preparation of Peat for Agricultural Use.*

(a) *Excavation.* As to the time and manner of getting out peat, the circumstances of each case must determine. I only venture here to offer a few hints on this subject, which belongs so exclusively to the farm. The month of August is generally the appropriate time for throwing up peat, as then the swamps are usually most free from water, and most accessible to men and teams; but peat is often dug to best advantage in the winter, not only on account of the cheapness of labor, and from there being less hurry with other matters on the farm at that season; but also because the freezing and thawing of the peat that is thrown out, must probably aid to disintegrate it and prepare it for use.

A correspondent of the *Homestead*, signing himself "Commentator," has given directions for getting out peat that are well worth the attention of farmers. He says:

"The composting of muck and peat, with our stable and barnyard manures, is surely destined to become one of the most important items in farm management throughout all the older States at least. One of the difficulties which lie in the way, is the first removal of the muck from its low and generally watery bed; to facilitate this, in many locations, it is less expensive to dry it before carting, by beginning an excavation at the border of the marsh in Autumn, sufficiently wide for a cart path, throwing the muck out upon the surface on each side, and on a floor of boards or planks, to prevent it from absorbing moisture from the wet ground beneath; this broad ditch to be carried a sufficient length and depth to obtain the requisite quantity of muck. Thus thrown out, the two piles are now in a convenient form to be covered with boards, which if properly done and kept covered till the succeeding Autumn, the muck will be found to be dry and light, and in some cases may be carted away on the surface, or it may be best to let it remain a few months longer until the bottom of the ditch has become sufficiently frozen to bear a team, it can then be more easily loaded upon a sled or sleigh, and drawn to the yards and barn. In other localities, and where large quantities are wanted, and it lies deep, a sort of wooden railroad and inclined plane can be constructed by means of a plank track for the wheels of the cart to run upon, the team walking between these planks, and if the vehicle is inclined to 'run off the track,' it may usually be prevented by scantlings, say four inches thick, nailed upon one of the tracks on each side of the place where the wheel should run; two or more teams and carts may now be employed, returning into the excavation outside of this track. As the work progresses the track can be extended at both ends, and by continuing or increasing the inclination at the upper end a large and high pile may be made, and if kept dry will answer for years for composting, and can be easily drawn to the barn at any time."

(*b*) *Exposure or seasoning of peat.* In most cases the chief or only use of exposing the thrown up peat to the action of the air and weather during several months or a whole year, is to rid it of the great amount of water which adheres to it, and thus to reduce its bulk and weight previous to cartage.

The general effect of exposure as proved further on by my analyses, is to reduce the amount of matter soluble in water, and cause peats to approach in this respect a fertile soil, so that instead of containing 2.4 or even 6 per cent. of substances soluble in water, as at first, they are brought to contain but one-half these amounts or even less. This change, however, goes on so rapidly after peat is mingled with the soil, that previous exposure is rarely necessary, and most peats may be used perfectly fresh.

When a peat contains sulphate of iron, or, if such a case be possible, soluble organic salts of iron, to an injurious extent, these may be converted into other insoluble and innocuous bodies, by a sufficient exposure to the air. Sulphate of protoxyd of iron is thus changed into sulphate of peroxyd of iron, which is said to exert no hurtful effect on vegetation, while the soluble organic bodies of peat are oxydized and either converted into carbonic acid gas, carbonate of ammonia and water, or else made insoluble.

It is not probable, however, that merely throwing up a vitriol peat into heaps and exposing it thus imperfectly to the atmosphere, is sufficient to correct its bad qualities. Such peats need the addition of some alkaline body, as ammonia, lime, or potash to render them salutary fertilizers.

(*c*) *And this brings us to the subject of composting with muck or peat*, which appears to be the best means of taking full advantage of all the good qualities of muck, and of obviating or neutralizing the ill results that might follow the use of some raw mucks, either from a peculiarity in their composition, (soluble organic compounds of iron, sulphate of protoxyd of iron,) or from too great indestructibility.

The chemical changes (oxydation of *iron* and *organic acids*,) which prepare the inert or even hurtful ingredients of peat to minister to the support of vegetation, take place most rapidly in presence of an *alkaline* body.

The alkali may be *ammonia* coming from the decomposition of animal matters, or *lime*, *potash* or *soda*.

A great variety of matters may of course be employed for making or mixing with muck composts, but there are only a few which allow of extensive and economical use, and our notice will be confined to these.

First of all, the composting of muck with *stable manure* deserves attention. Its advantages may be summed up in two statements.

1st. It is an easy and perfect method of composting all manures, even those kinds most liable to loss by fermentation, as horse-dung; and, 2d. It develops the inert fertilizing qualities of the muck itself.

Without attempting any explanation of the changes undergone by a muck and manure compost, further than to say that the fermentation which begins in the manure extends to and involves the muck, reducing the whole to nearly, if not exactly, the condition of well-rotted dung, and that in this process the muck effectually prevents the loss of ammonia,—I may appropriately give the practical experience of farmers who have proved in the most conclusive manner how profitable it is to devote a good deal of time and care to the preparation of this kind of compost.

Preparation of Composts.

To a given quantity of stable manure, two or three times as much weathered or seasoned muck by bulk may be used. The manure may either be removed from the stables, and daily mixed with the appropriate amount of muck, by shoveling the two together, at the heap, out of doors; or as some excellent farmers prefer, a trench, water tight, four inches deep and twenty inches wide, is constructed in the stable floor, immediately behind the cattle, and every morning a bushel-basketful of muck is put behind each animal. In this way the urine is perfectly absorbed by the muck, while the warmth of the freshly voided excrements so facilitates the fermentative process, that, according to Mr. F. Holbrook, of Brattleboro, Vt., who I believe first employed and described this method, *much more muck can thus be well prepared for use* in the Spring, than by any of the ordinary modes of composting. When the dung and muck are removed from the stable, they should be well intermixed, and as fast as the compost is prepared, it should be put into a compact heap, and covered with a layer of muck several inches thick. It will then hardly require any shelter if used in the Spring.

On the farm of Mr. Pond, of Milford, Conn., I have seen a large pile of this compost, and have witnessed its effect as applied by that gentleman to a field of sixteen acres of fine gravelly or coarse sandy soil, which, from having a light color and excessive porosity, had become dark, unctuous, and retentive of moisture, so that during the drouth of 1856, the crops on this field were good and continued to flourish, while on the contiguous land they were dried up and nearly ruined.

By reference to the Transactions of the Connecticut State Agricultural Society for 1857, it will be seen in the very interesting report of the committee on farms and reclaimed lands, that on the farms which received the high premiums, and the most honorable mention, composts of muck and stable manure are largely employed.

Messrs. Stephen Hoyt & Sons of New Canaan, Mr. Samuel Prentice of Greenville, Mr. Philip Scarborough of Brooklyn, and Mr. Elisha Dickerman of Orange, near New Haven, have used this compost with the most decided advantage, and doubtless all these gentlemen would concur in the opinion of many other excellent farmers, viz.: *That a well made compost of two loads of muck and one of stable manure is equal to three loads of the manure itself.*

This opinion is so well substantiated that we need not hesitate to pronounce it a fact, and if a fact, it is one which deserves to be painted in bold letters on every barn-door in Connecticut.

In the vicinity of cities, muck is often composted *to great advantage with night soil.* The Liebig Manufacturing Company's Poudrette, manufactured at East Hartford, (for analysis of which see my 1st Annual Report, pp. 41 and 43,) is a carefully made preparation, of which these two matters are the chief ingredients. In the neighborhood of New Haven large quantities of this kind of compost are annually made, and the manufacture might be vastly extended with the utmost advantage to all parties concerned. Every farmer who can, would find it profitable, and not only so but pleasant and healthful, to compost the privy and sink waste of his premises with muck. The outlay of a few dollars would provide such conveniences as are needful to accomplish this with ease, and instead of being afflicted with a nuisance, yielding an intolerable quantity of miasmatic smell and a few shovelfuls of effete waste, he might convert his *necessary* into an odorless convenience, and make enough poudrette to fertilize a large garden to the highest degree. (See Mr. Edwin Hoyt's account of its use for this purpose.)

Guano, so serviceable in its first applications to light soils, may be composted with muck to the greatest advantage. Guano is an excellent material for bringing muck into good condition, and on the other hand the muck most effectually prevents any waste of the costly guano, and at the same time, by furnishing the soil with its own ingredients, to a greater or less degree, prevents the exhaustion that often follows the use of guano alone. The quantity of muck should be pretty large compared to that of the guano,—a bushel of guano will compost six, eight, or probably ten of muck. Both should be quite fine, and should be well mixed, the mixture should be moistened and kept covered with a layer of muck of several inches of thickness. This sort of compost would probably be sufficiently fermented in a week or two of warm weather, and should be made and kept under cover.

If no more than five or six parts of muck to one of guano are employed, the compost, according to the experience of Simon Brown, Esq., of the Boston *Cultivator*, (Patent Office Report for 1856,) will prove injurious if placed in the hill in contact with seed, but may be applied broadcast without danger.

The *White fish* or *Menhaden*, so abundantly caught along our Sound coast during the summer months, or any variety of fish may be composted with muck, so as to make a powerful manure, with complete avoidance of the excessively disagreeable stench which is produced when these fish are put directly on the land. Messrs. Stephen Hoyt & Sons of New Canaan, Conn., make this compost on a large scale. They have employed 220,000 fish in one season, and use ten or twelve loads of muck to one of fish. A layer of muck one foot or more in thickness is spread upon the ground, and covered with a layer of fish, on this is put another layer of muck and another of fish, and so on till the pile is several feet high, finishing with a good layer of muck.

In the Summer when this work is usually attended to, the fermentation begins at once, so that no delay must be allowed after the fish are taken, in mixing the compost, and in a short time the operation is complete; the fish disappear, bones excepted, and by shoveling over, a uniform mass is obtained, almost free from odor, and retaining perfectly all the manurial value of the fish. Lands well manured with this compost will keep in heart and improve, while, as is well known to our coast farmers, the use of fish alone is ruinous, in the end, on light soil.

For further particulars of the composts made by the Messrs. Hoyt, see analysis further on.

It is obvious that any other easily decomposing animal matters, as slaughter-house offal, soap-boiler's scraps, glue waste, etc., etc., may be composted in a similar manner, and that all these substances may be made together into one compost.

In case of the composts with guano, yard manure and other animal matters, *ammonia* is the alkali which promotes these changes, and it would appear that this substance, on some accounts, excels all others in its efficacy, but the other alkaline bodies, *potash* and *lime*, are scarcely less active in this respect, and being at the same time, of themselves useful fertilizers, they may be employed with double advantage in preparing muck composts.

Potash-lye and *soda-ash* have been recommended for composting with muck; but, although they are no doubt highly efficacious, they are quite too costly for extended use.

The other alkaline materials that may be cheaply employed, and are recommended, are *wood-ashes* leached and unleached, *ashes of peat*, *marl*, (consisting of carbonate of lime,) *quick lime*, *gas lime*, and what is called "*salt and lime mixture.*"

With regard to the proportions to be used, no definite rules can be laid down; but we may safely follow those who have had experience in the matter. Thus, to a cord of muck, which is about 100 bushels, may be added of unleached wood ashes twelve bushels, or of leached wood ashes twenty bushels, or of peat ashes twenty bushels, or of marl or gas lime twenty bushels. Ten bushels of quick lime, slaked with water or salt-brine previous to use, is enough for a cord of muck.

Instead of using the above mentioned substances singly, any or all of them may be employed together.

The muck should be as fine and free from lumps as possible, and must be intimately mixed with the other ingredients by shoveling over. The mass is then thrown up into a compact heap which may be four feet high. When the heap is formed, it is good to pour on as much water as the mass will absorb, (this may be omitted if the muck is already quite moist,) and finally the whole is covered over with a few inches of pure muck, so as to retain moisture and heat. If the heap is put up in the Spring, it may stand undisturbed for one or two months, when it is well to shovel it over and add water if it has become dry. It should then be built up again, covered with fresh muck, and allowed to stand as before until thoroughly decomposed. The time required for this purpose varies with the kind of muck, and the quality of the other material used. The weather and thoroughness of intermixture of the ingredients also materially affect the rapidity of decomposition. In all cases five or six months of summer weather is a sufficient time to fit these composts for application to the soil.

The use of "*salt and lime mixture*" is strongly recommended by so many writers, that a few more words may be devoted to its consideration.

In Dr. Dana's Muck Manual, and in Johnston's Agricultural Chemistry, it is stated that common salt is decomposed by quick lime, with the production of carbonate of soda. Now although this change *may* occur in the soil or in presence of the organic matters of peat, yet there is no *proof* that it does take place, and *all the probabilities are opposed to such a change*, so that from theoretical grounds, there is no advantage to be anticipated from a mixture of salt and lime over the unmixed lime, as far as the action on peat or muck is concerned.

But the extraordinary usefulness of the salt and lime mixture for composting has been so extensively and vigorously maintained, that many will be inclined to despise the chemistry that doubts its benefits.

Therefore without entering into a chemical discussion of its merits, we will be content here, to assert, that, if useful, its usefulness is not as yet explained, or the explanations given are entirely unsatisfactory.

That it is useful is testified to by good farmers as follows. Says Mr. F. Holbrook of Vermont, (quoted from Patent Office Report for 1856, page 193.) "I had a heap of seventy-five half cords of muck mixed with lime in the proportion of a half cord of muck to a bushel of lime. The muck was drawn to the field when wanted in August. A bushel of salt to six bushels of lime was dissolved in water enough to slake the lime down to a fine dry powder, the lime being slaked no faster than wanted, and spread immediately while warm, over the layers of muck, which were about six inches thick; then a coating of lime and so on, until the heap reached the height of five feet, a convenient width, and length enough to embrace the whole quantity of the muck. In about three weeks a powerful decomposition was apparent, and the heap was nicely overhauled, nothing more being done to it till it was loaded the next Spring for spreading. The compost was spread on the plowed surface of a dry sandy loam at the rate of about fifteen cords to the acre and harrowed in. The land was planted with corn, and the crop was more than sixty bushels to the acre."

Other writers assert that they "have decomposed with this mixture spent tan, saw dust, corn stalks, swamp muck, leaves from the woods, indeed every variety of inert substance, and *in much shorter time than it could be done by any other means.*"*

It deserves to be ascertained by direct comparative experiment, whether the lime slaked with a solution of salt, does really act with more power and rapidity than if slaked with water alone. If the "salt and lime mixture" possesses peculiar virtues, it is important to be known, and of not less consequence is it to determine that its reputation is fictitious.

There appears to be no doubt that the soluble and more active (caustic) forms of alkaline bodies exert powerful decomposing and solvent action on muck. It is asserted too that the insoluble and less active matters of this kind, also have an effect though a less complete and rapid one. Thus, carbonate of lime in the various forms of marl, leached ashes and peat ashes, (for in all these it is the chief and most "alkaline" ingredient,) are recommended to compost with muck. But we are not informed what is the character of the changes they produce in muck or peat. From our chemical knowledge we should almost decide that in general they can have no material effect, and yet it is very unsafe to judge in these things without actual and precise practical knowledge.

* Working Farmer, Vol. III. page 280.

The admixture of any earthy matter with peat will facilitate its decomposition in so far as it promotes the separation of the particles of the peat from each other, and the consequent access of air. This benefit may well amount to something when we add to peat one-fifth of its bulk of marl or leached ashes, but the question comes up: Do these insoluble mild alkalies exert any direct action? Would not as much soil of any kind be equally efficacious by promoting to an equal degree the contact of oxygen from the atmosphere?

It is possible that the carbonate of lime in presence of water and carbonic acid, whereby it becomes soluble to a slight extent, may act to liberate some ammonia from the soluble portions of the peat, and this ammonia may react on the remainder of the peat to produce the same effects as it does in the case of a compost made with animal matters. But speculations on this point though easily made, are of no value, except to suggest practical trials.

It often happens that opinions entertained by practical men, not only by farmers, but by mechanics and artisans as well, are founded on so unreliable a basis, are supported by trials so destitute of precision, that their accuracy may well be doubted, and from all the accounts I have met with it does not seem to be well established that composts made with carbonate of lime, are better than the muck and carbonate used separately. This, it is plain, is another question worthy of investigation.

If there is any advantage in composting muck with carbonate of lime, then nature has in some localities furnished admirable facilities for making this kind of fertilizer: thus in Salisbury, Ct., on the farm of John Adam, Esq., occurs a peat swamp, at the bottom of which, after excavating through four feet of peat, a layer of shell-marl, containing a large percentage of carbonate of lime, is found, which it is believed may be obtained in large quantities. (see analysis No. 34, in appendix.)

Such deposits are by no means uncommon, and whoever can demonstrate by a series of carefully conducted experiments, whether this marl is most economically applied to the soil directly or in compost with muck, will confer no small favor on Agriculture.

It must not be forgotten that we have already insisted upon using leached wood ashes and carbonate of lime in *conjunction with* peat, in order to supply the deficiencies of the latter; and in the agricultural papers are numerous accounts of the efficacy of such mixtures, but whether these bodies exert any good effect upon the peat itself, so that it is needful in general to take the trouble to make a *compost*, is it seems to me, a question not yet settled. In the case of vitriol peats, however, carbonate of lime is the cheapest and most appropriate means of destroying the noxious sulphate of protoxyd of iron, and correcting their deleterious quality. When carbonate of lime is brought in contact with sulphate of protoxyd of iron, the two bodies mutually decompose, with formation of sulphate of lime (gypsum) and carbonate of protoxyd of iron. The latter substance absorbs oxygen from the air with the utmost avidity, and passes into the peroxyd of iron, which is entirely inert.

8. I now proceed to discuss *the plan employed in the analysis of the Peats* which I have examined.

The specimens came to me in all stages of dryness. Some freshly dug and wet, others after a long exposure so that they were air-dry; some that were sent in the moist state, became dry before being subjected to examination; others were prepared for analysis while still moist.

A sufficient quantity of each specimen was carefully pulverized, intermixed and put into a stoppered bottle and thus preserved for experiment.

The first point in the examination was to make a general analysis, viz.: to ascertain the amount of water, and the proportions of vegetable matter and of ash.

In the special analysis, it was sought to obtain some nearer insight into the condition of the organic matter. For this purpose I deemed it best to employ the usual method of treating with an alkali and determining the quantity soluble therein, which corresponds to the humic (and ulmic) acid, and accordingly this operation has been carried out with no inconsiderable trouble. Unfortunately we do not now know whether these humic acids are possessed of any special fertilizing or other properties, which can confer interest on the knowledge of their quantity, nor can we ever learn their significance, if indeed they possess any, without numerous experiments directed immediately to this point. The only value, then, of these determinations, is that they give us some idea of the degree to which the peaty decomposition is advanced.

In the earlier analyses 1 to 17 inclusive, the treatment with carbonate of soda was not carried far enough to dissolve the whole of the soluble organic acids. It was merely attempted to make *comparative* determinations by treating all alike for the same time, and with the same quantity of alkali. I have little doubt that in some cases not more than one-half of the portion really soluble in carbonate of soda is given as such. In the later analyses, 18 to 33, however, the treatment was continued until complete separation of the soluble organic acids was effected.

In no instance was any special examination of these soluble acids undertaken, since in the present state of our knowledge, this labor could hardly be expected to yield any new results of agricultural importance.

By acting on a peat for a long time with a hot solution of carbonate of soda, there is taken up not merely a quantity of organic matter, but inorganic matters likewise enter solution. Silica, oxyd of iron and alumina are thus dissolved. In this process too, sulphate of lime is converted into carbonate of lime, but not dissolved.

The total amount of these soluble inorganic matters has been determined with approximate accuracy in analyses 18 to 33.

It was deemed of the highest importance to study the quantity and character of the bodies which pure water is able to dissolve from peats. In the watery extract of a peat we may expect to find those substances which make it directly useful as a fertilizer, and also those which, like sulphate of iron, are noxious to vegetation. The general character of the matters soluble in water has been indicated already, and the analyses themselves give the special details.

With regard to the entire ash, and the amount of nitrogen, it is unnecessary here to remark upon the importance of investigating them, or to add to what has been written in the preceding pages. The details of the process used in the analysis of peat are given in the accompanying note* by my friend, Dr. Robert A. Fisher, to whose skillful assistance I am largely indebted for the analytical data of this Report, especially for the analyses 18 to 33. I must also express my obligations to Mr. Edward H. Twining, assistant in the Yale Analytical Laboratory, for the analyses 1 to 17, executed by him in 1857.

9. *On the Use of Peat Analyses, and on the Value of Practical Information.*

When I began this investigation, it was known that some peats or mucks were highly useful, while others had proved detrimental, certain reasons too were known why they were good or bad in their effects, and in agricultural writings existed a great deal of statement that was partly true but more or less

---

* Note on the Process of Analysis.—The following is the general method employed in the analysis of peats and mucks: To prepare a sample for analysis, half a pound, more or less, of the substance to be examined, is pulverized and passed through a wire sieve of 24 meshes to the inch. It is then thoroughly mixed and bottled for use.

I. 2 grams of the above are dried (in a tared porcelain capsule,) at the temperature of 212 degrees, until they no longer decrease in weight. The loss sustained represents the *amount of water*, (according to Marsilly Annales des Mines, 1857, XII., 404, peat loses carbon if dried at a temperature higher than 212 degrees.)

II. The capsule containing the residue from I. is slowly heated to incipient redness, and maintained at that temperature until the organic matter is entirely consumed. The loss gives the total amount of *organic*, the residue the total amount of *inorganic* matter.

Note.—In peats containing sulphate of the protoxide of iron, the loss that occurs during ignition is partly due to the escape of sulphuric acid, which is set free by the decomposition of the above mentioned salt of iron. But the quantity is usually so small in comparison with the organic matter that it may be disregarded. The same may be said of the combined water in the clay that is mixed with some mucks, which is only expelled at a high temperature.

III. 3 grams of the sample are digested for half an hour, with 200 cubic centimeters (66.6 times their weight,) of boiling water, then remove from the sand bath, and at the end of twenty-four hours, the clear liquid is decanted. This operation is twice repeated upon the residue; the three solutions are mixed, filtered, concentrated, and finally evaporated to dryness (in a tared platinum capsule,) over a water bath. The residue, which must be dried at 212 degrees, until it ceases to lose weight, gives the *total amount soluble in water*. The dried residue is then heated to low reduess, and maintained at that temperature until the organic matter is burned off. The loss represents the amount of *organic matter soluble in water*, the ash gives the quantity of *soluble inorganic matter*.

IV. 1 gram is digested for two hours, at a temperature just below the boiling point, with 100 cubic centimeters of a solution containing 5 per cent. crystallized carbonate of soda. It is then removed from the sand bath and allowed to settle. When the supernatant liquid has become perfectly transparent, it is carefully decanted. This operation is repeated until all the organic matter soluble in this menstruum is removed; which is accomplished as soon as the carbonate of soda solution comes off colorless. The residue, which is to be washed with boiling water until the washings no longer affect test papers, is thrown upon a tared filter, and dried tinctured with uncertain speculation. *It was to learn whether other than the then known causes of the excellence or worthlessness of peats existed, and to test the correctness of the current opinions, that this investigation was undertaken.* By a comparative study of the characters of numerous specimens from all parts of Connecticut, it was hoped to arrive at some definite and reliable general conclusions as to their value—to ascertain the range of their excellence, and to establish safe rules for their use. I believe that this work has been satisfactorily accomplished. Besides these general results it was forseen that this investigation would assist in deciding a question much discussed of late, viz.: the ability of chemical analysis to pronounce upon the precise value of any particular specimen.

I had at the outset no great faith that the chemist could tell by his analyses, if this peat be good or that bad, or how much better one is than another. Now that 33 peats have been examined, I believe we are able in most cases to decide by analysis, with great probability, whether any specimen is useful or hurtful, and if the former, whether it has a high or low degree of excellence ; and yet, as will be seen further on, there are great difficulties in defining the precise limits where the good peats

---

at 212 degrees. It is the *total amount of organic and inorganic matter insoluble in carbonate of soda.* The loss that it suffers upon ignition, indicates the amount of *organic matter*, the ash gives the *inorganic* matter.

NOTE.—The time required to insure perfect settling after digesting with carbonate of soda solution, varies, with different peats, from 24 hours to several days. With proper care, the results obtained are very satisfactory. Two analyses of No. 6, executed at different times, gave *total insoluble in carbonate of soda.* 1st analysis 23.20 per cent.; 2d analysis 23.45 per cent.; which residues yielded respectively 14.30 and 14.15 per cent. of ash.

V. The quantity of *organic matter insoluble in water but soluble in solution of carbonate of soda*, is ascertained by deducting the joint weight of the amounts soluble in water, and insoluble in carbonate of soda, from the total amount of organic matter present. The *inorganic matter insoluble in water, but soluble in carbonate of soda*, is determined by deducting the joint weight of the amounts of inorganic matter soluble in water, and insoluble in carbonate of soda, from the total inorganic matter.

VI. The amount of nitrogen is estimated by the combustion of 1 gram with soda-lime in an iron tube, collection of the ammonia in a standard fifth solution (12.6 grams to the liter,) of oxalic acid, and determination of the residual free acid by an equivalent solution of caustic potash.

This method in skilful hands uniformly gives such correct and corresponding results that it was deemed unnecessary to make duplicate analyses. In one case, however, Dr. Fisher executed a second analysis which confirmed the numbers obtained by Mr. Twining a year before. S. W. J.

pass into the bad. It is not to be expected that the analysis of a peat or muck will ever suffice to fix its manurial value, as the analysis of a guano or superphosphate shows the worth of these fertilizers. From the nature of the case, the muck analyses admit only a much looser and more general interpretation.

Whatever may be the merits of analyses of peat and muck, it is certain that their value is to be only brought out in all perfection by the knowledge derived from actual trial on the farm. However far we may pursue our researches into the conditions of vegetable production, there will always remain unsettled points, and facts will be observed in practice which science can only imperfectly explain. Hence practice will always be in advance of science in certain particulars, and must be invariably appealed to before any doctrine can be really established. If peat were now for the first time discovered and brought to the chemist, he could not, after the most minute analysis, positively assert its usefulness, although he might find such strong probabilities that its action would be highly fertilizing, as to warrant immediate and careful trial. It is only when *experience on the farm* has proved its benefit, that he acquires satisfactory data for his decisions.

The chemist who will serve agriculture in the details of its operations, must not merely proceed from his science out, towards practice; but he must often, and not less often, go in the other direction, for in the field there exist conditions which can only be studied there, as they are wanting in the laboratory and in the study.

These considerations induced me to address a Circular to the parties who had sent in specimens, asking information on those points which appeared likely to be of general service, and would subserve the end of this inquiry. The circular was as follows, one slight amendation excepted:

QUERIES.

1. What is the length and breadth, and the number of acres in the swamp or marsh?

2. What is the average, and the greatest depth of the muck or peat?

3. Is it drained or not, and if so, to what depth and how long has it been dry?

4. Is it a salt or fresh water marsh?

5. Are the upper portions or layers dry during the summer? If so, how long, and to what depth?

6. Have any crops been produced on the drained or dry portions? If so, what and how large crops? And what manures have proved useful on them?

7. What is the soil underlying, and at the edges of the swamp?

8. Does the swamp receive much wash from surrounding hills? If so, of what kinds of soil are they?

9. Has the swamp (if fresh water,) both inlet and outlet? Is the water hard or soft? How large are the streams? Are they subject to heavy freshets in Spring and Autumn? Do they dry up in Summer?

10. If several samples are sent, are they from one place?

11. At the place where the sample or samples were taken, is there much variation in the quality or appearance of the muck at different depths? If so, specify these differences, and give the thickness of each layer?

12. What kind of trees or vegetation grows on the muck, and what kinds of timber or branches are found in it? Observe particularly if there be indications of much pine or other resinous timber.

13. Has the muck been employed *fresh* from the swamp, withont any lengthened exposure to the weather, as a dressing for grass or other crops, and with what results?

14. Has the long dug and exposed muck been applied to crops without other manures, and with what results compared to good stable manure?

15. Has the muck been composted or used as an absorbent? If so, with what materials, and to what advantage?

16. If composted, describe the manner of composting, giving the quantities employed.

17. If several mucks are sent, which do you consider best from actual experience?

18. Has the peat been used for fuel? If so, what is its quality for such use?

19. Please communicate any other interesting facts with regard to the occurrence or uses of the muck or peat, which you may know.

10. *Results of analyses and answers to the Circular.*

Here follow the details of each analysis, accompanied by the information obligingly furnished by the gentlemen who sent in the mucks and peats. I have in some cases re-arranged, condensed, or otherwise edited the original answers as appeared necessary.

Brief comments are appended to some of the analyses, but it would swell the Report to an unwarrantable degree, to extend these remarks as might be wished, in each individual case.

No. 1.—Peat from Lewis M. Norton, Goshen. Came in form of dry, tough, heavy cakes, of a dark chocolate color. With exception of a few grass roots was well decomposed.

Analysis.

Organic matter, *soluble in carbonate of soda,	17.63	
" insoluble in " " "	34.79	
Total,		52.42
†Inorganic matter, - - - - -		35.21
Water, - - - - - - -		12.37
		100.00

Soluble in water, 1.54 per cent.
Nitrogen, 1.28=ammonia, 1.63 "

For answer to circular see No. 3.

No. 2.—Peat from Lewis M. Norton, Goshen. Like No. 1, but heavier.

---

* The proportions of organic matter in analyses 1–17 are not strictly correct.

† Ash chiefly sand, contained but little carbonate of lime.

Analysis.

Organic matter soluble in carbonate of soda,	60.02	
" insoluble in " "	11.65	
Total,		71.67
*Inorganic matter, - - - -		8.00
Water, - - - -		20.33
		100.00

Nitrogen, 1.85=2.24 ammonia.

For answer to Circular see No. 3.

No. 3.—Swamp muck from Lewis M. Norton, Goshen. Came in dry, very light coherent cakes, consisting largely of the flattened stems of swamp plants. Color light brown.

Analysis.

Organic matter soluble in carbonate of soda,	50.60	
" insoluble in " "	29.75	
Total,		80.35
†Inorganic matter, - - - - -		4.52
Water, - - - -		15.13
		100.00

Soluble in water, 2.51

Nitrogen 1.90=2.31 ammonia.

Answers to circular *respecting Nos.* 1, 2 *and* 3.

1. The swamp contains about 50 acres, was formerly a pond. Nearly all around it, at the height of about 6 feet above the present surface may be seen the ancient high water mark.

2. The greatest depth excavated is 10–11 feet. The greatest depth observed is 32 feet.

3. Six years ago it was undrained, but is now drained to the depth of 3–4 feet.

4. The water is fresh.

5. The upper portions are dry enough for cultivation in summer and barely hard enough for plowing and taking off crops.

---

* The ash contains 37 per cent. of carbonate of lime.

† Ash contains 33 per cent. of carbonate of lime.

6. Trials have been made in raising corn, potatoes, buckwheat and grass. These experiments are comparatively recent, and the crops not very large, and in regard to corn and potatoes it seems necessary that some manure be put in the hill. Carrots have done well; pumpkins have done well. Decomposed manures only have been used. Potato *tops* grow large—the same of corn—but the tract being somewhat lower than the surrounding country is subject to early frosts.

7. Sand, and in some places clay (pure and good), granite boulders are found at the edges on digging.

8. There are no high hills in the vicinity, and no wash.

9. The swamp has two or three inlets, and one outlet at the south-west. Soft water. Streams ordinarily small, but subject to freshets or high water always with a large fall of rain. The streams are rarely if ever quite dry.

10–11. The three samples are from nearly the same place No. 1 is from the margin of the swamp; is mixed with sand and clay, and lies on *the bottom*—on which there is a bed of sand and clay, say 3–4 feet from the surface. It forms a stratum of 6–10 inches in depth, is quite distinct from all above it, and is undoubtedly of the earliest formation. Some three years ago specimens *very similar* were taken out at a depth of 10 feet and 5–6 rods from the margin; I suppose that all below is of this kind.

No. 2 is from the *surface* after removing the upper 3–4 inches. It evidently has been somewhat decomposed by the action of the atmosphere—say 8 to 10 inches deep.

No. 3 is found between 1 and 2, though it should be stated that there is but little so light and poor as this sample.

12. The roots of large trees, spruce or pine, are found, but not near the outside. These roots, so far as observed, are about 18 inches below the surface. No trunks of trees but many small alders are found at about the same depth in a vertical position. These are all cut easily through with the shovel. I found one piece of alder, of the thickness of a man's wrist, lying horizontally at the depth of 8 feet. The bark in appearance resembled that of an alder just cut. (In a later statement Mr. Norton remarks): As above described, and as since observed, the roots of many trees appear. They all seem to be of nearly the same depth

below the surface (about 18 inches,) *with good peat above and all around them.* Some roots and trunks even of red ash are found near the outside. But at a remove of some 2 or 3 rods from the outside none such appear. Those of red ash are much rotten and seldom require the use of an axe. But farther in the swamp the *roots only* are found, and these are all of the resinous kind. We have had occasion to dig out *many* of these—strong (solid as new some of them,) and highly resinous. The indications are that these trees were say 1 to 2 feet in diameter—but unlike the ash, *these trees never fell down.* They must have *decayed standing,* as nothing appears to indicate the remains of a fallen tree.

13. It has not been considered as of much value when used *fresh* from the swamp.

14. There have been no careful experiments in its use after long exposure.

15. In compost, as an absorbent it has been extensively used, and with marked success, thrown into hog pens or put in barnyards.

16. Method of composting: 2 parts muck with 1 part stable manure in a large heap—done in the Spring before the fermentation of the manure and not stirred—carried upon the land the next Spring.

17. We have mostly used the grassy or surface muck—sometimes other—all good.

18. I have used peat for fuel (no wood of any consequence,) for some 4 or 5 years. No one else here has employed it. It is cut or dug with an instrument such as is used in Ireland. It answers for domestic purposes well, *but it must be dry and kept dry.* Ashes many and valuable only as manure—as they seem to contain no potash. In my kitchen stove I have a grate, and the ashes descend to a close brick vault below. Carry out a load at once—very convenient—peat cheaper than wood.

LEWIS M. NORTON.

No. 4.—Swamp muck from Messrs. Pond & Miles, Milford. Coherent but very light and porous in texture, full of roots and stems. Color chocolate brown—surface peat.

Analysis.

Organic matter soluble in carbonate of soda,	65.15	
" " insoluble in " " "	11.95	
Total,		77.10
*Inorganic matter, - - - -		3.23
Water, - - - - - - -		19.67
		100.00

Soluble in water, 1.63

Nitrogen, 1.20=1.46 ammonia.

For answer to circular see No. 5.

No. 5.—Swamp muck from Messrs. Pond & Miles, Milford. Very light and loose in texture. Color, brownish red. When dry easily separates into thin layers. Taken from a depth of 3 feet.

Analysis.

Organic matter soluble in water, - -	2.62	
" soluble in carbonate of soda,	65.13	
" insoluble in " " "	16.65	
Total,		84.40
Inorganic matter soluble in water, - -	80	
Insoluble in water, - - -	1.20	
†Total,		2.00
Water, - - . - -		13.60
		100.00

Nitrogen, 0.95=1.15 ammonia.

ANSWERS TO CIRCULAR.

1. The swamp contains 3–4 of an acre.
2. The depth is 10 feet.
3. It is not drained.
4. The water is fresh.
5. It is dry for three or four months in summer, to the depth of 3½ feet.
6. No crops have been raised on it.

---

* Mostly sand and oxyd of iron with small quantities of carbonate and sulphate of lime.

† The ash is white, and besides sand, contains little else than sulphate of lime.

7. The neighboring and underlying soil is sand and coarse gravel.

8. It receives much wash from sandy hills and the highways which pass near it.

9. The swamp has neither inlet nor outlet. The water has a dark mahogany color.

10 and 11. Two samples were sent, taken from one to three feet from the surface. The surface peat (No. 4) is of a darkish brown for a depth of two feet. Below it is of a lighter color, (No. 5.)

12. Small maples, black alders and bilberry bushes; pine and white birch trees grow in the swamp. The last named predominates. Trunks of trees 3 feet in diameter have been found at a depth of several feet in the muck.

13. The fresh muck has never been applied to crops, but where it has been thrown out, vegetation in the shape of weeds has been rank on the top of the piles.

15. The weathered muck has not been used alone on crops.

15. The muck has been composted to good advantage with horse, hog and cow manure.

16. In composting the materials have been put together in layers, one part manure to about three of muck.

17. I consider the surface peat to be the best.

18. It has not been used for fuel.

19. I find it a great benefit to my land.

Wm. J. Pond.

No. 6.—Peat from Samuel Camp, Plainville. Dry hard lumps, very black and uniform in appearance.

Analysis.

Organic matter soluble in carbonate of soda,	43.20	
" insoluble " " " "	8.90	
Total,		52.10
*Inorganic matter, - - - -		29.20
Water, - - - - -		18.70
		100.00

* The ash besides a large amount of sand, contains much carbonate and sulphate of lime and some oxyd of iron.

Soluble in water, 2.50.
Nitrogen, 2.10=2.55 ammonia.

ANSWERS TO CIRCULAR.

1. Length of marsh 1½ miles, width from 25 to 50 rods.

2. Depth from 2 to 4 feet.

3. A small part has been drained 7 years to the depth of 4 feet.

4. It is a fresh water marsh.

5. The marsh is dry to the depth of one foot for 3 or 4 months; the portion drained is dry to the bottom at all times.

6. The drained portion was sown with herdsgrass and has lain in grass, the herdsgrass has run out and swamp grass has come in, except where a kind of clay or earth, a sample of which I sent you, was thrown upon the surface and there is found a good quality of English grass, no other dressing has been given. The average yield is 1½ tons per acre.

7. The underlying soil is generally gravel and clay; around the marsh are occasional beds of the before-mentioned clay.

8. It receives the wash of the mountain that extends through Farmington.

9. It has both inlet and outlet, a living stream of soft water sufficient to drive small mills, and subject to heavy freshets.

12. Oak prevails in the deposit; elm and maple were growing on the marsh when cleared.

13. When used fresh from the marsh but little advantage is derived from it, when long exposed and dried considerable advantage; but much the greatest by composting with some kind of manure, and the clay before mentioned, which is found in and about the marsh, does well used in that way.

14. This muck is worth for manure half as much as yard manure; when composted it is equal to yard manure. It makes a very good soil when used alone on sand.

15. I find it an excellent absorbent, and sometimes pump from a cistern in my yard the liquid it contains, and pour it upon piles of muck, which makes it a good fertilizer. I have used it with either yard manure, lime, ashes, guano or clay, with about equal success.

16. To 1 load of muck, 1 of clay, or $\frac{1}{4}$ yard manure, or 2 bushels of lime, or 4 bushels of ashes. The clay, lime and ashes may be mixed, but the yard manure must be placed in layers so as to cause fermentation.

18. It burns freely, making a very hot fire.

19. The above described deposit is principally on one main stream, but there are spurs running toward the mountain where little streams come in that yield the best quality of muck by about one-third; from these I generally dig my supplies.

This muck deposit is on the east side of the great plain lying parallel with the Farmington mountain. On the northwest there is a deposit brought down by the Pequabuc, covering perhaps a thousand acres, very little of it is drained but that which is is very productive.

SAMUEL CAMP.

No. 7.—Peat from Russell U. Peck, Berlin. Color chocolate brown.

Analysis.

Organic matter soluble in carbonate of soda,	38.49	
" insoluble in " " "	30.51	
Total,		69.00
*Inorganic matter,		13.59
Water,		17.41
		100.00

Soluble in water,	2.61
Nitrogen, 1.62=ammonia,	1.97

ANSWERS TO CIRCULAR.

1. The swamp is about 60 rods long and 40 broad. It contains about 5 acres.

2. The muck is 10 feet deep one rod from the edge; at two rods from the edge it is over 15 feet deep. The greatest or average depth is unknown.

3. Two years ago it was partially drained to the depth of two feet.

---

* Ash besides much sand, contains a large amount of carbonate and sulphate of lime and oxyd of iron.

4. The water is fresh.

5. The surface is dry to the depth of one foot.

6. No crop has been grown on it except coarse grass.

7. The underlying and adjoining soil is clay and full of rock.

8. A large amount of water from the adjacent high woodland runs into the swamp. The soil of the hills is a reddish loam.

9. It has both inlet and outlet, and is also fed at the edges by springs of cold soft water. It is flooded by heavy rains and dries up in summer.

10. The sample sent, was taken two feet below the surface.

11. At a depth of 4 feet, the muck has more the appearance of leaves and wood; but after long exposure to the weather it turns black and resembles the upper layer.

12. No trees now grow in the swamp. The vegetation consists of coarse grasses and brakes. The logs and branches found deep in the muck mostly appear to be red ash—none of them are pines.

13. The muck has been used fresh on corn and meadow with good effect.

14. The long exposed muck has been used and is equal to one-half as much barn-yard manure.

15. It has been composted with stable manure, with night-soil, and hen-dung. The compost of the two latter has had wonderful effect upon tobacco.

16. The composts with night-soil and hen-dung have been made under cover, using one part of manure to ten of muck. Other manures have been mixed with their own bulk of muck in the field.

18. It has not been used as fuel.

R. U. Peck.

No. 8.—Swamp muck from Rev. B. F. Northrop, Griswold. The dried masses were light, coherent but easily crushed, were of a grayish brown color, and much fine white sand was perceptible in them.

Analysis.

Organic matter soluble in carbonate of soda,	42.30	
" insoluble in " "	10.15	
Total,		52.45
*Inorganic matter, - - -		34.70
Water, - - - -		12.85
		100.00

Soluble in water, 1.64.
Nitrogen 1.31=1.60 ammonia.

ANSWERS TO CIRCULAR.

1. The swamp is nearly a triangle with irregular sides, containing about 1 acre, 3¼ rods.

2. As to depth, the estimated average is 4½ feet. Greatest depth dug, 6 feet, from the dip of the sides, greatest estimated depth 16 feet. A similar muck bed in an adjoining lot has been penetrated to that depth.

3. It has been drained for 4 years to a depth of two feet.

4. The water is fresh.

5. Perfectly dry at the depth of two feet all summer.

6. It has grown no crop but grass, which has been improving in quality since I drained it. No manures have been tried.

7. As the ditch approached the shallow part of the bed, at the depth of 6 feet, a substratum resembling very fine clay, and of a very light color, was thrown out. The edges are a gravelly loam.

8. The muck bed receives no wash from hills.

9. A stream of soft water runs through the deposit, it comes from a large spring, and runs about a quarter of a mile before it

* The ash is almost entirely white quartz sand, with some sulphate of lime.

enters my lot. In ordinary seasons it will fill a 4 inch pipe. Heavy rains make a little torrent of it. But the surrounding hills are covered with grass and granitic rocks, so there is little wash. The stream never dries. It is turned on to the upland in summer.

10. Only one sample was sent.

11. For two feet in depth there is no deviation in quality or appearance of the muck. Below that depth, and consequently below the water line—the muck assumes a brownish tinge, and appears as if the decomposition was not perfected, though on exposure to frost, I can discover but little difference.

12. The only vegetation is grass. Oak logs several inches through have been dug up, at depths varying from two to four feet. Hickory nuts with the shucks on have been found at the depth of three feet. No indications of resinous substances have been found. Maples and elms grow thriftily at one angle of the bog, where no effort has been made to eradicate them.

13 and 14. The muck has not been used as a manure.

15. It has been composted with horse-dung, and in some instances, ashes, in small quantities. I have raised excellent crops of corn and oats, much to the wonder of my neighbors, who knew I had the manure of only one horse. I purchased a few loads of poor manure last Spring, which together with what my horse made, was composted with muck and a few bushels of ashes, making about 8 or 10 cords. This was spread on 120 rods of ground, and ploughed in. The lot was planted with corn, (Rhode Island Premium.) The product was 99 measured bushels of ears, which is considered a large yield for this section.

16. In composting, the muck and manure have been spread in alternate layers, three of the muck to one of manure.

19. But little if any use was made of the muck by former owners. The impression seemed to be that it would injure the land. When I first began to use it, I found many who were utterly skeptical as to its value as a manure.

B. F. Northrop.

No. 9.—Peat from J. H. Stanwood, Colebrook. Came in hard lumps of a chocolate color. Well decomposed.

Analysis.

Organic matter soluble in carbonate of soda,	49.65	
" insoluble in " " "	7.40	
Total,		57.05
*Inorganic matter, - - - -		4.57
Water, - - - - -		38.38
		100.00

Soluble in water, 1.83.

Nitrogen, 1.23=1.50 ammonia.

ANSWERS TO CIRCULAR.

1. The swamp is about 1½ miles in length, and may be likened in form to a pair of spectacles. The widest portions are about eighty rods in width, and it contains in all about one hundred and fifty acres.

2. The depth in the southern portion is probably not more than four or five feet on the average; while in the northern portion, from which the sample was taken, the depth is so great that it cannot be ascertained by any means which I have at hand. A pole has been pushed down sixteen feet without touching bottom, at the distance of four or five rods from the margin.

3. The swamp has been for the most part drained.

4. The water is fresh.

5. The depth of drainage is from one to three feet, and the portion from which the sample was taken has been but partially drained until within the past four years.

6. The upper portions are usually dry during the summer to the depth of two or three feet.

7. Excellent crops of potatoes, carrots, turnips, oats and grass have been produced on some of the drained portions. The only manures used have been ashes and stable manure. Could

* The ash prepared by me contains besides sand, much sulphate of lime, but no carbonate of lime. The ash sent by Mr. Stanwood, the full analysis of which is given on another page was obviously obtained from a peat found in another part of the swamp.

discover no effect from the ashes. Prefer horse manure to any other.

8. The soil underlying and at the edges of the swamp is white sand mixed with stones of various sizes.

9. The meadow is surrounded with hills, and must undoubtedly receive considerable wash from them. Their soil is a sandy loam, rough and rocky in its natural state.

10. The swamp has both inlet and outlet. The water is soft. Shahaugan Brook, which flows through it, is from two to three rods in width, and is subject to heavy freshets Spring and Autumn, but these are of short duration.

11. Only one sample sent.

12. The quality of the muck at the place where the sample was taken is quite uniform to the depth of four or five feet. Below that is peat to depth unknown.

13. The original growth of timber was ash, maple and pine, with some hemlock. Many of the roots and stumps of pine still remain in a good state of preservation. Black alder and sweet elder, together with the red raspberry, are found among the undergrowth.

14. The muck has been used to some extent as a top-dressing for grass and other crops with satisfactory results, although no particular benefit was noticeable during the first year. After that the effects might be seen for a number of years.

15. I know of no experiments having been made with a view of testing its value after having been long dug, as compared with stable manure.

16. Composting has not, I believe, been practiced to much extent. Whenever it has been done, stable manure and ashes have been the materials used. Experiments made by myself have confirmed me in the opinion that a compost of equal parts muck and stable manure is equal to the same quality of stable manure. I found a compost made of two bushels of unleached ashes to twenty-five of muck superior to stable manure as a top-dressing for grass on a warm, dry soil. We however use it mostly as an absorbent, the acidity is corrected by the exposure it receives, and much fertilizing matter is saved that would otherwise be lost.

17. My method of composting is as follows: I draw my muck to the barn-yard placing the loads as near together as I can tip them from the cart. Upon this I spread whatever manure or ashes I have at hand, and mix with the cattle's feet and heap up with a scraper. I have also my stables arranged under one of my barns, so that the muck is mixed with the manure in a trench behind the cattle.

19. The peat has been used merely to test its value as fuel, and has proved a superior article, but so long as plenty of wood can be had for little more than the labor of getting it, few will be willing to substitute peat in its stead.

JOHN H. STANWOOD.

Colebrook, Nov. 13th, 1858.

No. 10. Peat from N. Hart, Jr., West Cornwall. Hard dry lumps of a dark brown, almost black color.

Analysis.

Organic matter, soluble in carbonate of soda,	55.11	
" " Insoluble in carbonate of soda,	10.29	
Total		65.40
*Inorganic matter,		14.89
Water,		19.71
		100.00

†Soluble in water, 6.20.
Nitrogen, 2.10=2.55 ammonia.

ANSWERS TO CIRCULAR.

1. The swamp is 100 rods long by 20 wide, contains 12½ acres.

2. Average depth 10 feet. Greatest depth 15 to 20 feet.

3. It is drained with a ditch four feet deep around the outside, and one 80 rods long through the middle north and south, and one east and west at the upper end of the middle.

4. It is a fresh water swamp. It has been dry 13 years.

5. It is dry enough the year through to go all over it with a team and loaded cart.

6. We have raised medium crops of corn, potatoes and

---

* The ash besides sand contains very much carbonate and sulphate of lime.

† In the soluble portion are no salts of iron.

pumpkins. Five acres of it is in upland grasses, and has cut three tons per acre.

Have manured by spreading the ashes produced in burning the bogs, in the fall, and with stable manure the next spring, and with upland soil from old headlands.

7. Clay and sand form the adjacent underlying soil.

8. The swamp receives no wash from hills.

9. A small stream of soft water runs through the swamp, which is sometimes dry in summer, and is never high enough to flood the swamp.

11. The surface deposit to a depth of 18 inches is made up of fine decomposed vegetable matter. Below this it is more like peat and coarse vegetable matter.

12. The trees in the swamp are black ash, white maple, and recently, willow. We often find the trunks of hemlock trees of various sizes, some, 18 inches in diameter, several feet below the surface.

13 and 14. The muck has never been used as a manure.

15. We formerly composted it with stable manure, and with ashes, but have remodeled our stables, and now use it as an absorbent and to increase the bulk of manure to double its original quantity, and consider it more valuable than the same quantity of stable manure.

16. Have composted in the yard by putting a layer of muck on the ground a foot thick, and then a layer of manure (by wheeling the cleanings of the stables every morning) of about $\frac{2}{3}$ the quantity of the muck, and so on until the pile is completed. This should be turned some days before using.

I have mixed 25 bushels of ashes with the same number of loads of muck, and applied it to $\frac{3}{4}$ of an acre. The result was far beyond that obtained by applying 300 lbs. best guano to the same piece.

18. Have not given it a fair trial as to its burning qualities.

19. In the use of muck we proceed as follows: Soon after haying we throw up enough for a year's use, or several hundred loads. In the fall the summer's accumulation in hog pens and barn cellars is spread upon the mowing grounds, and a liberal supply of muck carted in and spread in the bottoms of the cel-

lars ready for the season for stabling cattle. When this is well saturated with the drippings of the stables a new supply is added. The accumulation of the winter is usually applied to the land for the corn crop, except the finer portion which is used to top-dress meadow land. A new supply is then drawn in for the swine to work up. This is added to from time to time, and as the swine are fed on whey, they will convert a large quantity into valuable manure for top-dressing mowing land.

So successful has been the use of it, that we could hardly carry on our farming operations without it.

N. HART, JR.

No. 11. Swamp-muck from A. L. Loveland, North Granby. This muck is black, and dried to very hard lumps, in which grains of quartz and mica sand are seen.

Analysis.

Organic matter soluble in carbonate of soda,	38.27	
" insoluble in " "	2.89	
Total,		41.16
* Inorganic matter, - - - - -		47.24
Water, - -		11.60
		100.00

Soluble in water, 0.75 per cent.
Nitrogen 1.00=1.22 ammonia.

ANSWERS TO CIRCULAR.

1. The place from which the specimen sent was taken, is a swale extending over a somewhat broken surface of more than half a mile in length, though the width, on an average, is not more than 15 rods.

2. The greatest depth will not exceed six feet. Wherever the swale is broken, the separation is covered with timber, the land is quite stony, and the descent is such that the brook which passes through it runs quite rapidly.

* The ash is chiefly sand, with a little sulphate of lime.

3. None of these lands (nor scarcely any in the town,) are drained, though nothing could return a better profit.

4. It is a fresh water marsh.

5. It is constantly wet from springs, and difficult to cross at any season. A yearling steer once sunk and perished in the muck. On some portions the surface is tough with grass roots, and will roll beneath one's step like the waves upon a lake. Springs of water are underneath, and the mud is very soft.

6. No crops have ever been taken from these lands, except perhaps some coarse grass on limited portions. Alders and maples are cut off once in twelve years or so. No manures are ever put on, and the vast riches of such lands have been hidden until recent agitation of the subject has brought them to light.

7. The base of this muck is mostly a hard-pan mixed with stone. The borders have a deep, loamy soil on which apple-orchards flourish. The white birch takes root in it whenever it is plowed for grain, until vast fields are covered with them. They grow rapidly, and when matured are cut and the ground cleared for potatoes and grain.

8. There is not much wash from the hills, but where there is any, the soil is a light loam, overlying gravel and sand mixed with much stone.

9. The swale has no inlet but abundant outlet. Springs of clear cold water well up mostly from the borders in never-failing quantity. These disappear sluggishly over a large surface till they reach a rapid descent, when they take the form of a brook and circle round opposing elevations of land till they reach the larger mill streams in the valleys below. They are never dry, and are but slightly affected by storms.

10–11. The sample sent was from one place, which will fairly represent most deposits in this township, as there is little variation in quality.

12. The vegetation consists of alders, maples, willows, grape vines, flags and a tall, coarse grass. It is pretty free from fallen trees. No pines grow on these lands.

13, 14 and 15. The muck has never been used for any purpose. It will be used next season for the first time.

19. In the adjoining town of Granville, Mass., similar swales, stretching along the base of hard-timbered hills, have been ditched and converted into mowings worth one hundred dollars per acre. Sand from the hills has been spread on them, and the best grasses flourish. The material dug from the ditches has been carted into barn-yards, and makes excellent manure. These lands are the very cream of the farms where they have been cleared up. There is no tough compact peat on such lands to work; the material is a rich fine muck or mould. As I have said, there is a great extent of such lands, but the farmers have never dreamed of their worth. They will now begin to clear and ditch them, as most of them can be easily drained.

A. L. LOVELAND.

No. 12. Peat from Daniel Buck, Jr., Poquonock, came as dry, quite coherent, brick-shaped cakes, well decomposed. Color a rich chocolate brown.

Analysis.

Organic matter soluble in carbonate of soda,	27.19	
" insoluble in " "	48.84	
Total,		76.03
* Inorganic matter,		5.92
Water,		18.05
		100.00

Soluble in water, 2.94 per cent.

Nitrogen, 2.40=2.92 ammonia.

For answer to Circular see No. 13.

No. 13. Swamp muck from Daniel Buck, Jr., Poquonock. This muck forms the light loose surface layers of the peat No. 12, which it resembles in color.

---

* Ash is chiefly carbonate and sulphate of lime, and magnesia.

Analysis.

Organic matter, soluble in carbonate of soda,	33.66	
" insoluble in " " "	40.51	
Total,		74.17
*Inorganic matter,		8.63
Water,		17.20
		100.00

Soluble in water, 1.80 per cent.
Nitrogen, 2.40=2.92 ammonia.

ANSWERS TO CIRCULAR.

1. The swamp contains about 15 acres.

2. Its depth at the upper end is about 3 feet; in the center 30 feet.

3. It was drained in 1851 to an average depth of 5 feet.

4. It is a fresh water marsh.

5. It is dry during the summer, say two feet in depth.

6. It has grown potatoes, carrots, corn and cabbages. Cannot state amount per acre. Stable manure and ashes from burning bogs have been applied to it, but no special manures.

7. Sand is the underlying and adjacent soil.

8. The swamp receives no wash from hills.

9. It has no inlet; an outlet has been made by draining. It is fed by springs of soft water which suffer no freshets, and are never dry.

10. The sample is from one place, and is of average quality.

11. It does not occur in layers, but in masses, though there is found occasionally a layer of what is called "Stone Peat."

12. The trees were cut off in '49 and '50—oak, hackmatack, white pines.

13. The muck has been applied fresh with good results; the grass is not as tall but thicker and finer and of a darker green in the Spring, than when barn-yard manure is spread on in the Spring.

---

* Ash is like that of No. 12, carbonate and sulphate of lime. By comparing this with the preceding, it is seen that exposure to the air increases the amount of matters soluble in alkalies, but diminishes the portion soluble in water.

14. Experiments with the weathered muck have not been made in such a way as to give comparison.

15 and 16. The muck is composted with stable manure in proportion of 8 loads of muck and 4 of manure; but it is principally carted into the barn-yard and pig-styes. The 8 loads of muck and 4 of manure when properly forked over, are equal to 12 loads barn-yard manure on sandy soil.

17. Muck is the upper crust of swamps, that is, the peat that has been exposed to action of frost and rain, of say 15 inches depth, under that is the peat.

19. As fuel it is equal to soft wood—makes as pleasant a fire to sit by as Cannel coal or hickory wood.

DANIEL BUCK, JR.

No. 14. Swamp muck from Philip Scarborough, Brooklyn.

Analysis.

Organic matter soluble in carbonate of soda,	51.45	
" insoluble " " " "	25.00	
Total,		76.45
*Inorganic matter,		7.67
Water,		15.88
		100.00

Soluble in water, 1.43.
Nitrogen, 1.20=1.46 ammonia.

ANSWERS TO CIRCULAR.

1. The swamp contains about one hundred acres.
2. No bottom has been found at a depth of 12 feet. It is probably much deeper.
3. It is drained to about the depth of 2 feet, and has been so beyond my memory.
4. The water is fresh.
5. It is dry throughout the season to the depth of 1 foot.
6. It has once grown potatoes with all appearance of a good crop till they were destroyed by a flood.

---

* Ash is mostly sulphate of lime, with a little carbonate and some sand.

7. The soil at the edges of the swamp is a yellow mould.

8. It receives much wash (yellow loam) from the adjacent hill.

9. A small brook runs through the swamp which is never quite dry, and is subject to heavy freshets.

10. The one sample sent is from the upper end of the swamp.

11. The muck is of uniform quality—very open and porous, so far as has been observed.

12. The only trees in the swamp are maples.

13 and 14. The muck has been dry, and carted in the fall, spread and plowed in in the spring to great advantage for corn crops. I estimate its value at about one-third that of stable-manure.

15 and 16. One load of muck to one of stable-cellar manure makes a compost equal to two loads of clear manure. In preparing the compost I begin with a layer of muck of 10 inches depth. Upon this the manure is spread, and the whole is covered with muck to the depth of one foot. In this way there is no loss either by volatilization or leaching.

18. It burns well when dry, with smell of sulphur.

(Signed) PHILIP SCARBOROUGH.

In a communication in the *Homestead*, Mr. Scarborough says: "When of the age of twelve years, my father and self, in the fall of the year, carted out of a pond hole upwards of 100 loads of muck, which lay during the winter in load heaps, and was spread in the spring, plowed in and planted with corn, and I have never seen so great a growth of corn since,—at that time, which was about fifty-eight years ago, it was a very common practice to hoe corn in August, and being the plow boy, I remember that when on the horse, the tassels were as high as my head, but the grain was lacking at harvesting, the yield being probably not over forty bushels to the acre; it ought to have gone to one hundred in proportion to the stalks.

I have never used the peat in any form when it was decomposed, but ample returns have been made; on corn, oats, rye, and grass, it has added one-third to the yield."

No. 15.—Swamp muck from Adams White, Brooklyn. When dry formed hard chocolate brown lumps.

Analysis.

Organic matter soluble in carbonate of soda,	54.38	
" insoluble in " "	23.14	
Total,		77.52
*Inorganic matter, - - - - -		9.03
Water, - - - - -		13.45
		100.00

†Soluble in water, 5.90.
Nitrogen 2.89=3.54 ammonia.

ANSWERS TO CIRCULAR.

1. The deposit extends over one acre of surface.
2. The depth is from one to 5 feet—average 2½ feet.
3. It is undrained.
4. The water is fresh.
5. The surface is dry for two or three months in summer to the depth of 1 to 1½ feet.
6. No crops have been grown on it.
7. The soil adjoining and beneath is very hard—partly clay.
8. The swamp receives little wash.
9. There is now no inlet or outlet except an old ditch nearly filled up, which takes off a small portion of the surface water. In winter there is some overflow from rains and snows.

11. There is little variation in the quality of the muck, except that it is rather firmer in texture at or near the bottom.

12. The only vegetation on it is coarse grasses and briers.

13 and 14. No use has been made of the unmixed muck.

15. The muck has been composted with stable manure from cattle, horses and hogs, and also with horn-shavings and bone-turnings.

16. In composting, 20 loads are drawn on to upland in September and thrown up in a long pile. Early in the Spring 20 loads of stable manure are laid along side, and covered with the

* Contains some sand and much sulphate, with a little carbonate of lime.

† This water solution contains no salts of iron.

muck. As soon as it has heated moderately, the whole is forked over and well mixed. This compost has been used for corn (with plaster in the hill,) on dry sandy soil to great advantage. I consider the compost worth more per cord than the barn-yard manure. A compost of 500 lbs. of horn-shavings to 10 loads of muck and 10 bushels of unleached ashes, made the best manure I ever used; stable or yard manure used beside it did not produce more than half as much. I have used the compost principally for a corn crop—always with success—also for potatoes. It is not so good for that crop. For small grain it makes too much straw, and the grain seed is not so heavy.

18. It is a poor fuel.

ADAMS WHITE.

REMARKS.—This muck, containing 3½ per cent. of potential ammonia, besides much salts of lime, is of excellent quality as a fertilizer. It is largely soluble in water, (6 per cent.) but no injurious iron compounds are found in the solution. It is to be regretted, that, as Mr. White informs me, he cannot any more excavate it economically, on account of the obstructed drainage.

No. 16.—Swamp muck from Paris Dyer, Brooklyn. Grayish black lumps much admixed with soil and easily crushed.

Analysis.

Organic matter soluble in carbonate of soda,	18.86	
" insoluble in " " "	5.02	
Total,		23.88
*Inorganic matter,		67.77
Water,		8.35
		100.00

Soluble in water, 2.63.

Nitrogen, 1.03=1.26 ammonia.

No answer to the circular was received from Mr. Dyer. Though so largely mixed with soil, the muck yields a good percentage of nitrogen and would make a very good absorbent.

* The ash is mostly sand and soil, and contains but traces of sulphate of lime.

No. 17.—Swamp muck from Perrin Scarborough, Brooklyn. Color chocolate brown.

Analysis.

Organic matter *soluble in water,	9.17	
" Insol. in water, but sol. in carb. soda,	35.10	
" Insoluble in water and carb. soda,	16.83	
Total,		60.10
† Inorganic matter, soluble in water,	5.96	
" Insoluble in water, but sol. in carb. soda,	4.22	
" Insoluble in water and carbonate soda,	15.60	
‡ Total,		25.78
Water,		14.12
		100.00

Nitrogen, 0.86=1.05 ammonia.

ANSWER TO CIRCULAR.

1. The meadow (bog) is about 40 rods long by 12 rods wide.
2. The muck is 2½ to 3 feet deep.
3. It is partly drained by a small stream running along one side of the marsh, and also by a ditch dug ten years ago, to the depth of 3 feet, and extending one-half the length of the marsh.
4. It is a fresh water marsh.
5. The parts adjoining the ditch are rather dry for two or three months in summer.
6. The only yield from the marsh has been one-half ton of poor bog hay per acre.
7. The adjoining and underlying soil is hard, and is made up of gravel stone and some clay.
8. There is no wash from the adjacent lands.

* This determination is not accurate, but includes some sulphuric acid expelled from sulphate of iron by the heat used in burning off the organic matter.

† Consists mostly of sulphate of protoxyd of iron, (green vitriol) with much sulphate of lime, and a little sulphate of alumina and common salt.

‡ The ash, chiefly oxyd of iron, contains also much sand, as well as the ingredients under †.

9. The stream (of soft water) is not subject to any considerable freshets.

11. At the place where I took the sample, the surface muck to the depth of about 12 inches has a dark color, and then for about two feet, is of a reddish appearance and more compact, being made up of decayed vegetable matter and some decayed limbs of trees. When thrown up to the weather and dried, it is as light as a cork. Some portions of it when thrown out to the weather for a short time, will be covered with a thin white crust that has the taste of alum or saltpetre.

12. No trees are now growing in the marsh. The branches found in the lower muck I should think were pine.

13, 14 and 15. About the only trial I have made was as follows: Seventy-five loads were dug, and left exposed to the weather for one year. I then mixed it with stable manure in the proportion of five loads of muck to one of manure, and applied in the hill to corn, at the rate of about twenty-five loads to the acre. The result was not what I expected, although I had a fair crop. After two years but little effect could be seen.

18. It has not been used as fuel.

PERRIN SCARBOROUGH.

REMARKS.—As already mentioned, this is the best characterized vitriol-muck of any that I have examined. Mr. Scarborough says above of this muck, that "*some portions* of it when thrown out to the weather became covered with a thin white crust that has the taste of alum or saltpetre." Doubtless the sample sent for analysis is one of this kind, and therefore represents the worst quality. The "thin white crust" is the sulphates of iron and alumina, and the presence of these matters in the lower muck accounts for the poor growth of grass, and for the indifferent results of the trial on corn.

The use of the *fresh muck*, if it contained nearly so much soluble iron compounds as given in the above analysis, would probably be destructive to all crops. The use of lime and ashes, or long weathering, would correct these bad qualities; and so would composting with stable manure, if the latter were used in sufficient quantity; but the analysis makes it fully evident that this is a material to be used with caution.

No. 18.—Swamp muck from Geo. K. Virgin, Collinsville. Very dry and light, full of fine (grass) roots, which make it retain when dry the form in which it was cut out. Color light brownish gray. "Exposed since last winter." From the grass roots this is evidently the surface muck.

Analysis.

Organic matter soluble in water, - -	2.21	
" insoluble in water but soluble in carbonate of soda, (treated four times,) -	20.57	
" insoluble in water and carbonate of soda, -	8.25	
Total,		31.03
Inorganic matter *soluble in water,	0.32	
" Insoluble in water but soluble in carb. soda, (treated four times),	9.41	
" insol. in water and carb. soda,	8.05	
†Total,		57.78
Water, - - - - -		11.19
		100.00

Nitrogen, 0.64=0.78 ammonia.

No. 19.—Swamp muck from Geo. K. Virgin, Collinsville. Quite moist, crumbly; contains much micaceous sand. Color chocolate brown. "Taken four feet below the surface."

Analysis.

Organic matter soluble in water, -	1.12	
" insoluble in water, but soluble in carbonate of soda, (treated three times,) -	9.19	
" insoluble in water and carbonate of soda,	5.10	

---

* Portion soluble in water consists chiefly of sulphate of lime and salts of iron; the latter in the larger proportion.

† The ash consists mostly of sand, yields to acids much iron, a minute quantity of sulphate of lime, some magnesia, and a trace of phosphoric acid. It contains no carbonate of lime. [See No. 20.]

Total, - - - -		15.41
* Inorganic matter, soluble in water, -	0.28	
" insoluble in water, but soluble in carbonate of soda, (treated three times,)	1.08	
" insoluble in water and carbonate of soda, -	48.65	
† Total, - - -		50.01
Water, - - - - - -		34.58
		100.00

Nitrogen, 0.34=0.41 ammonia,

No. 20.—Swamp muck from Geo. K. Virgin, Collinsville. Very moist, well decomposed—not lumpy or coherent. Color black. The label was defaced by decay, but the specimen was probably taken at a depth intermediate between Nos. 18 and 19.

Analysis.

Organic matter, soluble in water, -	0.72	
" insoluble in water but soluble in carbonate of soda, (treated four times,) -	9.31	
" insoluble in water and carbonate of soda, -	3.65	
Total, - - - -		13.68
‡ Inorganic matter, soluble in water, - -	0.25	
" insoluble in water but soluble in carbonate of soda, (treated four times,)	0.76	
" insoluble in water and carbonate of soda, -	28.20	

* Portion soluble in water consists principally of sulphate of lime and salts of iron.

† Ash is mostly sand, with a little sulphate of lime and considerable oxyd of iron, soluble in acids. Phosphoric acid and magnesia in traces. [See No. 20.

‡ Portion soluble in water consists of sulphate of lime with small quantity of salts of iron.

* Total, - - - - -	29.21
Water, - - - - - -	57.11
	100.00

Nitrogen, 0.28=0.34 ammonia.

ANSWERS TO CIRCULAR.

1. The swamp contains 5 acres.
2. The greatest depth is 10 feet. The average depth 4 feet.
3. It is undrained.
4. The water is fresh.
5. Parts of the swamp are surface-dry in summer.
6. No crops have been raised on it.
7. On one side of the swamp the soil is a sandy loam, and the other side gravel.
8. It does not receive much wash from the surrounding lands.
9. A small stream fed by springs flows from the swamp.
10. The three samples were taken from one place.
11. Little difference in the quality of the muck at various depths is observed.
12. The swamp is occupied by maple, oak and hemlock, with some pine and cedar trees.

13, 14, 15 and 16. The only trial of this muck was made with a few loads that had been exposed to the frost one winter. It was applied to a piece of sandy, poor land, and the effects of it were astonishing.

It has not been used as fuel.

GEO. K. VIRGIN.

REMARKS.—On reference to the table it will be seen that when these three mucks of Mr. Virgin are reduced to the same state of dryness, they agree quite closely in composition. As their content of ammonia when dry is only about 8–10 per cent, and the amount of soluble matters is likewise small, it is obvious that the "astonishing" results observed from its use must be chiefly ascribed to its physical characters—to its effect in correcting the texture and dryness of the "sandy poor soil."

* Ash almost entirely sand and oxyd of iron, with traces of sulphate of lime and phosphoric acid.

No. 21. Salt-marsh muck, Solomon Mead, New Haven. Light and porous, coherent from grass roots. Color, greyish brown. Had been long dug and exposed to air.

Analysis.

Organic matter soluble in water,	3.30	
" " insoluble in water but sol. in carb. soda, (treated 6 times,)	40.52	
" " insoluble in water and carb. soda,	8.20	
Total,		52.02
Inorganic matter, *soluble in water,	2.60	
" " insoluble in water, but sol. in carb. soda, (treated 6 times,)	10.02	
" " insol. in water and carb. soda,	23.90	
† Total,		36.52
Water, - - - - - -		11.46
		100.00

Nitrogen, 1.51=1.84 ammonia.

ANSWERS TO CIRCULAR.

1. The marsh is 3 miles long and 80 rods wide. Its contents are estimated at 480 acres.

2. The average depth is 10 feet; greatest depth 15 to 20 feet.

3. The marsh is partially drained, but cannot be made dry on account of the setting back of tide-water.

4. It is one-half salt, and one-half fresh water marsh. The sample was taken from the fresh water part.

5. The surface of the muck is usually dry in summer to the depth of one to two feet.

6. A few crops of potatoes have been grown on it with good results; but grass is the chief product. Guano and yard manure have been applied.

7 and 8. The marsh receives wash from a considerable extent of territory, the soil being a sand or sandy loam.

---

* Portion soluble in water contains lime and soda in moderate quantity, still more sulphuric acid and chlorine. No iron.

† Ash mostly sand, with much oxyd of iron, some salt and sulphate of lime, traces of magnesia and phosphoric acid. Exposure has obviously rendered oxyd of iron insoluble.

9. It has both inlet and outlet in a stream of soft water two rods wide that runs through it, and is subject to freshets, but does not dry up in summer.

11. But little variation in the quality of the muck is observed in digging down.

12. Beside bog-meadow grass, there flourish willow, elm, and soft maple trees. But few branches are found in the muck, of what kind it is difficult to determine.

13. The muck has been employed fresh dug for potatoes, &c., with very favorable results.

14. The long dug muck has been applied to crops with less favorable results, as far as the present crop is concerned, than those furnished by good stable manure.

15. It has been extensively composted with ashes, bones, lime, white fish, yard manures, sty and slaughter-yard materials, plaster, guano, night soil, &c., &c., with great advantage.

16. In preparing composts, the pile is commenced by a layer of muck say one foot deep, then a layer of yard manure say 8 inches deep is laid on, and so alternately to the top. For composts with night soil, I use three or four times its bulk of muck; with guano or ashes the proportion of muck is still increased.

18. It has not been used to any extent as fuel.

S. MEAD.

No. 22. Swamp muck from Edwin Hoyt, New Canaan, light and loose in texture, not coherent, much intermixed with soil. Color, light brownish grey.

Analysis.

Organic matter, soluble in water, -	2.84	
" insoluble in water but soluble in carbonate of soda, (treated three times,)	13.42	
" insoluble in water and carbonate of soda, - - -	7.55	
Total, - - - -		23.81

Inorganic matter *soluble in water, - -	2.72	
" insoluble in water but soluble in carbonate of soda, (treated three times, -	19.88	
" insol. in water and carb. soda,	46.30	
† Total, - - - -		68.90
Water, - - - -		7.29
		100.00

Nitrogen, 0.45=0.54 ammonia.
For answer to Circular see No. 24.

No. 23. Swamp muck (No. 22,) saturated with horse urine, having been put under the stalls. Edwin Hoyt, New Canaan. Color darker than No. 22.

Analysis.

Organic matter, soluble in water, - -	2.34	
" insoluble in water but soluble in carbonate of soda, (treated three times,) - -	13.49	
" insol. in water and carb. soda,	8.05	
Total, - - - -		23.88
‡ Inorganic matter, soluble in water, -	1.54	
" insol. in water but sol. in carb. soda, (treated three times,)	12.42	
" insol. in water and carb. soda,	56.20	
§ Total, - - -		70.16
Water, - - - -		5.96
		100.00

Nitrogen 0.90=1.09 ammonia.
For answer to circular see No. 24.

---

* Portion soluble in water consists almost entirely of sulphate of iron, and perhaps organic salts of the same base. No lime.

† Mostly sand and soil. In the acid solution were found much iron, a little sulphuric acid lime and magnesia, and traces of phosphoric acid.

‡ Portion soluble in water contains large quantities of lime, sulphuric acid, chlorine and carbonic acid, but only a slight *trace* of iron. It thus appears that the iron existing in the peat (No. 22) in the *soluble* form, is rendered *insoluble* by composting.

§ Ash, as No. 22, but containing larger quantities of sulphuric and phosphoric acids, of lime and magnesia.

No. 24. Swamp muck No. 22 composted with white fish. Edwin Hoyt, New Canaan. Color darker than No. 23. No evidence of the fish except a few bones.

Analysis.

Organic matter, soluble in water,	-	1.15	
"	Insoluble in water but soluble in carbonate of soda, (treated three times,) - -	17.29	
"	Insoluble in water and carbonate of soda, - -	8.00	
Total, - - - -			26.44
* Inorganic matter, soluble in water,	-	1.67	
"	insol. in water but sol. in carb. soda, (treated three times,)	14.13	
"	insol. in water and carb. soda,	51.10	
† Total, - - - -			66.90
Water, - - - -			6.66
			100.00

Nitrogen, 1.01=1.22 ammonia.

ANSWERS TO CIRCULAR.

1. The swamp is nearly square, and contains about 10 acres.
2. The average depth of muck is about 5 feet. The greatest depth is 12 feet or more, although we do not take it out below 8 feet.
3. It was drained four years ago to the depth of 5 feet.
4. It is a fresh water marsh.
5. The upper portions are always dry to the level of the outlet, except as wetted by rains.
6. Four acres were thoroughly underdrained four years ago, and planted with corn and potatoes. The yield of potatoes was exceedingly fine. The crop of corn was good—more than an average yield. The tillage not being as complete as we desired

* Portion soluble in water consists principally of sulphate of lime, with only *traces* of iron. In this case, as in No. 23, the soluble salts of iron contained in the peat are, by composting rendered insoluble.

† Ash as Nos. 22 and 23, but sulphuric and phosphoric acids, lime and magnesia, present in still larger quantities.

for seeding, it was planted with corn the second season. The yield was good—full sixty bushels per acre. The third season it was seeded with oats, which grew very rapidly and promised a large crop, but just as they began to fill, about one-third of them lodged. That portion which stood up filled well, and yielded at the rate of fifty bushels per acre. This, the fourth season, the piece was in grass, the crop was more than average, yet would have been larger had not the young grass all been killed under that portion of the field where the oats fell. No manure has been used on the swamp.

7. The surrounding soil is gravel, with a mixture of clay. The bed of the swamp after the muck is removed, presents a very stony surface like that of the neighboring uplands.

8. The swamp receives but little wash from the adjoining hills.

9. A small stream flows through it that is liable to freshets, but never dries up.

11. There are some variations in its appearance at different depths. The first two feet it is *very black* and crumbly, and is made up of very fine particles, I suppose on account of its being plowed and exposed to frost and weather. For the next three or four feet it has a reddish cast and considerable *odor*. This layer appears to contain more vegetable matter. At this depth we sometimes find logs as large as a man's body, and have traced out whole trees, which at first are as easily cut through with the spade as any part of the muck, but after exposure, they become quite hard. This layer we consider the most valuable, and is such as I sent you. See No. 22. Below a depth of 6 feet it has a lighter color, and contains less vegetable matter. At a depth of 8 feet clay predominates, and it is not worth carting out upon our soils.

12. The swamp was once covered with maple, elm, and red-ash trees. But for a number of years one-half has been in meadow and the other half is covered with bogs. Near the main ditch the bogs are rapidly dying out and may be easily kicked to pieces, which I attribute to the draining.

13. It has not been used fresh from the swamp, as we con-

sider this manner of application very wasteful. We have always composted it except in one instance, which is given below.

14. The long dug and exposed muck has been once experimented on as follows: Four years ago, this Autumn, (1858,) we drew a large quantity of it upon a field designed for corn the following season. A portion of this muck was composted with horse-dung, (about 5 of muck to 1 of dung,) the pile heated and fermented well and was turned once before using. The remainder of the muck was left untouched until about the middle of May. At this time the muck and compost were each spread and plowed in on separate portions of the field at the rate of 40 loads per acre. The result was very marked, and was distinguishable as far as the field could be seen. The corn where the stable compost was applied showed a decided gain over the other parts of the field after it was two weeks old, and kept ahead throughout the season. The yield by the compost was nearly double that of the clear muck. I do not think the yield was much increased by the application of muck alone. The oat crop following the corn, was also much the best where the stable compost was applied to the other; so also the grass.

15. The muck has been much employed by us as an absorbent. Our horse stables are constructed with a movable floor and pit beneath which holds 20 loads of muck of 25 bushels per load. Spring and fall this pit is filled with fresh muck which receives all the urine of the horses, and being occasionally worked over and mixed furnishes us annually with 40 loads of the most valuable manure. See No. 23.

Our stables are sprinkled with muck every morning at the rate of one bushel per stall, and the smell of ammonia, &c., so offensive in most stables, is never perceived in ours. Not only are the stables kept sweet, but the ammonia is saved by this procedure. Our privies are also deodorized by the use of muck, which is sprinkled over the surface of the pit once a week, and from them alone we thus prepare annually enough "poudrette" to manure our corn in the hill. The wagons we use in drawing fish in the summer shortly become very offensive from the blood, oil, &c., which adheres to them; but a slight sprinkling of muck renders them perfectly inodorous in a short space of time.

16. Very much of our muck is composted with yard manure. Our proportions are one load of manure to three of muck. I think as much muck should be used as can be made to heat properly. The quantity varies of course with the kind of manure employed.

We use muck largely in our barn-yards, and after it becomes thoroughly saturated and intermixed with the droppings of the stock, it is piled up to ferment, and the yard is covered again with fresh muck. We are convinced that the oftener a compost pile of yard manure and muck is worked over after fermenting, the better. We work it over and add to it a little more muck and other material, and the air being thus allowed to penetrate it, a new fermentation or heating takes place, rendering it more decomposable and valuable.

During the present season, (1858,) we have composted about 200,000 white fish with about 700 loads (17,500 bushels,) of muck. We vary the proportions somewhat according to the crop the compost is intended for. For rye we apply 20 to 25 loads per acre of a compost made with 4,500 fish, (one load) and with this manuring, no matter how poor the soil, the rye will be as large as a man can cradle. Much of ours we have to reap. For oats we use less fish, as this crop is apt to lodge. For corn, one part fish to ten or twelve muck is about right, while for grass or any top-dressing, the proportion of fish may be increased.

We find it is best to mix the fish in the summer and not use the compost until the next spring and summer. Yet we are obliged to use in Sept. for our winter rye a great deal of the compost made in July. We usually compost the first arrivals of fish in June for our winter grain; after this pile has stood three or four weeks it is worked over thoroughly. In this space of time the fish become pretty well decomposed, though they still preserve their form and smell outrageously. As the pile is worked over, a sprinkling of muck or plaster is given to retain any escaping ammonia. At the time of use in September the fish have completely disappeared, bones and fins excepted.

The effect on the muck is to blacken it and make it more loose and crumbly. As to the results of the use of this compost, we find them in the highest degree satisfactory. We have raised 30 to 35 bushels of rye per acre on land that without it could have yielded 6 or 8 bushels at the utmost. This year we have corn that will give 60 to 70 bushels per acre, that otherwise would yield but 20 to 25 bushels. It makes large potatoes, excellent turnips and carrots.

18. It is not suitable for fuel.

19. I will add one other fact relative to its absorbent power. We collect the (human) urine in barrels conveniently disposed about our premises. One of these having become full and very offensive, I proposed to filter it through muck. Another barrel was accordingly filled with the latter and the putrid urine poured upon it. Although the stench of the urine was so intense that it was hardly possible to proceed with the operation, it was all filtered through the muck, and came out *perfectly clear, odorless, and with no more taste than pure water would acquire by running through the muck.*

EDWIN HOYT.

REMARKS.—When we compare the quality of the muck employed by the Messrs. Hoyt, as shown by the analysis, with the great results they have made it yield in their favor, we have a fine illustration of the merits of muck as an absorbent and amendment.

The muck is of poor quality, containing in the dry state but twenty-six *per cent* of organic matter and one-half of one *per cent* of potential ammonia, and being in the fresh state considerably charged with salts of iron. But the composts with horse-urine and with fish are admirable fertilizers, as proved by analysis, and especially by the crops grown with their aid. In the composts we find all the iron *insoluble*, and as stated p. 131, the percentages of ammonia doubled. The Messrs. Hoyt would have found it impossible to economize their manure in any other way to nearly the extent they are enabled to do by the use of muck, which, though it must be hauled up a long steep hill, at great expense, is of incalculable advantage to their farm. It must not be forgotton, however, that the success of the Messrs. Hoyt is due not only to the use of muck, but also to the enterprise which they expend in laying hold of every form of fertilizing material within their reach, and to their systematic employment of thorough drainage, deep tillage and all other scientific improvements.

No. 25. Swamp muck from A. M. Haling, Rockville, fresh dug. Color snuff-brown, with a little white fiber.

Analysis.

Organic matter soluble in water, - - -	3.43	
" insol. in water but sol. in carb. soda, (treated eight times,) -	52.15	
" insol. in water and carb. soda,	8.65	
Total, - - - - - -		64.23
Inorganic matter *soluble in water, - -	0.35	
" insol. in water but sol. in carb. soda, (treated eight times,)	0.16	
" insol. in water and carb. soda,	4.90	
† Total, - - - -		5.41
Water, - - - - - - -		30.36

Nitrogen 1.62=1.97 ammonia.
For answer to circular see No. 26.

No. 26. Swamp muck, A. M. Haling, Rockville, like No. 25, but exposed two years.

* Portion soluble in water consists chiefly of sulphate of lime; contains a trace of salts of iron.

† Contains much sand, no carbonate of lime, much oxyd of iron, some sulphate of lime and magnesia, and more phosphoric acid than most of the peats that I have examined.

Analysis.

Organic matter soluble in water, - -	3.87	
" insol. in water but sol. in carb. soda, (treated eight times,)	71.57	
" insol. in water and carb. soda,	8.44	
Total, - - - - -		83.88
* Inorganic matter soluble in water, -	0.23	
" insol. in water but sol. in carb. soda, (treated eight times,) - - -	0.00	
" insol. in water and carb. soda, (3.70 ?) -	1.98†	
‡ Total, - - -		2.21
Water, - - - - - -		13.91
		100.00

Nitrogen, .132=1.60 ammenia.

ANSWERS TO CIRCULAR.

1. The swamp from which Nos. 25 and 26 were dug is oval in shape and contains about five acres.

2. The greatest depth of muck or peat is ten feet, averaging about two feet.

3. It is not drained.

4. It is fresh water.

5. It is dug in very dry summers to the depth of four to five feet.

6. No crops have been raised on the swamp.

* Portion soluble in water consists chiefly of sulphate of lime and salts of iron.

† This peat yields upon ignition 2.21 per cent of ash, (average of two determinations—2.18 per cent and 2.23 per cent). Deducting the amount of inorganic matter soluble in water, (0.23 per cent) there should remain 1.98 per cent as the amount of inorganic matter insoluble in water and carbonate of soda. But the residue, insoluble in carbonate of soda yields 3.70 per cent of ash. As all traces of carbonate of soda were thoroughly removed by repeated treatments with boiling water, may not this discrepancy in the result be due to the fact that a portion of the soda has formed an insoluble combination with the organic matter that it was not capable of dissolving (?)

‡ Ash as No. 25.

7. The soil at the edges of the swamp is quite gravelly and open, underlaid with fine sand. At the depth of five to six feet underlying the swamp, is the hardest kind of gravel that I ever saw.

8. The swamp does not receive wash from any source, the land surrounding it being nearly level.

9. The swamp has neither inlet or outlet.

10. The two samples 25 and 26 are from one place.

11. There is not any perceptible variation in the quality of the muck at different depths.

12. The swamp is covered with a small bush resembling the low laurel, with an occasional stunted maple.

13, 14, 15, 16, 17 and 18. Has not been used either as a manure absorbent or fuel.

A. M. HALING.

REMARKS.—If Mr. Haling succeeds in drying this swamp which he is engaged in trying to effect by digging a well near it, he will doubtless find this muck an excellent absorbent, and adjunct to mineral manures. The inorganic matters are small in quantity, but, after exposure, of good quality. Salts of lime and phosphoric acid are present in larger relative quantity than usual.

No. 27.—Swamp muck from A. M. Haling, Rockville. Fresh dug; color, snuff brown. "A good substitute for barn-yard manure."

Analysis.

Organic matter	soluble in water, - - -	3.87	
"	insol. in water but sol. in carb. soda, (treated seven times,)	44.04	
"	insol. in water and carb. soda,	4.25	
Total,	- - - - - -		52.16
Inorganic matter	*soluble in water, -	0.51	
"	insol. in water but sol. in carb. soda, (treated seven times,)	4.07	
"	insol. in water and carb. soda,	5.05	

* Portion soluble in water contains iron and sulphuric acid in considerable quantities, lime and carbonic acid small.

* Total, - - - - -	9.63
Water, - - - - -	38.21
	100.00

Nitrogen 1.88=2.28 ammonia.

ANSWERS TO CIRCULAR.

1. The sample No. 27 is from a swamp of about 10 rods in width and 30 rods in length.

2. The average depth is about 18 inches, while in holes of 20 to 50 feet in diameter it is 8 to 10 feet deep.

3 and 5. It is drained and is dry to the depth of 2 feet below the surface.

4. It is a fresh water swamp.

6. During the four years since it was drained it has produced grass at the rate of 1½ tons of hay per acre.

7. The adjoining and underlying soil is a black loam with clay subsoil, except at the lower end of the swamp where it is a coarse gravel.

8. It does not receive much wash, as there is no stream running through it,

12. Oak trees of 12 to 15 inches diameter have been found in some of the holes spoken of, at a depth of 2 to 4 feet below the surface.

13. The muck has only been used as a top-dresssing on grass and with excellent results.

A. M. HALING.

REMARKS.—Ammonia and phosphoric acid are both present in this muck in considerable quantity, the soluble salts of iron are not abundant enough to be detrimental; sulphates and carbonates of lime and magnesia are also contained in it. The swamp is small, is surrounded with a rich surface soil, rests on a retentive clay bottom, had no outlet, and for years has been a repository for the leaves and *debris* of a hard-wood vegetation, latterly of grasses, so that taking into the account its amending qualities, we cannot wonder that it should be a "good substitute for barn-yard manure on light gravelly soils."

* Ash contains much sand and oxyd of iron, but also considerable quantities of magnesia, carbonate, sulphate and some phosphate of lime.

No. 28. Peat from Albert Day, Brooklyn. Color very dark brown, almost black, quite coherent and hard, even when not dry. Thought to be injurious to crops.

Organic matter soluble in water, -	2.45	
" insol. in water but sol. in carb. soda, (treated nine times,)	46.25	
" insol. in water and carb. soda,	6.35	
Total, - - - - - -		55.05
Inorganic matter *soluble in water,	0.32	
" insol. in water but sol. in carb. soda, (treated nine times,)	0.65	
" insol. in water and carb. soda,	5.40	
† Total, - - - - - -		6.37
Water, - - - - - - -		38.58
		100.00

Nitrogen, 0.84=1.02 ammonia.

ANSWERS TO CIRCULAR.

1. The swamp is nearly circular, and covers about one-fourth of an acre.

2. It lies in a sort of basin; about twelve feet deep in the center, and but a few inches at the edge.

3. It is not drained.

4. It is a fresh water marsh.

5. The upper portion is dry eight or ten inches in very dry seasons *only*.

7. The soil underlying and at the edges of the swamp is sand and clay.

8. It does not receive any wash from hills.

9. The swamp has an outlet where a small quantity of water is discharged in wet weather only. I think the water is soft.

---

* Portion soluble in water consists mostly of sulphate of lime and a trace of iron. No carbonic acid.

† Ash nearly free from sand, contains much iron, considerable sulphate of lime, a little carbonate of lime, and traces of magnesia and phosphoric acid.

10. Two samples sent in one box from different places in the swamp.*

11. The muck at the surface to the depth of sixteen or eighteen inches is quite black, with less appearance of undecayed vegetable matter than it has below that depth, where it begins to have a reddish color, and at the depth of 2½ or 3 feet is quite red, or brown, to the bottom of the deposit.

12. A few stinted maples, coarse grass and moss grow on it. At the depth of four or six feet, logs and limbs are found, which resemble cedar or hemlock more nearly than anything else.

13. It has not been used fresh.

14. This muck was applied 20 years ago by my father, and he thought it very useful, though no such definite trials were made as to test its value satisfactorily. I have used it in large quantities in my hog and cattle yards, (before completing my barn-cellar) but have seen no more benefit from it thus employed than fiom loam (from the roadside or head-lands on my fields) used in the same manner. This led me to attempt testing it more carefully.

In 1852 I carted out 250 to 300 loads of the peat and piled it on a lot adjoining the swamp. After six months had expired I drew most of it into my yards, leaving 8 or 10 loads in the field. Here it remained two winters, covering a space of about a square rod to the depth of six inches. It was then plowed in and the field planted to corn. The soil was light and friable, resting on a loose sandy or gravelly sub-soil. The whole field was otherwise manured alike. The only difference I could perceive in the corn upon the two portions, was not in favor of the peat; it diminished rather than increased the growth, and during several following years the succeeding crops of oats and grass were less where the peat had been applied. One load of muck was used as a top-dressing for grass which looked fresh for a few days, but no material effect was produced upon the quantity of hay. Two loads were taken to my orchard and a bushel put around each tree and worked into the soil, and the growth was less than during any previous year.

* When the box was opened the different samples could not be distinguished by appearance, and one analysis was made on a mixture of several fragments.

15 and 16. Having heard of the advantages of composting muck with soda ash and guano, I purchased a quantity of each for trial. Ten loads (thirty bushels each) of muck were composted with 175 lbs. soda ash, and ten loads of muck with 175 lbs. of guano,* and these composts were used separately on my corn land at the rate of 50 loads per acre, sown broadcast and thoroughly harrowed in. The corn on the plots thus treated, gave about the same yield as on the remainder of the field that was dressed with 12 loads of hog-manure per acre. An adjoining field had been manured with long manure and planted with potatoes. I selected twelve rows and put into each hill, on six of them, a full shovel full of the soda-ash compost, and on the remainder as much of the guano compost, and I am decidedly of the opinion that the corn was poorer where the muck composts were applied, than elsewhere.

18. The peat has not been used as fuel.

ALBERT DAY.

REMARKS.—I could but feel much interest in the result of the analysis of Mr. Day's muck after hearing from his own lips the account of its failure to do any good, or rather of its positively deleterious action. I was therefore surprised to find nothing in the sample he sent that would account for its ill effects. Still I am able to gather from the letters of Mr. Day, what is doubtless the true state of the case.

Mr. Day wrote me in one of his interesting letters as follows: "I have noticed when plowing the field adjoining the muck swamp, that near the latter a deep furrow of eight or ten inches would bring up a reddish, rather hard substance, resembling iron rust, and the peat at the depth of four feet has nearly the same reddish color."

Further, the muck of Mr. Day's sending, though containing but very little soluble salts of iron, does contain much oxyd of iron, and as Mr. Day excuses his delay in sending it (June 1858,) on account of water in the swamp, it is probable that the samples he did send were *surface* specimens perhaps from the *margin* of the swamp that had been, accordingly, exposed to air and washed

* I have always doubted the genuineness of this guano.

so that they do not represent the mass of the muck, which is probably more or less impregnated with soluble iron compound.

The swamp is an undrained basin that only discharges water in wet weather, consequently the mass of muck retains any injurious matters that may find their way into it.

But why should these ill results follow when "the muck in each instance of experiment has been exposed to the atmosphere a year or more and not used in a raw state?" The muck itself is quite coherent and hard even when not dry, and we can readily understand that if thrown up in a high heap, a year's exposure might not suffice to oxydize or wash out the iron, and from the trials with it after use as an absorbent in the yards, it would seem that the quantity of injurious iron compounds in it is quite large at first.

No. 29.—Peat from Chauncey Goodyear, Beaver Pond, New Haven. Very hard, tough, black cakes, that had to be cut with a hatchet in order to be reduced to powder. "As good as fresh cow-dung."

Analysis.

Organic matter soluble in water, -	1.80	
" insoluble in water but soluble in carbonate of soda, (treated eight times,)	45.42	
" insoluble in water and carbonate of soda, -	10.35	
Total,		57.57
Inorganic matter *soluble in water,	0.35	
" Insoluble in water but soluble in carb. soda, (treated eight times),	7.98	
" insol. in water and carb. soda,	18.80	
†Total,		27.13
Water, - - - - - - -		15.30
		100.00

Nitrogen, 1.68=2.04 ammonia.

---

* Portion soluble in water consists principally of sulphate and carbonate of lime and salts of iron; contains traces of chlorine.

† Much fine sand, with oxyd of iron, and some carbonate and sulphate of lime, and traces of phosphoric acid and magnesia.

ANSWERS TO CIRCULAR.

1. The Beaver Pond swamp is about one mile long by one-fourth of a mile wide.

2. The muck has been excavated to the depth of eight feet, and is probably much deeper.

3. The swamp has been more or less ditched, but not drained.

4 and 5. The water is fresh and soft, and stands at nearly the same level throughout the year, except at—

6. The upper end which is higher and where several acres have been cultivated, and always give good crops even in the dryest seasons.

7. The soil adjoining is sand and gravel.

8. There is some wash from the adjacent lands.

11. Where the sample was taken, the muck is of nearly uniform quality at all depths, though somewhat lighter at the depth of four feet.

12. The vegetation in the swamp consists of coarse grass and other aquatic herbage together with willow and cedar trees.

13. The muck has been largely used in the fresh state, and in this condition is as good as cow-dung.

15. The muck has been variously composted, especially with fish and with excellent results.

18. It makes good fuel.

CHAUNCEY GOODYEAR.

REMARKS.—This muck lying near the city of New Haven, is in great request in the city gardens, and the ownership of the swamp itself is divided among many persons, who find it extremely useful to give body and retentiveness to the hungry city soil. The analysis shows that its direct fertilizing qualities are also by no means inconsiderable, and it deserves to come into still more extensive use.

No. 30.—Salt marsh muck from Rev. Wm. Clift, Stonington. Color rich snuff-brown.

Analysis.

Organic matter soluble in water,	3.33	
" Insol. in water, but sol. in carb. soda,	51.68	
" Insoluble in water and carb. soda,	9.80	
Total,		64.81
* Inorganic matter, soluble in water,	2.82	
" Insol. in water, but sol. in carb. soda, 7.	0.00	
" †Insol. in water and carbonate soda, (7.45?)	5.16	
‡ Total,		8.68
Water,		26.51
		100.00

Nitrogen, 0.95=1.16 ammonia.

ANSWERS TO CIRCULAR.

1. The marsh embraces about nine acres, lying immediately north of the track of the Providence & Stonington railroad. It is about three times as long as broad.

2. Average depth 5 feet; greatest 8 feet.

3. Drained 18 inches deep.

4. Originally a fresh-water swamp, until a hundred years ago or more, when the tide broke in. A foot or more on top is made up of marine deposite. A tide gate was put in in the fall of 1855.

5. The water stands about 18 inches below the surface during the summer.

6. Fine crops have grown upon it this season; two tons or more to the acre of herds-grass and clover, good corn, potatoes, beans and turnips on a small portion. The manures used were pig-dung, superphosphate of lime and horse flesh composted with muck for the hoed crops.

---

* Portion soluble in water contains sulphuric acid, soda and chlorine in considerable quantities, as also traces of lime and iron. No carbonic acid.

† See note under No. 26.

‡ Ash contains large quantities of sulphuric acid, lime and magnesia, considerable common salt, traces of phosphoric acid.

7. The soil underlying and near is a clayey gravel and yellowish loam.

8. Very little wash is received by the marsh.

9. A small brook runs through the marsh, say four months in winter and spring, coming down from drained swamps above. The brook is sometimes swollen full, but is dry in summer.

10. The sample was taken from various parts of the marsh.

11. Not much difference is observable in the character of the muck at various depths after passing through the salt marsh turf—decayed stumps and logs are common, mostly maple.

12. Once the whole was probably a maple swamp, with other swamp brush-wood.

13. It has not been used fresh; is too acid; even potatoes do not yield well in it the first season, without manure.

14 and 15. Nearly all the muck used has been composted with stable manures—fish, lime, &c. It makes excellent bedding kept in the stables, and when applied to crops has always given good returns.

16. No accurate rules are observed in composting. Three or four loads of muck to one of stable manure, put together in the fall or winter in alternate layers, and forked over twice before spreading and plowing in, may represent the method of composting.

I consider a compost made of one load of stable manure and three of muck, equal in value to four loads of yard manure. Almost all garden plants, particularly grape vines and strawberry plants, show a strong affinity for the undecomposed bits of salt marsh turf in the soil. The roots are matted in with it, so that it is impossible to separate them.

18. It has been used some for fuel, and though not first rate, burns well.

19. I consider the salt marsh as reclaimed worth three hundred dollars an acre, and think it will pay the interest on that sum as long as it is properly cared for. These marshes are among the most valuable grass lands in the state, and ought to receive the immediate attention of their owners.

W. Clift.

Remarks.—There is one point in the history of this muck that deserves further notice. Mr. Clift mentions that it is not applied in the fresh state—"it is too acid" and requires exposure before it can be used profitably.

By the term "too acid" Mr. Clift doubtless intends merely to designate in the customary manner its hurtful quality when fresh, without expressing a definite opinion as to the cause. The presence of so much (8.4 per cent. of the *dry* muck) soluble matters is the reason why it must be weathered or composted, and these soluble bodies are chiefly common salt, sulphate of magnesia, and perhaps alkaline crenates and humates, which are partly washed out or destroyed by weathering. It is probably these saline matters toward which the affinity of the roots of vegetables and garden plants is especially manifested.

It is not unlikely that in some parts of the marsh, sulphate of iron may be found, as is the case with the salt marsh mud, No. 33 from the same vicinity.

No. 31.—Swamp muck from Henry Keeler, South Salem, N. Y. Dug April, 1858. Color, light snuff-brown.

Analysis.

Organic matter soluble in water,	2.13	
" " insoluble in water but sol. in carb. soda, (treated 8 times,)	45.12	
" " insoluble in water and carb. soda,	12.05	
Total,		59.30
Inorganic matter, *soluble in water,	0.78	
" " insoluble in water, but sol. in carb. soda, (treated 8 times,)	3.79	
" " insol. in water and carb. soda,	16.70	
† Total,		21.27
Water, - - - - - - - -		19.43
		100.00

Nitrogen, 1.57—1.90 ammonia.

---

* Portion soluble in water contains much sulphuric acid and iron, also lime in considerable quantity.

† Ash contains much sand, and large quantities of carbonate and sulphate of lime, with oxyd of iron, magnesia and phosphoric acid.

ANSWERS TO CIRCULAR.

1. The swamp contains about one-half acre.

2. The greatest depth of muck is 10 feet, the average 5 feet.

3. It was partially drained a few years ago by ditches 3 or 4 feet deep.

4. The water is fresh.

5. During summer the muck is dry to the depth of 3 to 4 ft.

6. No crops have been cultivated in the swamp.

7. The swamp is underlaid by rock, the soil about is clay loam.

8. The swamp receives some wash from a steep granite hill covered with a rocky soil.

9. The inlets and outlets are small but permanent springs.

11. The muck is alike at all depths as far as drained.

12. The vegetation consists of a few small ash, white wood, and soft maple trees and swamp weeds. It is too much shaded for grasses.

13. Has been used in the fresh state applied to corn and potatoes, and appears to be equal to good barn manure.

14. It has rarely been weathered more than two months, and then applied side by side with the best yard manure has given equally good results.

15 and 16. Has been composted with an equal quantity of yard manure to advantage.

19. When dry this muck is friable and easily pulverized. I have used it fresh dug with potatoes, putting about two quarts in the hill and dropping the potato on it, and the yield was one-eight more than on the same soil without muck.

HENRY KEELER.

REMARKS.—This muck hardly differs from leaf-mould, and since it contains all the mineral matters of leaves as well as a good percentage of potential ammonia, it is readily understood how it may equal good yard manure in its effects.

No. 32.—Peat from John Adams, Salisbury, (Falls Village.) Color, light snuff-brown, overlies a bed of shell-marl.

Analysis.

Organic matter, soluble in water, - -	1.71	
" insoluble in water but soluble in carbonate of soda, (treated eight times,) -	42.87	
" insoluble in water and carbonate of soda, - - -	10.65	
Total, - - - -		55.23
* Inorganic matter, soluble in water, -	1.02	
" insoluble in water, but soluble in carbonate of soda, (treated eight times,)	1.33	
" insoluble in water and carbonate of soda, - -	14.35	
† Total, - - - -		16.70
Water, - - - - -		28.07
		100.00

Nitrogen, 1.76=2.14 ammonia,

ANSWERS TO CIRCULAR.

1. The lot containing the muck and marl (No. 34,) is about 50 rods long, and from 15 to 20 wide, and contains about 5 acres.
2. The average depth of the muck is about 5 feet and in some places it is 12 feet deep.
3. It is drained 12 inches deep.
4. It is a fresh water swamp.
5. It is difficult to drive oxen on most of it except in the *very* dryest times.
6. Never has been cultivated; produces nothing but coarse grass.
7. The neighboring soil is sand underlaid by a blue hard pan.

---

* Portion soluble in water contains much sulphate of lime, with traces of salts of iron, chloride of sodium and silica. The ash contains some carbonic acid.

† Ash consists of sand, with much oxyd of iron, much carbonate and sulphate of lime, traces of magnesia and phosphoric acid, no potash.

8. The swamp receives a good deal of wash from the high hills west of it.

9. It has large springs for inlets, and sufficient outlet. The water is hard. In freshets has a quick flooding of water from large hills.

11. There appears not to be any perceptible differences in the layers of muck.

12. The swamp was formerly covered with alders, should think pine had grown there generations ago.

13. Some of the muck has been used fresh from the swamp with very little effect.

14. The exposed muck does not compare as a fertilizer with any of the ordinary manure.

15. I have used the muck as an absorbent in my hog-pen, and also mixed with stable manure, with good results.

16. Have not composted in any other way than specified in 15.

18. The muck burns pretty well as fuel.

JOHN ADAMS.

APPENDIX.

No. 33.—Salt marsh mud from Rev. Wm. Clift, Stonington. Color when dry dark ash-gray.

Analysis.

Organic matter, soluble in water, - -	5.40	
" insoluble in water but soluble in carbonate of soda, (treated five times,) - -	16.72	
" insoluble in water and carbonate of soda, - -	7.25	
Total, - - - - -		29.37
* Inorganic matter, soluble in water, -	7.40	
" insoluble in water but soluble in carbonate of soda, (treated five times,)	6.40	
" insoluble in water and carbonate of soda,	48.05	
† Total, - - - -		61.85
Water, - - - - -		8.78
		100.00

Nitrogen, 1.32=1.59 ammonia.

Remarks.—This mud is "from the bottom of a salt marsh ditch where the tide flows daily." After such treatment as is adapted to remove or decompose the soluble iron salts, (compost-

* Portion soluble in water contains sulphuric acid, chlorine, iron, lime, potash and soda in large quantities.

† Ash chiefly sand, yields to acids much oxyd of iron, sulphates of lime, iron and magnesia, also potash and soda with traces of phosphoric acid. This marsh mud yields to pure water sulphate of protoxyd of iron (green vitriol,) in small quantities, and when burned, pungent vapors of sulphuric acid are expelled from it.

ing with lime, fish or stable manure,) this mud must make an excellent fertilizer, as it contains much more saline matters than are met with in any muck or peat, and is by no means deficient in nitrogen. The quantities at the disposal of the farmers along Long Island Sound are immense.

No. 34.—Shell marl, from John Adams, Salisbury (Falls Village P. O.) This material underlies the muck No. 32, forming a bed 8 or 10 feet thick. When air dry it gave the following results:

Analysis.

Organic matter soluble in water, - -	0.70	
" insoluble in water, -	5.82	
Total,		6.52
Inorganic matter, *soluble in water, - -	1.42	
" insoluble " - -	61.44	
† Total,		62.86
Water, - - - - - -		30.62
		100.00

Remarks.—Mr. Adams writes that he has applied this marl to grass land without perceiving any benefit. Probably an application of it to light poor land would be found useful, and it is worth extended trial.

No. 35.—Mud from beneath marsh muck No. 21, from Solomon Mead, New Haven. Described as "clay muck." "Has

---

* Portion soluble in water consists chiefly of sulphate of lime, with traces of salts of iron and potash.

† An analysis of this marl made by Mr. E. H. Twining, after drying it completely, is as follows:—

Carbonate of lime, - - - - - - - - -	83.45
Organic matter, - - - - - - - -	8.13
Sand, - - - - - - - - -	2.71
Oxyd of iron and alumina with traces of sulphuric acid, phosphoric acid, potash and magnesia, - - - - - -	5.71
	100.00

sufficient tenacity to make bricks." "Excellent for improving the physical characters of sandy soils."

Analysis.

Organic matter	soluble in water, -	0.88	
"	insol. in water but sol. in carb. soda, (treated three times,)	3.70	
"	insol. in water and carb soda,	3.95	
Total,	- - -		8.53
Inorganic matter	*soluble in water, - -	1.90	
"	insol. in water but sol in carb. soda, (treated three times,)	18.37	
"	insol in water and carb soda,	67.35	
† Total,	- - - -		87.62
Water,	- - - - -		3.85
			100.00

* Portion soluble in water contains much sulphate of lime and some salts of iron. with a small quantity of chloride of sodium. Contains also some silica, but no carbonic acid.

† Ash mostly a fine sand, with some clay; yields much iron and some sulphate of lime, and magnesia to acids.

11. *Tabulated Analyses.*

TABLE I. COMPOSITION OF MUCKS AND PEATS.—1–17.

	Organic Matter. Soluble in carbonate of soda.	Organic Matter. Insoluble in carbonate of soda.	Organic Matter. Total.	Inorganic matter.	Water.	Soluble in water.	Nitrogen. Ammonia.
1. Lewis M. Norton, Goshen, Conn.,	17.63	34.79	52.42	35.21	12.37	1.54	1.28=1.63
2. " " " "	60.02	11.65	71.67	8.00	20.33		1.85=2.24
3. " " " "	50.60	29.75	80.35	4.52	15.13	2.51	1.90=2.31
4. Messrs. Pond & Miles, Milford, "	65.15	11.95	77.10	3.23	19.67	1.63	1.20=1.46
5. " " " "	67.75	16.65	84.40	2.00	13.60	3.42	.95=1.15
6. Samuel Camp, Plainville, "	43.20	8.90	52.10	29.20	18.70	2.50	2.10=2.55
7. Russell U. Peck, Berlin, "	38.49	30.51	69.00	13.59	17.41	2.61	1.62=1.97
8. Rev. B. F. Northrop, Griswold, "	42.30	10.15	52.45	34.70	12.85	1.64	1.31=1.60
9. J. H. Stanwood, Colebrook, "	49.65	7.40	57.05	4.57	33.88	1.83	1.23=1.50
10. N. Hart, Jr., West Cornwall, "	55.11	10.29	65.40	14.89	19.71	6.20	2.10=2.55
11. A. L. Loveland, North Granby, "	38.27	2.89	41.16	47.24	11.60	.75	1.00=1.22
12. Daniel Buck, Jr., Poquonock, "	27.19	48.84	76.03	5.92	18.05	2.94	2.40=2.92
13. " " " "	33.66	40.51	74.17	8.63	17.20	1.80	2.40=2.92
14. Philip Scarborough, Brooklyn, "	51.45	25.00	76.45	7.67	15.88	1.43	1.20=1.46
15. Adams White, " "	54.38	23.14	77.52	9.03	13.45	5.90	2.89=3.54
16. Paris Dyer, " "	18.86	5.02	23.88	67.77	8.35	2.63	1.03=1.26
17. Perrin Scarborough, " "	43.27	16.83	60.10	25.78	14.12	15.13	0.86=1.05

TABLE II.—COMPOSITION OF MUCKS AND PEATS.—18–33.

	ORGANIC MATTER.				INORGANIC MATTER.				Water.	Nitrogen. Ammonia.
	Soluble in water.	Insol. in water but soluble in carbonate of soda.	Insoluble in water and carbonate of soda.	Total.	Soluble in water.	Insol. in water but soluble in carbonate of soda.	Insoluble in water and carbonate of soda.	Total.		
18. Geo. K. Virgin, Collinsville, Ct.,	2.21	20.57	8.25	31.03	0.32	9.41	48.05	57.78	11.19	0.64=0.78
19. " " "	1.12	9.19	5.10	15.41	0.28	1.08	48.65	50.01	34.58	0.34=0.41
20. " " "	0.72	9.31	3.65	13.68	0.25	0.76	28.20	29.21	57.11	0.28=0.34
21. S. Mead, New Haven, "	3.30	40.52	8.20	52.02	2.60	10.02	23.90	36.52	11.46	1.51=1.84
22. Edwin Hoyt, New Canaan, "	2.84	13.42	7.55	23.81	2.72	19.88	46.30	68.90	7.29	0.45=0.54
23. " " "	2.34	13.49	8.05	23.88	1.54	12.42	56.20	70.16	5.96	0.90=1.09
24. " " "	1.15	17.29	8.00	26.44	1.67	14.13	51.10	66.90	6.66	1.01=1.22
25. A. M. Haling, Rockville, "	3.43	52.15	8.65	64.23	0.35	0.16	4.90	5.41	30.36	1.62=1.97
26. " " "	3.87	71.57	8.44	83.88	0.23		1.98	2.21	13.91	1.32=1.60
27. " " "	3.87	44.04	4.25	52.16	0.51	4.07	5.05	9.63	38.21	1.88=2.28
28. Albert Day, Brooklyn, "	2.45	46.25	6.35	55.05	0.32	0.65	5.40	6.37	38.58	0.84=1.02
29. C. Goodyear, New Haven, "	1.80	45.42	*10.35	57.57	0.35	7.98	18.80	27.13	15.30	1.68=2.04
30. Rev. Wm. Clift, Stonington,	3.33	51.68	9.80	64.81	2.82		5.86	8.68	26.51	0.95=1.16
31. Henry Keeler, South Salem, N. Y.,	2.13	45.12	12.05	59.30	0.78	3.79	16.70	21.27	19.43	1.57=1.90
32. John Adams, Salisbury, Ct.,	1.71	42.87	10.65	55.23	1.02	1.33	14.35	16.70	28.07	1.76=2.14
33. Rev. Wm. Clift, Stonington, "	5.40	16.72	7.25	29.37	7.40	6.40	48.05	61.85	8.78	1.32=1.59

Average amount of potential ammonia in 33 mucks and peats. - - - - - - - - - - 1.37 per cent.

TABLE III.—COMPOSITION OF MUCKS AND PEATS.—1–17.

Calculated in the dry state: and the percentage of ammonia calculated in organic matter.

In this and the following table the matters *soluble in water* and the *ammonia* are calculated to two places of decimals; the other ingredients are expressed in round numbers.	Organic Matter.			Inorganic matter. Total.	Matter soluble in water.	Potential ammonia.	Percentage of potential ammonia calculated on the organ. matter.
	Sol. in carbonste of soda.	Insol. in carb. of soda.	Total.				
1. Lewis M. Norton, Goshen, Conn.,	20	40	60	40	1.75	1.85	3.10
2. " " " "	75	15	90	10		2.80	3.12
3. " " " "	60	35	95	5	2.95	2.71	2.87
4. Messrs. Pond & Miles, Milford, "	81	15	96	4	2.03	1.82	1.89
5. " " " "	79	19	98	2	3.97	1.33	1.36
6. Samuel Camp, Plainville, "	53	11	64	36	3.08	3.14	4.89
7. Russell U. Peck, Berlin, "	46	37	83	17	3.27	2.37	2.85
8. Rev. B. F. Northrop, Griswold, "	48	11	59	41	1.88	1.83	3.05
9. J. H. Stanwood, Colebrook, "	75	11	86	14	2.77	2.27	2.62
10. N. Hart, Jr., West Cornwall, "	69	13	82	18	7.75	3.18	3.90
11. A. L. Loveland, North Granby, "	43	4	47	53	85	1.38	2.96
12. Daniel Buck, Jr., Poquonock, "	33	60	93	7	3.58	3.56	3.84
13. " " " "	41	49	90	10	2.16	3.51	3.93
14. Philip Scarborough, Brooklyn, "	61	30	91	9	1.70	1.73	1.90
15. Adams White, " "	63	27	90	10	6.78	4.06	4.56
16. Paris Dyer, " "	21	5	26	74	2.85	1.36	5.28
17. Perrin Scarborough, " "	62	8	70	30	17.59	1.10	1.74

TABLE IV.—COMPOSITION OF MUCKS AND PEATS.—18–33.

Calculated in the dry state: and the percentage of ammonia calculated on organic matters.

	Organic Matter.				Inorganic Matter.				Potential ammonia.	Percentage of potential ammonia calculated on the organic matter.
	Soluble in water.	Insol. in water, but soluble in carbonate of soda.	Insol. in water and in carbonate of soda.	Total.	Soluble in water.	Insol. in water but soluble in carbonate of soda.	Insol. in water and in carbonate of soda.	Total.		
18. Geo. K. Virgin, Collinsville, Ct.,	2.48	23	9	35	0.35	11	54	65	0.87	2.51
19. " " " "	1.72	14	8	23	.43	2	75	77	.63	2.66
20. " " " "	1.67	22	8	32	.58	2	66	68	.79	2.48
21. Solomon Mead, New Haven, "	3.70	48	9	60	2.92	11	27	40	2.06	3.53
22. Edwin Hoyt, New Caanan, "	3.05	14	8	26	2.92	21	50	74	.58	2.26
23. " " " "	2.47	14	8	25	1.63	13	60	75	1.15	4.56
24. " " " "	1.23	18	9	28	1.79	15	55	72	1.31	4.61
25. A. M. Haling, Rockville, "	4.90	75	12	92	.50		7	8	2.81	3.06
26. " " " "	4.50	83	10	97	.27		2	3	1.86	1.90
27. " " "	6.24	71	7	84	.82	7	8	16	3.67	4.37
28. Albert Day, Brooklyn, "	4.01	76	10	90	.52	1	8	10	1.80	1.85
29. C. Goodyear, New Haven, "	2.11	54	12	68	.40	9	22	32	2.40	3.54
30. Rev. Wm. Clift, Stonington, "	4.56	71	13	88	3.86		8	12	1.58	1.78
31. Henry Keeler, South Salem, N. Y.	2.66	56	15	73	.97	5	21	27	2.37	3.20
32. John Adams, Salisbury, Ct.,	2.37	59	15	76	1.40	2	20	24	2.97	3.87
33. Rev. Wm. Clift, Stonington, Ct.	5.93	18	8	32	8.13	7	53	68	1.74	5.41

Average amount of potential ammonia in the organic matter of 33 mucks and peats, - - - - - - 3.14 per cent.

COMMERCIAL FERTILIZERS.

SCALE OF PRICES.

The valuation of the chief ingredients of commercial fertilizers remains as in my First Report, and is as follows:

Potash,	4 cts.	per lb.
Insoluble phosphoric acid,	4½	"
Soluble " "	12½	"
Ammonia,	14	"

THE QUINNIPIAC COMPANY'S FISH MANURE.

In March, 1858, I was consulted by the Quinnipiac Company of Wallingford, Conn., with reference to a fish manure which they manufacture, and obtained their consent to publish the result of the analyses that were made. Nothing is more obvious than that the true interests of the manufacturer and of the farmer are identical, and equally promoted as well by an exposure of what is worthless, as by commendation of what is useful. The Quinnipiac Company employed me to analyze their fish manure in order to ascertain definitely for themselves, how it compares with standard fertilizers, and are willing that I should pronounce public judgment on it according to its merits.

The quality and price of the fish manure is such that it deserves to be commended to our farmers; especially since, as I am credibly informed, the Company bears a high reputation, which is a guaranty that they will continue to manufacture an article as good as they have submitted for analysis.

Analysis.

Water,	9.67	9.63
Organic (animal) matter,	67.78	65.68
Sand,	2.05	1.96
Lime,	3.76	
Soluble phosphoric acid,	3.38	3.41
Insoluble " "	.81	.33
Ammonia yielded by animal matter	8.36	8.23
Calculated value,	$32.00 per ton.	
Manufacturer's price,	$31.40 per ton.	

This manure is not so rich either in phosphoric acid or in ammonia as the best qualities of fish manure; but it is nevertheless entitled to a high rank among concentrated fertilizers. It yields fully one-half as much ammonia as the best Peruvian guano, and nearly all the phosphoric acid it contains is in a form soluble in water.

The calculated value is estimated from the prices adopted in my First Annual Report.

The manure is sold by measure. The Company inform me that it weighs 35 pounds, and is sold at 55 cents, per struck bushel. From these figures the price per ton, as given above, is reckoned.

The mechanical condition is very good. In employing this manure it must be borne in mind that, like Peruvian guano, it is capable of supplying only a part of the wants of vegetation, so that the use of some phosphatic manure and of leached ashes, muck or stable manure, with it, will be better economy in most cases than depending on it alone.

The manufacturers recommend to apply it to Indian corn, for example, either broadcast at the rate of 20 to 40 bushels per acre or 3 bushels in the hill. It is doubtless generally the best plan to manure the plant rather than the soil, *i. e.*, if a crop grows in hills or drills, to manure in the hill or drill; if the crop is sown broadcast, manure in the same manner. If I understand rightly, a much larger application in the hill than three bushels per acre, is likely to prove detrimental.

It is to be hoped that this successful attempt to manufacture a substitute for Peruvian guano in our own State, will meet with such encouragement as to make fish manure a staple fertilizer. With the stimulus of abundant patronage, this kind of manure can be prepared of better quality and furnished at a less price; while if judiciously used, it cannot fail to improve our lands permanently, at the same time that it yields better yearly crops.

THE GREEN SAND MARL OF NEW JERSEY.

In the Spring of 1858 I was informed that the "New Jersey Fertilizer Company" intended shipping to this State some cargoes of this material, and although I am not aware that their intention has been carried out as yet, there is apparently no reason why the Green Sand Marl may not become an article of commerce between Connecticut and New Jersey, and I therefore communicate to the public such account of its nature and use as I have been able to collect.

The Green Sand Marl is a peculiar geological deposit, met with in various parts of this and other countries, but most largely developed in the State of New Jersey, where it occupies or underlies an area of 900 square miles. This tract extends from Sandy Hook south westwardly to Salem, on the Delaware River, a distance of ninety miles, and is six to fourteen miles in breadth. It is only in a few localilies, however, that it is found on the surface of the earth; it being overlaid with soil throughout the great share of this vast district. It has long been known that this marl, as it is called, is exceedingly useful as a fertilizer when applied upon the contiguous lands. The discovery is said to have been made by accident, and the effects were so striking, that in those parts of New Jersey, where it is easily accessible, it is now one of the chief reliances of the farmer.

The deposit of green sand marl has a variable thickness, and is by no means uniform in appearance. It often has a fine green color. This color is due to the *green sand* which is its characteristic ingredient. Often, and indeed generally, the color of the marl is greenish-gray or brown, from an admixture of clay and other substances. The green sand itself occurs in the form of grains like gunpowder. These grains are brown externally, if they have been exposed to the air, owing to the higher oxydation (or rusting,) of the protoxyd of iron contained in them;

but if washed or broken, their proper green color is always manifested. This color enables us to distinguish the green sand from all other sands by the eye alone.

The green sand has a nearly uniform composition, and hence is considered a distinct mineral, and for the sake of distinction is called *Glauconite* (which means "sea-green stone,") by the mineralogists.

In virtue of its composition and easy decomposability, green sand is an excellent fertilizer.

Its average composition in 100 parts is:

Silica,	49.5
Alumina,	7.3
Protoxyd of Iron,	22.8
Potash,	11.5
Water,	7.9
Lime,	.5
Magnesia,	trace.

On account of its finely divided state, when freely exposed to the air and water of the soil it gradually decomposes, and its potash, silica and protoxyd of iron become soluble, or at any rate available to vegetation. The protoxyd of iron which is useful in small quantity, but detrimental if largely present in the soil, is prevented from accumulating to excess by the fact that it rapidly absorbs oxygen from the air, and passes into peroxyd (iron rust.) The peroxyd of iron and alumina together with the silica, are important means of increasing the power of the soil to absorb and retain manures.

Many sandy and light soils are deficient in potash, and hence the green sand is useful when applied to them. It has indeed been supposed that this fertilizer owes its efficiency chiefly to its large content of potash. The other ingredients that we have mentioned are, however, useful to a greater or less degree.

Not only the green sand itself, but likewise the other matters which, with it, make up the marl, must be taken account of in considering its fertilizing value. The admixtures of clay, quartz sand, etc., are quite variable, ranging in quantity from 10 to 60 per cent. of the whole; thus more or less reducing the amount of manurial matters, and at the same time either improving or injuring the general composition by their own accidental ingredients.

The clay mixed with or overlying the green sand, in many localities contains quantities of a shining yellow mineral called iron pyrites or "fool's gold," which consists of iron and sulphur, and by exposure to the atmosphere is converted into sulphate of iron, (common copperas or green vitriol.) From this source the marl is sometimes so impregnated with sulphate of iron as to be destructive to vegetation when applied fresh from the pits. This difficulty is not, however, general, so far as I can learn, and in all cases is obviated by exposing the marl for a year or so to the weather, and by composting it with lime or with stable manure. By these means the iron is changed from the protoxyd to the peroxyd, which latter is harmless under all circumstances.

In some localities the marl is mixed with a large proportion of fragments of shells, and thus contains considerable carbonate and a small amount of phosphate of lime. Sulphate of lime or plaster, is also an occasional ingredient.

The following analyses copied from Professor Cook's Report on the Geology of New Jersey, clearly show the nature and extent of the variations in composition, to which the marl as employed for agricultural purposes is subject.

*Analyses.**

	1	2	3	4	5	6
Protoxyd of iron,	8.3	16.8	21.3		14.9	
Alumina,	6.1	6.6	8.0			
Lime,	2.4	12.5	1.0			
Magnesia,	.4	2.6	2.0			
Potash,	2.5	4.9	7.1	7.1	4.3	3.7
Soluble silica,	20.2	31.2	45.9			
Insoluble silica and sand,	49.9	5.6	4.0			
Sulphuric acid,	.9	.6	.4			
Phosphoric acid,	1.4	1.1	1.3	.2	2.6	6.9
Carbonic, "	.2	9.3				
Water,	7.1	8.9	8.1			
Soluble in water,	1.9	1.4	1.1	1.1	1.9	4.7

* In copying the analyses, the decimals of the percentages have been abridged from two figures to one.

Potash it is seen ranges from 2½ to 7 per cent. The average is about 4½ per cent. One of the specimens is half sand and insoluble matters. No. 2 contains 12½ per cent. of lime, and 9 per cent. of carbonic acid, or 21 per cent. of carbonate of lime. Phosphoric acid is almost wanting in No. 4; but in No. 6 exists to the amount of 7 per cent. The usual quantity of phosphoric acid however, does not exceed 1 to 2 per cent.

From the composition of the green sand marl we might know that it is a good manure without any actual trials; but the experience of the New Jersey farmers during many years has so fully demonstrated its value, that the question arises—may it not be procured and transported so cheaply as to admit of profitable use in this State? The following quotation from Professor Cook's Report may serve to assist us in answering this question.

"The absolute worth of the marl to farmers it is difficult to estimate. The region of country in which it is found has been almost made by it. Before its use the soil was exhausted, and much of the land had so lessened in value that its price was but little, if any more than that of government lands at the West; while now, by the use of the marl, these worn out soils have been brought to more than native fertility, and the value of the land increased from fifty to a hundred fold. In these districts as a general fact, the marl has been obtained at little more than the cost of digging and hauling but a short distance. There are instances however, in which large districts of worn out land have been entirely renovated by the use of these substances, though situated from five to fifteen miles from the marl beds, and when, if a fair allowance is made for labor, the cost per bushel could not have been less than from twelve to sixteen cents. Instances are known when it has been thought remunerative at twenty-five cents per bushel."

The New Jersey Fertilizer Company deliver the marl on board vessels at their wharf at Portland Heights, N. J., for seven cents per bushel. The bushel when first raised weighs 100 lbs.; when dry 80 lbs. I doubt not that the average qualities of this marl are better bushel for bushel, than leached ashes. The best kinds are much superior, and in the inferior sorts there is much more weight of valuable fertilizing matters than in an equal bulk of leached ashes; but this advantage has its offset in the superior fineness, and consequent greater activity of the leached ashes. If then the expenses of transportation are small, as they are when large quantities are shipped, there is no reason why our farmers, who are located near tide water, may not use this fertilizer to great advantage, especially if they can have a good article guaranteed them.

The marl is especially useful for potatoes and root crops, but on poor soils is good for any crop. It is applied at the rate of one to two hundred bushels per acre.

"ANIMALIZED PHOSPHATE OF LIME."

A specimen of the so-called "Animalized Phosphate of Lime," made by Hartley & Co., of Plymouth, Conn., received from Mr. Dyer, was analyzed with the following results, *per cent.:*

Water,		6.18
Sand and silica,		8.12
Organic and volatile matter,		8.61
Hydrated sulphate of lime, (unburned plaster,)		55.50
Carbonate of lime,		13.03
Magnesia,		1.77
Oxyd of iron, alumina and phosphoric acid,		1.76
Carbonic acid (combined with alkalies,)		1.03
Alkalies, chlorine and loss,		4.00
		100.00
Ammonia yielded by organic matter,	0.33	0.35

The analysis is not fully carried out, separate determinations of the quantity of phosphoric acid and of potash not having been made. The phosphoric acid cannot amount to more than 1½ per cent., the potash not more than 3 per cent. These quantities are of small account in a high-priced fertilizer. To finish the analysis in these particulars would serve no important use.

I find by a simple calculation that a manure equal, and indeed superior to the above, in composition and value, weight for weight, may be made after the following recipe:

60 pounds of ground plaster.
37 " hard wood ashes (unleached.)
3 " Peruvian guano.

Such a mixture can be manufactured at a profit for $10 per per ton, and if I do not greatly mistake, most farmers can get the ingredients for $5 to $7 per ton.

This article claims to be "made from the bones, blood and flesh of animals, digested in acid liquors, and dessicated with various saline fertilizers, in such a manner that all the valuable gases and salts are retained in a dry powder." It is seen that the quantity of "various saline fertilizers," is so large compared with the "bones, blood and flesh of animals," that the result is comparatively worthless commercially speaking. When we consider that 75 to 80 per cent. of a dead animal is water, it is easy to understand that it requires careful manufacturing to make a concentrated manure from the carcasses of horses, &c.

It is usual to employ oil-of-vitriol to decompose and deodorize animal matters in preparing manures. This is very well, but if a large quantity of cheap materials are afterward mixed up with the product, the value of the whole becomes so reduced, that the expense of manufacturing is a dead loss to the farmer who in the end pays for it, in case the manure finds a market.

If the sample furnished me represents the average quality of this manure, it may be confidently asserted that those who pay for it $50 per ton, (the manufacturers price,) will lose the better share of their money.

PERUVIAN GUANO.

From the store of Wm. Kellogg, Hartford.

Water,	17.22	17.41
Organic matter,	49.44	49.60
Total ammonia,	16.32	16.38
Phosphoric acid, soluble in water,	2.32	2.32
" " insoluble in water,	11.03	10.81
Sand,	1.90	2.07
Calculated value, $61.20.		

The above figures show that this fertilizer maintains its uniformity and excellence of composition to a remarkable degree.

The soluble phosphoric acid, it should be remembered, is equal in quantity to the average amount of this ingredient in our commercial superphosphates, and is accompanied with two to three per cent. of potash, which, though of trifling commercial value by the side of ammonia, is nevertheless of great manurial worth on the light soils where guano is most often applied.

ELIDE GUANO.

This is an article that purports to come from the coast of California. It is a genuine guano, similar though inferior to Peruvian. It is afforded at two-thirds the price of Peruvian, and an analysis is of much interest as showing its real commercial value. It appears from the analyses of other chemists that this guano is quite variable in composition, at least so far as the quantity of moisture is concerned. I give some of the results of Dr. Stewart, chemist to the Maryland Agricultural Society, and of Dr. Deck, of New York, by way of comparison. I should say with regard to its texture, that at first sight it is rather unpromising, containing some genuine stones and a good many hard lumps that are difficult to crush unless they are dried.

A mechanical analysis gave per cent.:

Fine portion passing a sieve of 20 holes per inch, -	74
Lumps easily reduced after drying, - -	22
Pebbles, - - - - - - -	4
	100.00

When dried, however, the whole is as easily crushed as Peruvian guano, the pebbles of course excepted.

The analysis of the whole, rejecting the pebbles only, is given under I. Under II. are figures from Dr. Stewart's, and under III. from Dr. Deck's analysis.

	I.		II.	III.
Water, - -	27.34	27.60	18.90	22.64
Organic and volatile matter,	39.20	38.75	43.30	43.53
(Yielding ammonia,)	(10.00)	(10.06)	(9.39)	(11.46)
Phos. acid soluble in water,	5.07	5.31	11.00	
" " insol. in water,	6.46	6.25		
Sulphuric acid, - -	4.94			
Lime, - - -	9.67	9.36		
Potash and a little soda,	5.52		9.60	
Sand and insoluble matters,	2.50	2.52	4.70	3.24

Calculated value, $46.60, or including the potash $50.

The high percentage of soluble phosphoric acid depends upon the presence of potash and soda.

It must be borne in mind that this manure is considerably variable in composition, and is so moist that it may easily deteriorate by keeping.

The specimen I have analyzed is considerably cheaper than Peruvian guano. It remains to be seen, however, whether other cargoes or other lots are equal to this, before the reputation of the Elide guano can be established.

SUPERPHOSPHATES OF LIME.

But four specimens of this manure have been analyzed this year. Two of these, I. and II., were from the store of Messrs. Backus and Barstow, Norwich; the others, III. and IV., from Wm. Kellogg, Hartford.

	I.		II.		III.	IV.
	Pike & Co. av. 10 b'gs.		Coe & Co. av. 25 b'gs.		Greene & Preston.	Coe's.
Water, organic & vol. matters,	38.50	38.50	36.55	36.15	32.96—32.28	40.85—41.25
Sand,	28.85	28.80	2.70	2.80	2.45— 2.80	6.05— 5.95
Soluble phosphoric acid,	1.98	2.22	2.85	2.92	2.28— 2.43	2.62— 1.70
Insoluble, " "	2.29	2.08	18.13	17.78	19.12—17.64	15.76—16.30
Ammonia,	2.44	2.45	3.14	3.11	1.39— 1.39	2.97— 2.74
Calculated value,	$14.00		$32.00		$26.31	$37.81 ℔ ton

I. Is seen to be a very inferior article; more than one-quarter of it (28 per cent) is *sand!* This fact indicates that it is most probably some manufacturing refuse. The calculated value will give the farmer an idea how much he can afford to pay for it; but manures so largely mixed with sand, cannot be carefully prepared; and as other samples may contain much more sand, it is best not to buy this manure at all unless on an analysis.

II. III. and IV. are all fair samples of "superphosphates," as that word is now used, though none of them contain appreciably more *soluble phosphoric acid* than Peruvian guano. It seems, as yet, impossible to find a real superphosphate (yielding 10–15 per cent. of soluble phosphoric acid) in the Connecticut market.

The above analyses do not accord very closely in some particulars. This is due to the fact that the samples were too moist to allow of intimate mixture. The slight differences are, however, of no importance in estimating the value of these articles.

All these specimens were in good mechanical condition. The first sample of Coe's superphosphate is of the same quality which it has hitherto possessed. The analyses of it read almost precisely like those made last year; but there is some falling off in the other sample IV., in which the percentages of sand and water are both somewhat larger, and all the active ingredients are accordingly reduced in proportion.

The difference in value between II. and IV. amounts to $4.20 per ton.

Green & Preston's is still inferior to IV. chiefly from containing less ammonia.

CASTOR PUMMACE.

Messrs. Baker, Latourette & Co., 142 Water St., New York City, manufacturers of linseed and castor oils, have recently undertaken the new enterprise of importing the castor bean from India, and expressing the oil from it in New York. The cake or pummace remaining from this operation, has been found to possess valuable fertilizing properties, and is already employed as a manure in England. I have been employed to analyze the castor pummace, and it has turned out so satisfactorily, that in my opinion it will be doing the members of the State Society a service, to communicate the results, and do so herewith, having obtained permission of the manufacturers.

Analysis.

Water,	9.24
Oil,	18.02
Woody fibre and mucilage,	38.29
Nitrogenous bodies (albumen, etc.,)	28.31
Ash,	6.14
	100.00

In the *ash* were found—

Sand,	0.75
Lime,	0.36
Phosphoric acid,	2.04
Alkalies with a little magnesia, sulphuric and carb. acids,	2.09
	6.14

The amount of nitrogen in the nitrogenous bodies was found to be 4.32 per cent., corresponding to 5.48 per cent. of potential ammonia.

On account of the purgative effect of the castor oil, the pummace cannot be employed as food for cattle, and its whole agricultural value must consist in its fertilizing applications.

Its worth commercially considered, lies exclusively* in its content of phosphoric acid and ammonia. Its calculated value, using the prices adopted in my first annual report, viz., four and a half cents per pound for insoluble phosphoric acid, and fourteen cents per pound for ammonia, is $17.20 per ton (2000 lbs.)

The manufacturers inform me that hitherto they have sent the castor pummace to England, where it commands a price of £4 10s. sterling per ton (the English ton of 2240 pounds I suppose.) They now intend bringing it into the home market, and there seems no reason why we cannot use it to as good advantage as English farmers can, if it is afforded at a fair price.†

The pummace is not hard like linseed-cake, but easily crumbles to pieces, and is sufficiently fine to be convenient in application.

It belongs to what are usually termed the stimulating manures, and is rapid in action, usually spending itself in one season.

It may be applied directly to the soil and harrowed in, or used in the preparation of composts. I should judge it would be found exceedingly servicable in composting muck, etc.

Some caution must be exercised in the use of this class of

* The opinion has been entertained that oil is a fertilizer; but numerous careful trials made in England and elsewhere have proved that pure oil is quite inert, and only such impure oils as contain nitrogenous animal matters produce any perceptible effects.

† I see by the advertisements of Messrs. Baker & Co., that they sell castor pummace at from $12 to $16 per ton, according to the quality. It is a cheap manure.

manures, because their action is so powerful that in very heavy doses they may overforce the crop, or even destroy the seed when put in contact with it at the time of planting. It has been asserted that the content of oil of the oil-cakes hinders the germination of seeds, by preventing access of water to them. I am inclined to believe however, that their detrimental action is due to their readiness of decomposition, whereby the seed is caused to rot. In fact there are only a few instances on record of their occasioning this sort of injury, and in these they appear to have been applied in very large quantity. We can estimate the proper allowance per acre of castor pummace, by comparing its per cent. of ammonia with that of guano. It contains just about one-third as much of this ingredient, and accordingly we may safely use three times as much of it. We know that 600 pounds of guano per acre is a very large manuring, and 200 or 300 pounds is usually the most profitable in the long run. These quantities correspond to 1800, 600 and 900 respectively of castor pummace. I find that the largest doses of rape cake, (a manure of almost identical composition, rather inferior in amount of ammonia perhaps) given in English and Saxon husbandry, are 1500 to 2000 pounds per acre, while 600 to 800 pounds are the customary applications. More is needed on heavy than on light soils.

It is frequently urged as an objection to manures of this sort that they exhaust the soil. It is however always the crops that are removed, and never the manure applied, which exhausts the soil. The *exclusive* and continued use of this or any similar fertilizer will be followed by exhaustion; but by judiciously alternating or combining it with mineral manures, as wood ashes leached or unleached, New Jersey green-sand, superphosphate of lime, or phosphatic guano, it may be used with safety and advantage.

BONE DUST AND BONE-MEAL.

These articles from the store of Wm. Kellogg, Hartford, have been analyzed with results as follows:

	Bone Dust.		Bone Meal.	
Water,	8.75	8.40	10.25	9.10
Organic matter,	27.25	27.27	26.02	27.55
Sand,	5.37	5.30	.10	.30
Earthy phosphates,	45.32	45.32	57.39	57.13
Carbonate of lime as loss,	13.31	13.71	6.24	5.92
	100.00	100.00	100.00	100.00
Potential ammonia,	2.98	3.00	4.25	4.28

Of the bone dust a more extended analysis was made, in which the amount of phosphoric acid was determined with more accuracy than in the above analyses. It was undertaken on account of the high percentage of carbonate of lime indicated, but not satisfactorily proved to be present by the first examinations. It confirms them as the following results show:

	Bone Dust.
Water,	8.75
Organic matter,	27.25
Sand,	5.37
Lime,	29.37
Oxyd of iron,	.52
Magnesia,	1.16
Phosphoric acid,	21.56
Carbonic acid (as loss,)	6.02
	100.00

The bone meal is of the kind used for feeding, and is a very finely-divided white and pure article, consisting apparently of turnings of bone, and is well adapted for its purpose.

The bone dust is obviously ground from bones that have been boiled or steamed to extract their fat, and have also parted with a portion of cartilage (animal tissue,) as is evident from the small percentage of potential ammonia.

In the collection of the bones, no great care has been taken to remove adhering dirt and sand, for we find more than five per cent. of this impurity. There is also thirteen and a half per cent. of carbonate of lime, which is more by five or six per cent. than is usually found in steamed or boiled bones. When we compare the composition of the dust with that of the meal, the latter representing pure bone, we find that there is a difference of twelve per cent. of phosphates (nearly six per cent. of phosphoric acid,) and one and a quarter per cent. of potential ammonia. Doubtless there has been no intentional adulteration practised on this bone dust; but it is not quite so pure as it ought to be. The sample is hardly so fine as to deserve the name of *dust*, as it contains a good share of unground fragments. Few of these, however, would not pass a sieve with eight holes to the linear inch, and it is therefore in a good form for use.

A few words with regard to the use of bone meal for feeding. When employed for this purpose, bone meal is intended to supply, especially to milch cows, the lack of phosphates in the food. It appears pretty well established that the soil of many pasture lands may become so exhausted of phosphoric acid, that the herbage does not yield to cows, enough of this ingredient for the proper nutriment of their bony system, and at the same time supply the large demand for phosphates made by the milk secreting organs. Cows thus poorly fed, turn instinctively to the proper remedy, and neglect no opportunity to gnaw upon any old bones they may be able to find. The results of continued feeding on such poor pastures, are a loss of health on the part of the cows, especially manifested in a weakening or softening of the bones—the *bone disease*, that is not now uncommon in our older dairy districts. It is found, if we may rely on the experience of our best farmers, that this evil "can be partially remedied by directly feeding finely ground bone meal to the cows." Other phosphates have been found to answer the same purpose, and doubtless the cheapest materials for this purpose are some of the "rock guanos" now common in our markets. The true remedy for bone disease, however, consists not in dosing the animal, but in so improving the soil that it shall produce a perfect food. A liberal application of some phosphatic manure is the obvious resort in extreme cases where the soil is absolutely deficient in phosphoric acid; but in my opinion there are few soils in New England (always excepting mere sand barrens) that do not originally contain enough of all the mineral food of plants, to yield perfectly nutritious fodder for an indefinitely long period, without the necessity for outlay in commercial or concentrated fertilizers, if they are brought into the proper physical conditions and manured with all the dung and urine that can be produced on them.

APPENDIX.

SOMBRERO GUANO.

So far as present data afford the means of judging, the Sombrero guano is the cheapest, and in composition the richest and most uniform of the phosphatic guanos. It comes from an island in the Caribbean, where it occurs as a porous rock of a yellowish white, pink or brown color, which, though quite firm in the mass, may yet be easily reduced to a fine powder.

This rock guano has been formed, doubtless, from the excrements of sea-fowl, which, exposed to alternate rains and sun, have entirely lost their animal matters, and soluble salts; and by processes familiar to the geologist, have left finally a cemented and hardened residue of phosphates of lime, magnesia and iron. This guano is of the same general character as the Columbian guano, which was in market some years ago, and much of the American guano now imported has a similar rock-like character.

The first importation into this State was made in the early part of this year (1859,) per schr. Telegraph, by Messrs. J. M. Huntington & Co., of Norwich; and in June the same house received another cargo by the schr. "Ik. Marvel."

I have analyzed eight samples, viz.: of the first importation:

I. From Backus and Barstow, Norwich, ground sample.

II. From the importers. Average made by myself from a large number of rock-specimens.

III. Ground guano from Backus & Barstow, Hartford.

And from the second cargo:

IV. A rock sample of the *white* variety.

V. Ditto of the *buff*.

VI. Ditto of the *pink*.

VII. Ground sample obtained by me from the mills at Norwich.

VIII. Furnished by Wm. B. Johnson & Co of New Haven.

The analyses are given in the following table:

ANALYSES OF SOMBRERO GUANO.

	I.		II.		III.		IV. White.		V. Buff.		VI. Pink.		VII.		VIII.	
Moisture expelled at boiling heat, } Matters expelled at red heat,.... }		9.06	0.20	0.20	8.50	8.14	2.57	2.62	2.77	2.70	3.17	3.26	7.52	7.60	7.20	7.22
			5.45	5.67	4.20	4.37	3.95	3.50	4.75	4.87	6.39	6.28	5.62	5.56	6.05	5.98
Sand,........................		0.80	0.52	0.50	0.56	0.57	0.35	0.40	1.55	1.20	1.75	1.90	1.50	1.30	1.25	1.45
Lime,........................	44.61	44.55	45.52	45.20	40.29	40.05	49.51	49.82	44.90	45.23	38.85	38.73	39.49	39.63	36.50	37.22
Phosphoric acid,................	35.55	36.99	37.04	36.63	33.86	33.71	37.63	37.83	34.86	34.70	35.34	35.72	31.43	31.54	31.88	31.44
Carbonic acid,.................							5.04	5.04	4.19	4.19	3.29	3.30	4.40	4.40		
Ox. iron and undetermined matters,							.95	.79	6.98	7.11	11.21	10.81	10.04	10.55		
							100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Phos. of lime equiv. to phos. acid,..	78.50		79.88		73.21		81.75		75.36		76.98		68.20		68.59	
Calculated value,..............	$32.64		$33.14		$30.41		$33.95		$31.30		$31.97		$28.33		$28.49	

This guano is sold at $30 per ton, and as the price of the best samples nearly reaches this figure when calculated with the valuation of phosphoric acid at 4 cents per pound, I was led to hope that we were warranted in estimating the price of this substance at 4 instead of 4½ cents per pound, as has been previously done. The analyses, however, show that this guano is liable to contain a not inconsiderable amount (8 per cent.) of moisture, and thus the percentage of phosphoric acid is somewhat reduced.

It is seen that the ground samples are not quite so rich in phosphoric acid as the unbroken lumps. This is due to two causes. 1st. There is unavoidably introduced into the cargo a certain amount of fine soil and other worthless matters during the loading of the vessel. 2d. The guano is impregnated with salt water, and the chlorids of sodium, calcium and magnesium thus introduced into it, rapidly absorb moisture from the air when the guano is ground, especially if the weather be damp. I have found that these ground samples when put into a perfectly dry atmosphere, at ordinary temperatures, lose six to seven per cent. of moisture in twenty-four hours, and recover it again in an equal time if exposed to moist air. The analyses III., VII. and VIII. show that the maximum amount of moisture is seven to eight per cent.

It is seen then that the Sombrero guano has withstood the most severe tests, and may be relied upon, especially since the importers use great care to select a pure material, and to reject the worthless or inferior rocks which occur with the native deposits.

The old notion that a good manure must have a bad smell is still entertained, even among very intelligent farmers. I have had the pleasure of giving my testimony personally against this prejudice, to some of them in reference to this guano, and it may not be useless here to repeat that "not all which stinks is good for manure, and not all which is good for manure stinks!" Asafœtida is no fertilizer, and plaster or lime, which everybody knows to be good manures, are almost entirely destitute of odor. So this guano is a powerful fertilizer when used where there is need of it; though it has no more smell than sand.

It has been questioned whether these rock phosphates really possess the fertilizing value which is deduced from their content of phosphoric acid. Experience has proved that the crystalized, or the more compact massive varieties of phosphorite (native phosphate of lime,) are very inefficient, or in some cases quite inert when used in coarse powder. This fact is due to their density and want of porosity, in consequence of which they are very slowly soluble.

The notion that there is a difference in the value of phosphates coming from mineral or organic sources, a difference depending upon the simple fact of origin, and that a phosphate or other plant food, is made more efficacious as a fertilizer, by having been a constituent of an animal or plant, is merely ridiculous, and is not supported by a single fact.

This doctrine of the "Progression of Primaries," as it has been termed, though vigorously advocated by the *Working Farmer*, is daily disproved by agricultural experience.

If these phosphates are acted upon by sulphuric acid, they yield a superphosphate which is as beneficial as any, and the *only* question of the activity of this Sombrero guano lies in its solubility, or what amounts to the same thing, its fineness.

The rock, as I have said, is for the most part extremely porous, and easily ground to powder when once reduced to small fragments. It is furthermore somewhat dissolved by pure water, and, in fact, to a greater extent than bone-ash, this being due to its containing the intermediate or *neutral phosphate of lime.*

From these considerations, I should not hesitate to believe that this guano would prove a sufficiently active phosphatic fertilizer, when used alone, in soils not altogether too dry or deficient in vegetable matter. The recommendation of the importers to use it in conjunction with Peruvian guano is one that will be found advantageous.