# AMERICAN MANURES;

AND

# FARMERS' AND PLANTERS'

# GUIDE.

COMPRISING

A DESCRIPTION OF THE ELEMENTS AND COMPOSITION OF PLANTS AND SOILS—THE THEORY AND PRACTICE OF COMPOSTING—THE VALUE OF STABLE MANURE AND WASTE PRODUCTS, ETC., ETC., ETC.

ALSO,

CHEMICAL ANALYSES OF THE PRINCIPAL MANUFACTURED FERTILIZERS—THEIR ASSUMED AND REAL VALUE—AND A FULL EXPOSÉ OF THE

# FRAUDS PRACTISED UPON PURCHASERS.



BY

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AND

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PHILADELPHIA:
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# COMMENDATIONS.

## NO. I.

*From Philadelphia's distinguished Lawyer, Theo. Cuyler:*

I have examined the several pages of the book entitled "American Manures and Farmers' and Planters' Guide," published at Philadelphia, by Chynoweth and Company, 1871, to which you asked my attention. These pages are numbered 214, 216, 227, 238, 240 and 244. I have also examined the book at large sufficiently to enable me to form an idea of its general scope and tenor. Assuming the statements of the book to be true at the pages indicated, they do not in my opinion transcend the bounds of legitimate criticism and are not libellous. The language, though severe and strong, is not more strong and severe than such facts justify in a book devoted to the useful instruction of the people in a preeminently important department of practical knowledge. I could much more easily understand, that silence and the suppression of such information on the part of those possessing it, would be an offence against society, than I could that its utterance would be a legal offence against the rights of an individual engaged in the perpetration of such deceptions. No man has a legal right to mislead and deceive the public. If he does so and injury to any individual results therefrom, he is liable in damages. If he does so and is exposed, he who exposes him has performed a duty, and not committed a wrong.

(Signed,) THEO. CUYLER.

## NO. II.

*From the Author of "American Grape Growers' Guide," etc.:*

Your book "American Manures and Farmers' and Planters' Guide," supplies, most effectually, a want that has long existed, and, no doubt, will save millions of dollars to the agricultural community, not only from the fearless manner in which you have exposed the frauds of the manufacturers of special fertilizers, but, also, by the lucid and scientific, yet practical and readily understood explanations given. You have brought the chemistry and general science of agriculture down to so fine a point that the most illiterate cultivator, if he can only read the English language, cannot help but know what is wanted to improve his land, and supply that want at a fair money value. Forty years ago, I was just arriving at manhood, and since that time, have been actively employed in practical farming and horticulture, and can truly state, from actual experience, that many of your deductions are perfectly correct. In fact, you have brought before the public a greater amount of reliable information, in condensed form, than is to be found in Liebig and Johnson combined, or any other work of the same kind which I have yet seen.

(Signed,) WM. CHORLTON.

## NO. III.

*From the North American and United States Gazette, the leading Commercial Paper of Philadelphia:*

The authors premise that strictly scientific writers on the use and composition of fertilizers are usually too technical for the comprehension of practical men, and the merely practical writers record results without elucidating causes or opening the philosophy involved. They essay to unfold the frauds of manufactured manures, of which, it is said, 500,000 tons are sold annually in this country, at a cost of $25,000,000, to the farmers. One chapter is surrendered to an exposition of the elements of manures and plants, and the action of one on the other; another to the kind and amount of fertilizer different plants need; one to the composition of soils, and others to the values of fertilizers in money. The last chapter is filled with analyses. There is enough in almost any ten pages treating of the patent manures and fertilizers to ground as many libel suits. One fertilizer after another is shown to be deficient in value, or over-priced, or otherwise undesirable, and the authors state how they secured the material from which their analyses were made. So far as the chemistry of agriculture is involved, the work is admirable. We hesitate only over the exposition made of special articles so long and highly commended. But conceding the truth of the statements, every farmer should use fertilizers, and telescopes endless in selecting them. We fail to notice any apparent commendation of one at the cost of the others, but do see that the German fertilizers have a double per cent. of phosphates over the best of our own. The book proposes to enable every farmer to compost for himself, and so secure a reliable fertilizer. The importance of the subject cannot be over-estimated, and the capital at issue will certainly advertize this work in one way or another strongly. It seems to be thoroughly fair and reliable.

## NO. IV.

## OUR HOME PHOSPHATES.

*From the Charleston, S. C., Courier:*

The manufacture and sale of Superphosphates under their many different names and varied experimental value have become of such importance in this country as to warrant steps being taken, not only to protect the planter from injustice, but also in the interest of the honest dealer who does give value received for money paid. The different Governments of Europe whom we are in the habit of calling slow, have long ago said that parties selling these articles shall affirm the constituents of their compounds and guarantee their proportions, in order that parties, whose general knowledge of chemistry may be sufficient for ordinary purposes shall, when they wish to use an organic or mineral constituent as the food of their crop, get what they pay for, or have the means of redress.

Our attention has been forcibly called to the subject by a careful perusal of a book laid upon our table purporting to be *American Manures*, their *money value*, by James Bennett Chynoweth, late Superintendent of Fertilizer Works, and William H. Bruckner, Ph. D., Analytical and Consulting Chemist, Philadelphia. A careful perusal will repay the planter and farmer, also those interested in the sale of Superphosphates. It is written in plain language and devoid of the symbols and technical character of the terms of Science. It is especially due from our Charleston manufacturers of Superphosphates that they give as wide a circulation as possible to the public of the valuable information conveyed in this publication.

If one-half of what is told of the many subterfuges and false proportions put upon our planting community by our Northern manufacturing friends is true, the market of the United States is in our hands, and we only need to use the resources which Providence has committed to us and their proper development, which ordinary intelligence should give, in order to obtain that controlling influence in our markets, which the possession of inexhaustible beds of *Native Bone Phosphate* entitle us. In any event, the natural course of trade ought in time to give us this control; but with the impetus which this description of facts, properly ventilated, should produce, Charleston ought at one bound to step to the front rank, in the United States at least, as a manufacturer of fertilizers.

We have taken the money value to the consumer of fourteen of the fertilizers mentioned in this publication, the names of which were most familiar to us, and some of whom are as household words over the Cotton States, and to find it to vary from four 96-100 dollars for the lowest value up, with variations to thirty-six 93-100 dollars. These fertilizers are sold at the place of manufacture at from forty-five to fifty-six dollars per ton of

2000 pounds. Now if our planting friends experienced so much benefit as their many flattering encomiums show, from so small a value received in proportion to the outlay made, how much more favorable would have been the reports, and how much more satisfactory the state of their money resources, had they received a fair value for the amount paid? These writers state that there is consumed in the United States to-day five hundred thousand tons of fertilizers at a cost to the consumers of twenty-five millions of dollars. How bright a vista of future prosperity looms up in future for us if we only use our best efforts to centralize this trade, so immense in its young proportion, and direct its regenerating influences over our much divided low country of South Carolina. The larger proportion of our community do not realize how large an influence the possession of these phosphate beds, properly developed, will have on our commercial position, and it will well become us in the future to use some efforts for home prosperity, and devote some time and capital for the proper management of our home institutions.

## NO. V.

*From the Journal of Applied Chemistry, published simultaneously in New York, Philadelphia and Boston:*

They carry a steady lance and strike pretty hard blows, and we should advise every farmer who proposes to buy fertilizers to read this book before he makes too large an investment. An accurate knowledge of the scientific part of this book would save every farmer the time and expense of many useless experiments. There is a large amount of information condensed into a small space, and so far as we have been able to detect from a hasty perusal, this information is carefully selected and correctly given according to the latest and best authorities. Some controversial portions of the work might, perhaps, have found a better place in the columns of influential newspapers, but we do not object to them as they add piquancy and spice to the feast the authors have afforded us. It is a pity that a few dishonest manufacturers of fertilizers have brought the business into such ill-repute, and the only remedy would appear to be just such an exposure of the tricks of the trade as is here given. We commend the book to the notice of our agricultural readers.

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# PREFACE TO THE SECOND EDITION.

MR. CHYNOWETH'S connection with "American Manures" having ceased, it affords the author pleasure in announcing that the first edition of the work has been exhausted, and thanking the public for their kind patronage of the same. While he is conscious that certain parties put forth all their energies to suppress the work in its infancy, he is glad to say that success has not crowned their efforts, as is evinced by this revised edition. And it is hoped, not only by him, but he trusts by all who have the welfare of their fellow-beings at heart, that subsequent editions may follow in quick succession.

It is the writer's intention to embrace in future editions of the work analyses, not only of manures representing those which have been examined, but of others; and judging from the following quotation of a letter from a manufacturer of fertilizers, dated Nov. 29th, he will not be surprised to find a marked improvement in the quality of the former.

"The book has exercised a great influence on the fertilizing business, and has put thousands of dollars into the pockets of the farmers. Every manufacturer has increased the quality of his article. The State of Delaware employs a State Chemist, and all manufacturers must have their fertilizers analyzed by that chemist before they are allowed to sell in that State, so that there was a fair chance to observe the rise of the Phosphate Business."

Immediately after the publication of "American Manures," Messrs. Wattson & Clark, manufacturers of Superphosphate of Lime, No. 135 North Water street, Philadelphia, *while candidly admitting the correctness of analyses and fairness of criticism of their product*, informed the writer that they manufacture a superphosphate of lime (never found in the market in bags), which they *warrant* to contain 10 per cent. of soluble phosphoric acid (anhydrous), and which *in quantity* they are willing to sell at the price laid down in this book, namely, 12½ cents per pound, for soluble phosphoric acid; or, in other words, they charge for the above superphosphate, $25 per short ton.

This statement is made, because *justice demands it;* and farmers *desirous of getting the worth of their money*, would do well to club together to purchase such an article in quantity. Subsequent division to meet the wants of each purchaser could easily be effected.

WILLIAM H. BRUCKNER.

*March*, 1872.

# PREFACE TO THE FIRST EDITION.

Knowledge is indispensably necessary to better the condition of mankind. The possession of the information that will enable us to procure what we need, is oftentimes more valuable than the possession of the same without such knowledge; the advantages of the latter are temporary, those of the former are permanent.

To be warned of danger is better than to be armed to resist it. When the wrongs and impositions practised on communities are fully exposed, they have no one to blame but themselves for their continuance. It has ever been considered the duty of each member of a community to do all in his power to expose and redress existing wrongs, especially when those wrongs affect the vital interests of all. From these considerations we feel it a duty, and we claim the right of giving freely the knowledge we possess on the subjects treated in this book. We shall unmask practices that have been backed up by favorable reports, and artfully designed statements, falsely claiming to be benefits conferred on the community, and which, from a want of knowledge to distinguish real from imaginary good, have passed currently as such. We shall not attempt to disprove the statements of dishonest manufacturers of fertilizers by mere reasoning; we only desire the reader closely to scrutinize and compare the facts as given, and make his own deductions. We challenge the parties assailed to disprove them.

We expect to offend some: when wrongs are exposed, this is inevitable; and those parties may endeavor to refute the statements made. Our justification is written down in the following pages. In the language of Cicero, we shall "Neither dare to say anything that is false, nor fear to say anything that is true."

PHILADELPHIA,
*May* 1*st*, 1871.

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# CHAPTER I.

## IMPORTANT INTRODUCTORY OBSERVATIONS.

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Within the past few years, several valuable additions have been made to the agricultural literature of our country, by some of the most practical, scientific men of the times, and we suppose that the publication of another book on the subject of farming, and its interests, may at this time, be considered unnecessary.

But when we have stated the reasons that lead us to issue this publication, and the important interests we intend to discuss, we think the public at large, and especially our progressive farmers, who desire to elevate their profession and raise the largest crops with the least possible outlay, without impairing the value of their lands, will agree with us, that the information contained in this book has long been needed, and that its publication is only the natural working of the law of demand and supply.

The bulk of the agricultural literature of the day has two vital defects, calculated to defeat the end for which it is intended. The direct cause of this failure may be traced to the writers themselves, who may be classified as follows:

First. The purely professional, scientific man, who, unfortunately, cannot divest his writings of the symbols and technical characters and terms of science; as he has a reputation to sustain or acquire among the savans of the world, and the scientific men of the country. Their works may be ever so progressive, and show great originality and merit, with an amount of labor and patient research deserving of the highest commendation. Still they signally fail in the object intended—that of giving plain, practical information to our farmers—as the most of them, on account of their technical character, present as much difficulty to the uninstructed mind of the general farmer as if they were written in Greek characters.

It is not our purpose to condemn works of this class; they are needed as text books in our educational institutions, and as books of reference for the scientific portion of the community. And as standard works in science, they could not be well given in any other form; and the farmer, had he the leisure, and the inclination, to give them a thorough study, would be amply repaid. But we must accept the fact, that the majority of our farmers are not educated chemists, and that in connection with the labors of the farm, they have not the time; and it cannot be expected that they would have the inclination to prosecute a study that requires so much patient research as the science of chemistry. To become acquainted with those intricate processes which are at all times taking place in the plant,—the germination of the seed, the causes that lead to the formation of the complex and changing compounds in the different stages of the growth of the plant, the formation of the varied colors and perfume of the blossoms, the changes that take place in the ripening of the fruit,—is a life-long study *for men who have leisure, with a natural aptitude for the subject.* We do not question the utility of these studies. A more intimate knowledge of vegetable physiology will undoubtedly be of incalculable benefit, in indicating the causes and cure of disease and blight in plants, which often disappoints the hopes of our farmers.

But the majority of those who have to take hold of the handles of the plow themselves, require more practical information; and in order to render it acceptable, it should be given in practical terms, so that when they seek information on any subject connected with their business, they shall not be discouraged by a long array of (to them) meaningless symbols, or have to be continually referring to a chemical dictionary to know what the writer means.

We do not intend any one to infer, that we ignore, or attempt to bring science into discredit. The farmer needs all the science he can get, and he would find himself greatly benefited by a general application of all its discoveries. But he needs an interpreter of the truths and facts that have been demonstrated by the patient research of those who have been favored with opportunities, time and means to devote to the subject.

And in this book we shall endeavor to give all the practical knowledge, so far developed and established as truths and fixed facts (*not speculations*), having a particular connection with agriculture, and this will be rendered in such plain language that a child may read and understand.

The second class of writers, whose productions are commonly found in the Agricultural Journals of the day, fall into the opposite extreme.

These writers are practical farmers, and write with the commendable intention of giving the results of their experience to benefit their brethren.

They generally give a brief description of their experiments, and the benefits derived from them, as shown in the improved condition and fertility of their lands. The information thus given is very good as far as it goes, but as these experiments are generally made without a clear knowledge of the defects intended to be remedied, or of the nature of the materials employed, they must naturally be risky: they may succeed or fail. As experiments so made must naturally cause a great waste of time and money, the value of practical knowledge is apparent.

The farmer to work intelligently should know what is the best and cheapest means to effect a desired end, and this cannot be done until he is fully acquainted with the chemical and physical defects of his soil, and the nature and properties of those materials that he can procure to correct them. There is no operation of the farm that cannot be performed so intelligently as the burning of limestone to produce quick lime, and the subsequent application of this lime to hasten the decomposition of dead vegetable substances in the soil, and give food to plants. It is not our intention to insult the good sense of our practical farmers by any labored defence of what is termed book farming. The prejudices supposed to exist against valuable information that can be given on this subject in books are only myths, the bugbear of those parties who make a business of giving information, and writing books on subjects of which they are entirely ignorant; and the thin veil of whose pretensions is so transparent that the farmer soon discovers the emptiness that is within, and those writers get the contempt and derision they so deservedly merit.

Farming should and can be elevated to a science; but in order to effect this, the farmer should realize that he has more to learn than the building of fences, ploughing and cultivating the soil, sowing the seed and gathering the harvest, with the general care of his live stock. That the necessary knowledge for the performance of these things can be transmitted orally, from father to son, without the aid of books, we will admit. But if this was all that was necessary to be known, farming would be degraded to mere labor and manual dexterity, not requiring as much skill and intelligence as is exhibited by some of the lower animals in providing for their wants. Traditional knowledge is not progressive. It is only when one generation preserves the knowledge they have acquired in the form of written books, that the next generation are enabled to extend that knowledge, and improve the arts or sciences to which they are devoted. If we do not know what has been already done, how are we to know where to begin to improve?

We might spend a lifetime in perfecting some invention that had been proved to be a failure a century before. We should all have to commence at the beginning, and life is too short to be wasted in that manner. The successive steps by which many of the arts and manufactures have advanced to their present perfection are fully recorded. We can profit by the mistakes, as well as the discoveries, of our ancestors, and these mistakes need not be again repeated. We are enabled to sift what is valuable from the worthless, appropriate it to our use and improve on it.

These are a few of the advantages of books on industrial pursuits. As far as agriculture is concerned, we think the intelligent farmer will admit that his business has less advantages in this respect than many others, and consequently is far behind the other industries of civilization.

There are many terse sayings and proverbs connected with farming, that have probably been handed down from father to son for hundreds of years. These generally contain a good deal of strong, sound common sense. One at this moment presents itself to our own mind. "The man who makes two blades of grass grow where one grew before is a benefactor to his country."

This saying is very good as far as it goes, but it seems to be incomplete, and we will make a little addition to it, as follows: "But the man who continually gathers from the soil, and returns nothing to it until he can gather no more, changing a fertile smiling land into a sterile wilderness, impoverishes himself, wrongs his country, and beggars his children." This may seem severe, but it is none the less true. How much individual poverty has been caused by excessive cropping, and a total neglect or an inadequate application of manures? That this state of things has in a great measure been caused by ignorance we will charitably admit, but whatever be the cause of the evil, the effect is the same.

In this vital principle of true and successful farming, sustaining fertility by sufficient manuring, we are as a nation shamefully ignorant and criminally negligent. In this matter many of our farmers seem totally indifferent, either to precept or example; and the work of deterioration is still going on, unchecked and unheeded in all parts of the country, while the very substances that would prevent and avert this great national evil are allowed to go to waste everywhere. Farmers often permit their stable manure to lie for months exposed to the influence of the weather, thus losing the most valuable part of it, namely the ammonia, and the soluble salts that are dissolved and washed away by the rain. Whereas all such substances should be carefully stored under cover, so that a certain amount of fermentation may be produced, thus preparing them as an active manure when needed. All the waste materials of the farm should thus be prepared. The day will come when this raw material of future crops will be considered as worthy of a store-house as the crop itself.

An accurate knowledge of the value of these waste products, as representing grass and butter, corn, beef and bread, and the other necessaries of life, will naturally lead to economy in saving those materials. It is the paramount object of this book, to give the farmer clear, comprehensive views of the theory and practice of manuring, so that he can, at the least possible expense, raise large crops, preserve the standard fertility of his lands, and leave an unimpaired inheritance to his children.

In order to do this we shall show the nature, properties, and source of the different elements that are exhausted by cultivation, and required to be renewed as manures.

The general composition of different crops and plants that are cultivated on the farm, also the nature source, and properties of the various soils from which these plants must be produced.

When the farmer is fully informed on these subjects, he can realize the commercial value of those elements of fertility, that are yearly removed from his land, in the various forms of the produce that is sent to market; and also, if he does not add anything to his soil in the shape of manure, and only realizes a bare living for his labor, he can see how much *poorer* he is becoming every year. A thorough knowledge and appreciation of these things will at once convince the farmer, that it is impossible for him to preserve the fertility of his soil unimpaired, even by the most economical and judicious saving and application of all the waste substances produced on his farm; that the portion of this produce which is removed from the farm, in the shape of cattle, and grain, and other produce, is a constant drain on the valuable elements of fertility, that should finally give his land a value; and that if he wishes to preserve its average productiveness, or improve it, he must return an equivalent in some cheaper form.

To meet this want, concentrated manures and superphosphate of lime are prepared, and the farmer finds in them the most convenient means at his command to supply the wants of his land. As the names and prices of these fertilizers are no criterion of their merits or value, this book will come directly to his assistance, and of the many evils of fraud and deception, he will be enabled to choose the least.

The manufacture of superphosphate of lime will be fully reviewed, showing what it now is, and what it should be.

Full analyses, with critical examinations, will be given, with a money value, based on the amount of the valuable constituents, solubility, and mechanical condition of the different manures.

These analyses of the different manufactured manures were made by Dr. William H. Bruckner. Samples were obtained, as follows: Packages already put up for sale to the farmer were purchased from the manufacturers or their agents. Each package was opened as soon as it arrived at our office, in the presence of witnesses, its contents thoroughly mixed, and a sample of about five pounds taken from at least fifty places of the thoroughly mixed heap, thus guarding against varying quality in the mass. Two analyses in all cases were made of different portions of this five-pound sample; hence there cannot possibly be any error in the result.

Having guarded ourselves against all possible contingencies, there will be no retraction on our part of anything stated about manufactured manures, however much manufacturers may *be offended or feel aggrieved.*

We have made no invidious distinctions between the different manures, but have endeavored to the best of our ability to deal out even-handed justice to all alike. We regret very much, however, that the limited time at our command would not permit us to examine all the manures offered in the market. We have selected the most prominent ones; and hope the neglected manufacturers will accept our want of time as an apology, when we inform them that their manures will receive our attention at the earliest possible moment—*sooner, perhaps, than they desire it.*

It is not our intention or desire to do an act of injustice to any one, but we are not to *be deterred from exposing fraud and imposition.*

We know that there are, or should be, some conscientious capable men in this business, who desire to make a good article, and give the farmer a fair return for his money. Their manures, as shown by Dr. Bruckner's analyses, are the best tests of their comparative honesty and capacity: "By their fruits ye shall know them."

One of the writers of this book has been thoroughly acquainted with the manufacture of fertilizers and superphosphate of lime for more than ten years, and during that time has super-intended two of the largest establishments for the manufacture of fertilizers in this country. He has also made the important subject of manuring an especial study, and he is thoroughly acquainted with the whole business as now conducted, the sources and nature of the materials used, the cost to the manufacturers and the methods of manufacturing, with its entire cost of production; all of which information so far has been preserved as secrets from the general public. The work of deception and dissimulation has been carried on so extensively by some of these manufacturers, that we need not wonder when we see them attempting to deceive even themselves.

There has also been a secrecy preserved in nearly all their operations, with an affectation of science that would rival the pretensions of the alchemists of the middle ages. The similarity does not stop there; all the other characteristics are preserved—unmitigated ignorance of the elements with which they work, or the ends they should produce. With unblushing effrontery they make a parade of science, placing themselves before the country as public benefactors, while they eat up the substance of the land without giving an adequate return, and are stumbling-blocks in the path of progress. That they have been able to do this with impunity, is due to the fact of the secrecy with which all their operations are conducted.

There is a sort of free-masonry preserved among them. In securing a customer, one of the standard phrases of the trade is, "We do not commend our article by giving another manufacturer a bad name."

No, dear reader. They do not speak ill of each other. What other business can boast the possession of this *virtue* in such an eminent degree? But withhold your admiration a moment, dear reader. "When rogues fall out, honest men get their due." These manufacturers live in glass houses, and throwing stones might endanger their own property.

This unity, and secrecy, in connection with the pressing wants of our farmers, have given them facilities for accumulating princely fortunes by practices that may be styled anything but honest, while at the same time making loud-mouthed pretensions of all the liberal virtues.

This may seem unnecessarily severe; but were it less so, it might fail in awakening a proper sense of the impositions that are practised upon the most deserving part of the community, *those who furnish us bread.*

One of the proofs of the dishonesty of some of the manufacturers may be found in their lying circulars and pamphlets, which are full of misrepresentations, and some even contain false and garbled analyses intended, or at least calculated to deceive, by giving combinations of elements that are not found in their manures, or, if found, in much less quantity than represented. The arts of the charlatan are extensively practised to deceive and impose on their customers. Many farmers are fully aware of the fact that they need something to enable them to raise good crops and renew their impoverished lands, and that in purchasing, they are entirely at the mercy of these compounders of manures. And if they pay a dollar for what is worth only fifty cents, it is simply because they cannot help themselves in getting the full value of their money.

The men who water milk, sand sugar, or sell shoddy for broad cloth, are termed swindlers, but the amount of their sales is comparatively small; and as we have ready means of detecting such frauds, the sales of these unprincipled dealers become beautifully less.

Not so, however, with manufacturers of fertilizers; from the appearance of the article detection is difficult. Hence some of the manufacturers of fertilizers count their profits by the hundreds of thousands of dollars yearly; and we shall prove that their practices are equally, or more culpable than those of the other party. When a manufacturer of fertilizers can realize as profits two hundred thousand dollars in a year, from the investment of an amount of capital that would barely purchase a farm of two hundred acres in some parts of the country, all honest men must admit that a great wrong is perpetrated, and that it cannot be too soon righted.

One of the objects of this book is to place this business fairly before the public; and, as it furnishes the raw material to the farmer, this raw material should have no advantage over the products of the farm. It should be as closely scrutinized as to quality, and its profits reduced to a legitimate standard. The farmer will be enabled, by the information here given, to select the manure that will yield him the largest return for the money expended.

This of course will place the dishonest manufacturer of fertilizers in the same category as the dishonest grocer, and he will soon discover from his reduced sales, that he must improve his article or quit the business.

The farmer can see at a glance the great value of the information here given. The importation and manufacture of fertilizers have become a business of great magnitude. Not less than five hundred thousand tons of prepared manures, guanos, bone-dust, and superphosphates of lime, are annually sold in this country, at a cost of about twenty five millions of dollars to the farmer and planter.

This fact shows that there must be a great demand based on a great want of these fertilizers. It also speaks well for the enterprise and progressive spirit of our farmers, that they are willing to invest this enormous amount of money. We shall show that this money expended does not give a commensurate return, in a proportional increase of the crops, and that nearly one half of it goes into the pockets of the manufacturers as profits.

But under present circumstances, how is the farmer to know, at the time of making his purchase of these manures, that he is getting a good article, and the large amount he pays is a good investment of his money? As these manures undergo no official inspection, he must necessarily buy them on the strength of their general reputation of being good, and the high sounding recommendations of the manufacturers and agents, with an array of glowing certificates from farmers, who probably did not receive a tithe of the benefit they should have received for the amount of money expended.

How is the farmer to know that the manure manufactured this year, is not greatly inferior to what was made the year before? The writers know that the value of manures of the same manufacturers varies considerably in different seasons. If a good manure is made one year, it establishes a reputation that enables the manufacturer to palm off an inferior article the next season. The farmer has no means of judging the quality of the article by its appearance, and has to rely on the honesty of the manufacturer; and this confidence, on his part, is too often abused. He finds, too late, that instead of being benefited as he expected, that the amount paid for the manure has been a direct tax on his scanty produce, involving a serious loss of time, labor and capital.

Our agricultural bureau at Washington has failed to give this momentous national question that attention the subject deserves and requires, as any one who reads the agricultural reports must admit. An office or bureau of inspection for these manures is imperatively demanded. Every concentrated manure, fertilizer, or superphosphate of lime should be analyzed by *competent* and *honest* chemists, and their processes made known, and the grade of the article fixed; and there should be a law requiring a guaranteed analysis to be attached to each bag or barrel of the manure, and the manufacturers to be liable to prosecution if their manures fall short of the guaranteed standard.

This is a matter of vital importance, not only to the practical agriculturist, but to the people at large. Every one should feel an interest in the productiveness of our soils; as all are consumers of its products, therefore all are pecuniarily interested. Moreover, when our lands fail in their natural fertility, the loss injures commerce, manufactures, mechanical arts, and paralyzes all new enterprises.

It is a grave mistake to suppose that farmers alone are interested in the practical results of tillage. They have no more than a common interest in maintaining or improving the natural fruitfulness of the earth.

Hence, we should all unite in endeavoring to impart knowledge to our farmers. If an increase of knowledge should save only five cents on the growing of a bushel of wheat, it would amount to nearly thirteen millions of dollars on the average wheat crop of this country. Or, if the same saving could be effected on each bushel of our average corn crop, it would amount to nearly fifty millions of dollars.

The writers have endeavored to impart what knowledge they possess, trusting and believing that their efforts will be appreciated by those for whom they have been exerted—Our Farmers and Planters.

Feeling confident that we shall have the patronage of the farmer, and the good wishes of the community at large (*dishonest manufacturers excepted*), in this new field of labor, we shall leave nothing undone in this, and in future editions, to render our work attractive, useful and instructive.

# CHAPTER II.

## ELEMENTS OF MANURES AND PLANTS.

**Manures** are substances added or applied to soils, to supply the wants of the different plants intended for the use of man and animals. That certain vegetable, animal and mineral substances applied to soils will quicken the growth of vegetation and increase the amount of production, are facts that have been known from the earliest period. But the nature and properties of these substances, called manures; the manner in which they act; the best modes of applying them; and their relative value and durability, are subjects still open to inquiry and discussion.

Some substances used as manures furnish directly the materials that enter into the composition of plants; while others are applied to change the physical character of the soil, and effect chemical changes on the insoluble materials that it may contain, rendering them soluble, and in such condition that they can be assimilated by plants.

As every part of man and animals is originally derived from the plants that have served them and their predecessors as food, and as no element can produce itself, and nothing is lost or destroyed; it is evident that the excrements of animals when living, together with their bodies after death, will contain everything that is necessary for the reproduction of plants.

But as these bodies are of a complex nature, and in the act of putrefaction and decay resolve themselves into simpler forms, a valuable part passing away in different gases; and as the greater part of the produce of the land is consumed in cities and towns, where the excrements are in a great measure allowed to go to waste, it is impossible to return the same elements in their changed form to the soil to produce other crops. Consequently, we have to look to other sources for the materials to make good this loss and preserve the fertility of the land.

There is no deficiency of the substances required for the growth of plants. A kind Providence has economically stored them for our use in a variety of forms. Hence the importance of a knowledge of the elements of manures; also where to procure them, and how to prepare and apply them.

## THE ELEMENTS.

To assist the farmer in obtaining a knowledge of the elements entering into the composition of cultivated plants, we have arranged them as follows:

I. **Gaseous Elements.**—Oxygen, Hydrogen, Nitrogen, Chlorine.

II. **Elements combining with Oxygen to form Acids.**—Silicon, Carbon, Phosphorus, Sulphur.

III. **Elements combining with Oxygen to form Bases.**—Calcium, Magnesium, Iron, Potassium, Sodium.

The combinations of Potassium and Sodium are termed *alkalies*.

The elements unite in definite proportions, called *equivalents*, representing the smallest quantity in which they enter into combination, one with the other. The equivalents are, for

| | | | |
|---|---|---|---|
| Oxygen | 8 | Phosphorus | 31 |
| Hydrogen | 1 | Sulphur | 16 |
| Nitrogen | 14 | Calcium | 20 |
| Chlorine | 35.5 | Magnesium | 12.2 |
| Silicon | 14 | Iron | 28 |
| Carbon | 6 | Potassium | 39 |
| Sodium | 23 | | |

To render the above intelligible, we give a few examples, viz: 8 pounds or parts of oxygen unite with 1 pound or part of hydrogen, to form 9 pounds or parts of water. Three parts of hydrogen unite with 14 parts of nitrogen, to form 17 parts of ammonia; and 16 parts of sulphur unite with 24 parts of oxygen, to form 40 parts of anhydrous sulphuric acid.

The laws that govern these combinations are arbitrary; any excess of an element does not affect the composition of the resulting compound.

**An Element** contains but one kind of matter, as Oxygen, Sulphur, Calcium.

**A Compound** is the union of two or more elements; as Water, Sulphuric Acid, Oxide of Calcium.

**An Oxide** is a combination of an element with oxygen; as calcium united with oxygen is called the oxide of calcium, or quick lime; or sulphur united with oxygen to produce sulphuric acid, is called an oxide of sulphur. The union of oxygen with different elements produces both *acids* and *bases*.

**A Salt** is the union of an acid with a base, the active properties of the acid being neutralized, and the compound having properties different from either; as lime or the oxide of calcium unites with sulphuric acid to form the sulphate of lime, or land plaster. A salt may also be produced by the union of an element with an element; as chlorine uniting with sodium to form common salt. The force that produces the combinations of dissimilar bodies is termed *Chemical Affinity*.

**Chemical Affinity** may be defined as an attraction exerted at insensible distances between particles of matter of different kinds, the result of which is the formation of new particles possessed of qualities different from those of their components; as quicklime combines with sulphuric acid, to form gypsum or land plaster.

This definition will show the difference between chemical attraction or affinity, and the forces of gravitation and cohesion. Gravitation is exerted *at all distances* between masses of matter without regard to their nature, and differs entirely from affinity.

**Cohesion** differs less widely from affinity, since its attraction is exerted only at minute distances. This force, however, is exerted more frequently, and with greater energy between similar particles of matter, than between particles of different kinds; and the operation of these forces is not attended with any material alteration in the properties of matter.

We shall now proceed to the consideration of the different elements found in plants, in the order of their division.

## GASEOUS ELEMENTS.

**Oxygen** was discovered by Priestly, in 1774. It is permanent, colorless, tasteless, and odorless, and is a supporter of combustion; any combustible substance burns in oxygen with increased brilliancy and rapidity. Some substances unite with oxygen at the common temperature, as is the case of the rusting of iron when moisture is present. Oxygen unites with all the elements entering into the composition of plants, in one or several proportions, as in the following substances, viz: One equivalent of calcium unites with one equivalent of oxygen to form oxide of calcium, commonly called quicklime; one equivalent of sulphur unites with three equivalents of oxygen to form anhydrous sulphuric acid. One equivalent of phosphorus unites with five equivalents of oxygen to form anhydrous phosphoric acid.

Mechanically mixed with nitrogen, oxygen forms about 21 per cent. by volume of the atmosphere, and is heavier than common air in the proportion of 11 to 10. Much more than one half of the weight of plants and animals is oxygen. How wonderful, that a gas should by powerful affinities be bound up in such vast stores in rocks and the solid mountains of the earth, as well as in the ocean, pervading all created matter, and being itself the essence of life; and that without it, plants and animals would speedily die.

Oxygen serves both as material for the production of matter in combining with other substances, as with carbon, forming carbonic acid; and also as a direct agent of the chemical vital processes in the plant.

The sources for the supply of oxygen to the plant, are carbonic acid, water, and nitric acid. These compounds offer to plants much more oxygen than they require, in consequence of which the most of the oxygen is again restored to the atmosphere; the plant retaining the carbon, a portion of the hydrogen, and the nitrogen of the nitric acid.

The amount of oxygen exhaled from plants is very considerable; it is, and must be equivalent to the quantity required for the purpose of respiration, combustion, and decay. If it were not so, the amount of this vital air in the atmosphere would either be increasing or diminishing, either cause unfitting it for the purpose of respiration.

If the law which governs the liberation of this substance were but slightly changed, an extinction of all plants and animals would follow. Increase or diminish in any sensible degree the vital air, or oxygen, and all vitality must shortly cease.

## HYDROGEN.

**Hydrogen** was discovered by Cavendish, in 1776. It is one of the most diffused bodies, and is transparent, odorless, tasteless, and inflammable.

It does not exist in nature, in the free or uncombined state, nor does it exist so abundantly as oxygen. It forms a part of all animals and plants, and one-ninth of the weight of water. At the same temperature, and under like pressure, it is sixteen times lighter than oxygen, and nearly fourteen and a half times lighter than common air.

This gas will not support a flame or combustion. But although hydrogen does not exist in nature in the free state, it is being continually formed by the decomposition of water, caused by the putrefaction of organic bodies; this liberated hydrogen uniting with nitrogen, carbon or sulphur, forming ammonia, carburetted and sulphuretted hydrogen. It is generally found in plants, in excess of the amount required to form water, showing that water is decomposed in the plant, and that the oxygen is expelled; the hydrogen being possibly retained as an attractive element, should there be a scarcity of moisture, to again combine with more oxygen and form water.

This element is assimilated by plants in ammonia and water; these sources are sufficient to furnish hydrogen.

## CARBURETTED HYDROGEN.

**Carburetted Hydrogen** is found in large quantities during the decay of vegetable matter in moist places or in stagnant pools, and may often be seen rising in bubbles in marshy places. In warm weather, and when vegetation commences to decay in the fall of the year, the amount formed is largely increased. It is called *marsh gas*, and its presence is the direct cause of the malaria of chills and fevers or the ague. It is largely generated in the distillation of soft or bituminous coal, and when mixed with atmospheric air, is the much dreaded *fire damp*, the explosion of which is so fatal to miners.

This gas is also given off with carbonic acid during the fermentation of compost heaps, or any large deposits of vegetable matter. It is present in all soils containing much decaying vegetable matter, and is a source of carbon and hydrogen to the growing plant; but to effect this a decomposition of its elements must be effected.

When it is present in large quantities, it is probable that it is just as poisonous to vegetable as it is to animal life, and shows insufficient oxidation of the carbon.

## SULPHURETTED HYDROGEN.

**Sulphuretted Hydrogen** is a gaseous compound of sulphur and hydrogen, and may be readily detected by the similiarity of its odor to rotten eggs. Water absorbs about three times its volume of this gas, and some sulphur springs contain large quantities of it. It is colorless, inflammable, and when breathed, highly poisonous. Being considerably heavier than common air, it may be poured into cavities and holes, and has been successfully used in killing vermin and rats. The gas is produced in marshy stagnant places, and in fish ponds, where vegetable matter is undergoing decay in the presence of the sulphates of the metals in solution, as the sulphate of iron, gypsum or land plaster; and in old pasture lands it may be frequently detected, even by the sense of smell, around the roots of the sod. As in the egg, so in other decaying animal matter, especially when the air is in a manner excluded, this gas is formed. The presence of this gas is detrimental to vegetable life; where it exists in considerable quantity it prevents the free excess of oxygen, without which plants as well as animals cannot live. Plants have not the power of rejecting poisonous substances any more than animals. The presence of these gases in the soil is a proof that it is unfitted for the proper and luxuriant growth of plants, and that an imperfect oxidation of the soil exists, that cannot too soon be remedied by cultivation and the addition of active manurial substances.

## NITROGEN.

**Nitrogen** is a permanent gas. It has neither taste, color nor smell, and is destitute of active properties. It is incombustible, and will not support combustion or respiration. Its most important function is to dilute the oxygen of the atmosphere, which contains 77 per cent. by weight, or 79 per cent. by volume of nitrogen.

Nitrogen does not enter into direct combination with any elements, excepting oxygen, with which it may be made to unite by subjecting the mixture of the gases to a succession of powerful electric shocks. The union of nitrogen with oxygen in proper proportions produces nitric acid, consisting of one equivalent or 14 parts of the former, with 5 equivalents or 40 parts of the latter.

Nitric acid in small quantity is produced in the atmosphere during thunderstorms by the same agency, and is absorbed by rains, thus furnishing a limited supply of this element to plants.

As before stated, 14 parts of nitrogen uniting with 3 parts of hydrogen, form ammonia; this compound, with nitric acid, being the most important source of nitrogen for plants.

Nitrogen is so essential to the growth of plants, that no matter if every other element was present in excess, without it they could never come to maturity.

Since nitrogen is so plentifully furnished in the atmosphere, a superficial observer would suppose that plants would never suffer from a lack of this substance. The closest investigations have failed to show that they can assimilate nitrogen in its pure state from the atmosphere; on the contrary, some plants discharge the nitrogen that is absorbed by the roots. On the other hand it has been directly proved, by a large amount of evidence, that it enters into their roots, either as ammonia or nitric acid.

There are various opinions as to the relative value of ammonia and nitric acid, in furnishing nitrogen to plants; but as the application of either substance is followed by direct beneficial results, it may be inferred that they are nearly equally valuable in proportion to the amount of nitrogen contained in each, although it is very probable that ammonia is more directly available.

Many persons suppose that the atmosphere furnishes a sufficient amount of this substance for the wants of vegetation, and that it is brought down by rains and dews into the soil. That ammonia is continually being formed from decaying animal and vegetable matter, and that it escapes into the atmosphere, we will admit; and we will now examine how far this supply will go to supply the wants of plants, based on the experiments of distinguished chemists.

In 1855 and 1856, Messrs. Lawes and Gilbert, at Rothamstead, England, collected on a large rain gauge presenting a surface of $\frac{1}{1000}$ of an acre, the entire rain-fall (with dews, etc., included), for those years. Prof. Way, at that time chemist to the Royal Agricultural Society of England, analyzed the waters, and found that the total amount of ammonia contained in them was equal to 7lbs in 1855, and 9½lbs in 1856, for an acre of surface. These amounts were yielded by 663,000 and 616,000 gallons of rain water respectively. In the waters collected at Insterburg, during the year ending March, 1865, Pincus and Roellig obtained 6.38 lbs of ammonia per acre. Bretschneider found in the waters collected at Ida Marienhuette, from April, 1865, to April, 1866, 12lbs for an acre of surface.

One hundred pounds of wheat, with the straw, require two and a half per cent. of nitrogen, equal to more than three per cent. of ammonia. The reader can see at a glance, how inadequate this amount of ammonia is to supply an ordinary crop with this element; 25 bushels of wheat, with the straw, will require 45lbs of ammonia; so that if the plant could assimilate all the ammonia of the rain water, 40lbs additional would have to be added or applied to an acre. These facts need no further comment, and conclusively prove the necessity of adding ammonia or nitrogen, in some form, to the growing plant, to supply this element.

## CHLORINE.

**Chlorine** is a yellowish green liquefiable gas, of a pungent, suffocating odor. It is incombustible, but supports the combustion of a few bodies. Chlorine is incapable of supporting respiration, causing instantaneous death when inhaled pure; when diluted with atmospheric air, and breathed in small quantities, it excites violent coughing, accompanied by an oppressive choking sensation, sometimes followed by spitting of blood.

Chlorine is abundantly found in nature in combination with sodium, as rock salt; it is also found in sea-water and marine plants.

The reader will see, by referring to the tables showing the Composition of Plants, that a very small amount of this element is required; and as it is always applied to the soil in alkaline chlorides, we shall review this element more fully under the head of Sodium.

The foregoing brief review of the gases that enter into the composition of plants, and the compounds they form with other elements, should be well considered and understood by the reader. It is not our intention to write a work on elementary chemistry; we give only such general chemical facts as are required to be known by the farmer, to render the subsequent part of this book fully intelligible.

## ELEMENTS COMBINING WITH OXYGEN TO FORM ACIDS.

**Silicon** is never found as such in nature. It was discovered by Humphry Davy, in 1813. It presents the appearance of a brown powder, or of scaly crystals resembling graphite. Silicon when combined with oxygen in the proportion of 53.34 of the latter, to 46.66 of the former, forms an acid known as Silicic Acid, or simply Silica. This acid occurs in nature both free and combined: free, as quartz, flint and pure white sand; combined, as felspar, serpentine, etc. The salts of silica are termed silicates, as silicates of potash, lime and magnesia. These silicates chemically combined with water are termed hydrated silicates, which are present in all or nearly all soils, and render a most valuable service to vegetation, by storing up soluble plant-food, and dealing it out when required.

**Silica** is either crystallized or amorphous. When crystallized, it forms six-sided, transparent, colorless prisms, known as rock crystal;

when amorphous, it is white, tasteless, and gritty, as in flint, sand, etc. It is insoluble in water, and in acids, hydrofluoric excepted. It enters largely into the composition of glass, porcelain, etc.; and we can safely say that the former contains over half its weight of this acid.

Silica, when chemically united with water, forms a transparent jelly, known as hydrated or soluble silica. This is soluble in water to a certain extent, and in acids, even in the feeble carbonic. From it, and from alkaline silicates, plants obtain their silica. This silica is prepared for the use of the plant by natural agencies, somewhat in the following manner. Suppose we allow carbonic acid and water to act on a combination of lime, potash, and silica, what takes place? The lime and potash combine with the carbonic acid to form carbonates of these substances, and the silica combining with water becomes plant-food. A long time, however, is required to effect this change, unless the alkaline silicate is in a very minute state of division.

The part taken by silica in natural operations is chiefly a mechanical one, for which its abundance and stability under ordinary circumstances peculiarly fits it; for it is found to constitute the great bulk of the soil, and serves as a support for the plant, and a reservoir for its food.

Soluble silica is indispensable to the growth of grasses and the straw of cereals, and forms the shining outer sheath of these plants. It is very abundant in the hard external coating of the Dutch rush used for polishing.

Silica as existing in plants is united with potash and soda, and may be said to be insoluble in water; but by the fermentation and decay of these plants carbonic acid is liberated, which uniting with the potash and soda forms carbonates of these substances, and the silica is separated as hydrated or soluble silica, to supply the wants of growing plants.

In the production of wheat and other cereals, the presence of this element, in a soluble state, is of the first importance in building up the straw or stalk.

If the reader refers to the tables showing the composition of the straw of the different grain crops, he will see what a large amount of this substance is required.

As the amount of soluble silica in the most of soils is comparatively small, every farmer who wishes to raise wheat or other grain, will see the importance of returning every particle of straw to his land to furnish this substance.

Another source of soluble silica at the command of the farmer are the weeds and reeds that grow in swampy places or running water, which contain a considerable amount of this substance. It also enters largely into the composition of the leaves of some trees, as the beech and red pine. The presence of decaying vegetable matter will also separate silica from its insoluble compounds, as before stated. This is one of the great benefits derived from green manuring. The lack of soluble silica vitally affects the growth of nearly all cultivated plants; but, as it can be economically manufactured and applied to the soil as silicate of soda, and also added in the waste products of previous crops, the farmer has full supplies at command.

## CARBON.

**Carbon** was discovered by Lavoisier in 1780. It enters largely into the composition of plants. It forms the bulk of mineral coal, charcoal, lampblack, black-lead, and is exhibited in its purest known state in the diamond. All these substances have the common property of uniting with oxygen in a state of combustion, and then producing carbonic acid gas.

**Carbonic Acid** is composed of one equivalent of carbon combined with two equivalents of oxygen. Its salts are termed carbonates. That plants a-similate this gas, and that it is the most important source of carbon necessary to their growth, will be shown under the head of Humus in Soils. Carbon forms from forty to fifty per cent. by weight of the different cultivated plants, so that in the economy of their growth, it may be considered one of the most important elements of their composition. This is one of the elements the farmer need not trouble himself in applying to his soil as a manure, because the atmosphere furnishes an abundant supply free of cost. The fact of the assimilation of carbon by plants from the atmosphere has been placed beyond doubt, by the investigations of eminent scientific men, from the time of Priestley, who made this discovery in 1771, up to the present time.

The farmer must not infer from the fact that the atmosphere furnishes to the plant all the carbon which it requires, that the presence of a mould of humus, or partially oxidized organic matter, is not necessary in a soil. Its presence produces beneficial physical effects, that tend directly to their healthy growth. Its capacity for absorbing fertilizing gases and giving them out as they are needed by plants, also its power of attracting heat and retaining moisture, are advantages obtained by the presence of a large amount of mould in the soil, which are not possessed by soils composed simply of sand, no matter how fine the state of division may be, or the amount of fertilizing elements they may contain

## PHOSPHORUS.

**Phosphorus** as commonly met with is yellow and transparent, resembling wax in consistency. Having a powerful affinity for oxygen, it never occurs free in nature. It is spontaneously inflammable, and for this reason is preserved under water. Phosphorus was originally prepared from urine by a tedious and disagreeable process; but Gahn, a Swedish chemist, having discovered that it enters largely into the composition of bones, it is now prepared from this class of bodies. When burnt in air or oxygen, it is converted into snow-like flocks, which are called *anhydrous* phosphoric acid.

**Phosphoric Acid** contains, in 100 parts, phosphorus 43.66, oxygen 56.34. This acid has a great affinity for water, and by exposure to a moist atmosphere is converted into *hydrated* phosphoric acid. There are several hydrates of this acid; but only one of these enters into the composition of manures, viz: tri-basic phosphoric acid. A tri-basic acid is one that requires three equivalents of the same or of different bases to form a salt; for example:

**Bone-Phosphate of Lime,** known as Basic Phosphate of Lime, is composed of one equivalent of phosphoric acid and three equivalents of lime, and contains, in 100 parts, phosphoric acid 45.81, lime 54.19. This is the state in which this salt is naturally found in bones, coprolites, phosphorite, apatite, etc.

**Neutral Phosphate of Lime** contains two equivalents of lime, one of water, and one of phosphoric acid; in 100 parts, phosphoric acid 52.20, lime 41.18, water 6.62.

**Superphosphate of Lime,** termed also acid and bi-phosphate of lime, contains one equivalent of phosphoric acid, one equivalent of lime, and two equivalents of water; containing, in 100 parts, phosphoric acid 60.69, lime 23.93, water 15.38. If we remove from bone-phosphate of lime the *three* equivalents of its base, and replace them with water, we obtain tri-basic phosphoric acid, usually in the form of a colorless, syrupy liquid, very acid to the taste. Again, if we remove from bone-phosphate of lime but *two* equivalents of lime, and replace them with water, we obtain *superphosphate of lime.* This change, in either case, can be effected by sulphuric acid. This acid, having a greater affinity for the lime than phosphoric acid has, unites with the lime, forming gypsum or land plaster. Superphosphate of lime forms white scales, which are very soluble in water, imparting to it an acid taste.

On the subject of the action of superphosphate of lime in soils, and its relative value compared with insoluble phosphoric acid, as contained in bone-dust, coprolites or mineral guano, we cannot do better than give an extract from Ronna's exhaustive report on that subject, as follows:

"What takes place, in fact, when superphosphates are presented to the soil? Coming into contact with the alkalies, or the earthy alkaline bases, the phosphoric acid in excess combines with them, and phosphate of lime is precipitated in a gelatinous condition, this being the one in which a sparingly soluble substance enters more freely into solution. Gelatinous phosphate of lime dissolves readily even in the feeble carbonic acid. When it presents itself, however, in the form of coprolites, solution is effected with the greatest difficulty. From this it may be seen, how little profitable it is, to use powdered coprolites, otherwise than upon new clearings and first ploughings, or upon soils in which probably free acids can act upon them, so that they may then be able to yield to vegetation by degrees a small quantity of phosphoric acid. Such coprolytic powder does not satisfy the demands of an advanced and progressive agriculture, that is, *immediate results*, but only effects, for which one is compelled to wait ten, yea, twenty years.

"Wœhler and Vœlcker have made some very interesting experiments on the solubility of phosphates in their dry, moist, and gelatinous state, on the solubility of bone-meal, of boiled bone, of glue refuse, of guano, of coprolites, of phosphorite, and of apatite, all of which prove the beneficial effect which the mechanical condition of phosphates exercises upon their solubility. Thus precipitated phosphate of lime, slightly moistened and allowed to remain in contact with water for a week, lost 1.10 gramme, while Suffolk coprolites lost but 0.09 gramme, and Cambridge coprolites, 0.08 gramme. The amount of water used in either case was 100 litres. In a solution of ammoniacal salts, in the proportion of 1 to 100, precipitated phosphate of lime lost 4.80 grammes, Suffolk coprolites, 0.24 gramme, and Cambridge coprolites, 0.33 gramme. A solution containing 1 per cent. of carbonate of ammonia, dissolved of precipitated phosphate of lime 2.48 grammes, of coprolites 0.36 gramme. Precipitated phosphate of lime afforded to a solution, containing 1 per cent. of sea-salt, 0.97 gramme; coprolites 0.19 gramme.

"But more than all the experiments in the laboratory, those of the practical agriculturist have confirmed the necessity of phosphates rendered soluble, and these are the experiments of twenty years, and of a whole country—which country indisputably occupies the front rank in regard to agricultural productions.

"As superphosphate of lime may be viewed as phosphate of lime dissolved in phosphoric acid, the former (phosphate of lime), as soon as the free acid is neutralized, is rendered insoluble or difficultly soluble in water, and is precipitated. Therefore, one of the objections made, viz., that, when superphosphate of lime is applied to certain soils, the soluble phosphate is lost by rain, is unfounded. From very careful experiments of Dr. Vœlcker on the transformation of soluble phosphates in contact with five different soils, which were first carefully analyzed, it is evident, that marly or chalky soils absorb the soluble phosphate more readily, that is, render it more quickly insoluble, than clayey or sandy soils. In the former soils, it appears that lime is the only operating force in this transformation. However quick absorption may take place, it is never instantaneous; for in soils containing an excess of lime, from 24 to 48 hours are required.

"As no acid combination can enter the plant without damaging it, and as superphosphates have never proven themselves injurious to plants, it follows herefrom, that phosphoric acid, which cannot exist in soils in a free state, is there neutralized, and that, in consequence, the soluble phosphate is converted into insoluble or sparingly soluble phosphate, regardless of the nature of the soil. It is an unfounded idea, that plants in the first stages of their growth are nourished by the soluble phosphate, and, during maturity, strengthened by the insoluble. It would therefore be foolish, to say the least, to prepare a superphosphate containing both soluble and insoluble phosphoric acid. Experience has proved to satisfaction, that, of two manures containing the same total amount of phosphoric acid, the one with the largest amount of soluble phosphate, other circumstances being equal, is the most effective.

"It is therefore indispensably necessary, especially in manufactories where mineral phosphates are worked, that the insoluble phosphate be rendered as completely soluble as possible. The manufacturer should at all times use every effort to increase the amount of *soluble* phosphoric acid in his superphosphate.

"If, on coming in contact with the soil, the soluble phosphate become insoluble, *why*, say the champions of pulverized coprolites, treat at great expense mineral matters with acid, and increase their cost, merely for the sake of again obtaining in the soil insoluble products? Answer: It is not the purpose of the acid alone to produce soluble phosphate. The mineral first of all is disintegrated by the acid, and then partially converted into soluble phosphate, etc., which, on being neutralized in the soil by lime, or by sesquioxide of iron, alumina, etc., is then brought into a very fine state of division. As the neutralization takes place in the soil itself, the phosphate is incorporated with the same in the simplest and most intimate manner. However fine the bones may be ground by mechanical operations, their tissue is not destroyed in them, and the phosphates within them are in a relatively raw condition. As to coprolites, even converted into powder ever so fine, they cannot have any effect on the soil, unless it contains free acids. Precipitated phosphates have not only a larger volume than those merely pulverized, but they are also, as we have proved, more freely soluble in water than mineral phosphates. Even if their elementary composition be the same, the finely divided condition of the precipitated phosphate presents indisputable advantages. The precipitated phosphate is dissolved by the most dilute acetic acid, while it has little action on the finest bone-meal, and still less on coprolites.

"The secret, therefore, of the efficiency of superphosphates consists in the fact, that the oluble phosphates of the superphosphate are converted in the soil itself into an insoluble but very finely divided product. If this change took place before the dissemination of the fertilizer, the purpose of the same would be but imperfectly accomplished. From these remarks it is plain why superphosphates applied in a liquid state are often more active than when used in a dry state. In fact, the solution of the phosphate is more perfectly disseminated, and enters more quickly into the most useful state for plant nourishing. The dry acid phosphate, inasmuch as it quickly becomes insoluble in the soil, remains, on the contrary, where it has been strewn; it may be in excess in certain places, and be wholly wanting in others. If rain does not disseminate it by mechanical means, it remains partially without producing any effect."

## SULPHUR.

**Sulphur**, commonly called Brimstone, is a solid of a yellow color, brittle, moderately hard, and devoid of taste or smell. It burns in oxygen or air with a blue flame, forming *sulphurous acid*. It is this that has the smell commonly attributed to sulphur. It occurs in nature both free and combined. As free, it is sublimed from the earth in some parts of Italy. It also flows from volcanoes. It is also very generally disseminated in nature, combined with iron, lead, copper, etc., and in many soils, as in iron pyrites—a combination of iron and sulphur. Sulphur, when united with oxygen and water in certain proportions, and under certain conditions, produces the *hydrated* sulphuric acid, or oil of vitriol.

**Sulphuric Acid**, or the Oil of Vitriol of commerce, technically termed 66° acid, contains anhydrous sulphuric acid, 75 parts, and 25 parts of water, in 100. This acid is extensively used in the arts and manufactures, and in the preparation of superphosphate of lime. It enters into the composition of all cultivated plants, and is usually found in small quantities in all soils, forming gypsum or land plaster. It is also found in some mineral waters. If needed by soils, the cheapest source at the command of the farmer is in gypsum or land plaster; every 100 lbs. of which, when pure, contain 46.51 lbs. of sulphuric acid.

## ELEMENTS COMBINING WITH OXYGEN TO FORM BASES.

**Calcium** is a solid of a light golden yellow color. It is harder than lead, and very malleable. It oxidizes slowly in air at the ordinary temperature; but when heated to redness it fuses and burns with a very brilliant white light, and is converted into lime, this lime being an oxide of calcium. This oxide occupies nearly the same position among bases as sulphuric acid does among acids, and is used in almost all the arts and manufactures.

**Oxide of Calcium**, or Quicklime, is composed of one equivalent or 20 parts of calcium, combined with one equivalent or 8 parts of oxygen.

**Carbonate of Lime**, or Limestone, is composed of oxide of calcium, combined with carbonic acid. When pure, every 100 lbs. of limestone contain 44 lbs. of carbonic acid, and 56 of oxide of calcium; so that one ton of pure limestone contains 11⅕ cwt. of oxide of calcium, or when burnt an equal amount of quicklime. Limestones generally contain a sensible quantity of mineral matter, as silica, magnesia, alumina, and oxide of iron, with traces of phosphoric acid, and sometimes potash and organic matter. This foreign matter, in the best quality of limestones, does not often exceed five per cent. When limestones are burnt, the carbonic acid is expelled, and the lime is left in the caustic state, as quicklime. When water is applied to quicklime great heat is developed, the lime swells and cracks, and finally falls to a fine bulky white powder. When quicklime is left in the open air, it gradually absorbs water from the atmosphere, and finally falls into a fine powder. In rich lime the increase of bulk by slaking may be 3 to 3½ times.

**Quicklime** on combination with water is converted into *hydrate of lime.* This hydrate consists of 75.68 lbs. of lime, and 24.32 lbs. of

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water chemically combined; hence 75.68 lbs. of quicklime, and 24.32 lbs. of water will produce 100 lbs. of hydrated or slaked lime. Quicklime has a great tendency to reabsorb carbonic acid, and, if spread on the soil and there slaked by absorbing moisture from the atmosphere, more than half of it would be changed back into limestone. Hence, lime should be slaked in large heaps, and would be still better preserved if these heaps were covered with sods. Lime can be applied to the soil, either in its natural state, as in limestone, or as burnt lime, or as hydrated or slaked lime, with beneficial results.

Marls are very rich in carbonate of lime, and some of the best varieties contain from 50 to 75 per cent. of it. By appropriate machinery limestone could be reduced to a fine powder more cheaply than by burning, where fuel is scarce and dear. Nevertheless, burnt lime is far superior to powdered limestone or marl for the purpose of agriculture; one of the reasons being that the slaking of lime reduces it to an impalpable powder, much finer than can be effected by the most perfect machinery. This extreme fineness of division diffuses it more uniformly through the soil, and makes it more readily soluble in water; 1000 lbs. of water will hold 1 lb. of slaked lime in solution: hence, if the annual rain-fall on an acre of land be seven million pounds, seven thousand pounds of hydrate of lime would be made soluble for the use of plants, if that amount were present.

Burnt lime is more beneficial than the carbonate, because it more readily neutralizes the acids contained in the soil, and causes the decomposition of the vegetable matter therein. This change is effected as follows: Most soils contain a considerable amount of organic or vegetable matter, surrounded by and saturated with an atmosphere of carbonic acid, which prevents free access of oxygen, the free access of which is absolutely necessary to the decomposition of this organic and vegetable matter Now, if burnt lime be intimately mixed with the soil, it absorbs this carbonic acid, and oxygen takes its place, and decomposition of this matter is the result. The lime, after indirectly producing this result, answers all the useful purposes of carbonate of lime in the form of ground limestone, and as it is found in marl; hence its greater value, independent of other considerations.

The office of lime in the liberation of nitrogen, as ammonia, from organic substances, is another valuable property. As nitrogen is an element necessary to the healthy growth of grains and plants used for food, its value herein is apparent.

Lime has also a beneficial effect on the inorganic or mineral matter in soils. Should iron be present, as iron pyrites, a compound of iron and sulphur; the lime, by absorbing carbonic acid and giving free access to the oxygen of the atmosphere, causes a rapid decomposition of this compound into peroxide, or rust of iron, and sulphuric acid. This acid at once unites with the lime and forms land plaster or gypsum in the soil.

The great source of potash and soda in soils is from the disintegration of rocks, such as felspar and granite. No matter how fine these rocks may be reduced, their valuable elements are scarcely at all soluble in water without previous chemical action. In these rocks, known to contain much potash and soda, there must be a chemical decomposition before the potash and soda can be available to plants. These silicates are slowly decomposed by the action of carbonic acid, but the action is much more rapid in the presence of lime; hence its great value for this purpose.

Another valuable property of lime is, that, in the presence of decaying organic matter, it will decompose common salt, forming carbonate of soda, and chloride of calcium; the latter being the most soluble form in which lime can be presented to plants.

The prominent chemical effects of lime in the soil being stated, we proceed to notice its physical effects, which are no less valuable and striking. It gives *lightness* and friability to heavy clay soils, thus facilitating the circulation of moisture, air and heat, as well as enabling the delicate roots to penetrate readily in all directions. It also gives sufficient *compactness* to loose, sandy soils, and corrects the leaching and washing out of the valuable fertilizing elements they contain.

The kind of spontaneous vegetation upon soils is a good indicator as to whether lime is needed, or may be used to advantage. In soils where sorrel, or the chestnut, and pine tree grow spontaneously, application of lime is useful, and such soils can seldom be cultivated profitably without it.

In relation to the application of lime, we would say, that it should at all times be kept as near the surface as possible, because its beneficial effects are greater in the presence of atmospheric air, and moisture. If placed too deep in the soil, these effects would be much less. The practice of spreading lime before the land is plowed, is not a good one, and ought to be discontinued. A better method is to apply it after the land is plowed, and previous to harrowing; this places it near the surface, and conforms to the conditions necessary to its maximum useful action on decaying vegetable matter, viz., free access of oxygen, light and heat. As the hydrate of lime is soluble in rain water, if placed near the surface, it will gradually permeate all parts of the soil, and perform all its useful functions beneath the surface, in the fixing and neutralizing of organic acids.

There are various opinions among farmers, as to whether it is more profitable to apply lime in large quantities at rare intervals, or in small amount yearly. There is an old saying that, "Lime enriches the fathers, but impoverishes the sons." This may in some cases be true. Lime is a great stimulant to the soil, as already shown, and if the amount added is too great for the amount of organic matter present, or the actual wants of the crops grown, there will be a waste of those valuable gases liberated from the decaying organic matter, and the store of this organic matter contained in the soil will be prematurely exhausted. The amount of lime added to an acre should not be less than forty or fifty bushels, and in cases where the physical condition of the soil requires changing, as in heavy clay soils, or those that contain a large amount of organic matter, from one hundred and fifty to two hundred bushels may be applied with advantage. The judgment of the farmer, aided by experience, is his best guide in this matter.

## SULPHATE OF LIME.

**Sulphate of Lime**, or Gypsum, is extensively applied to the soil as a manure; every 100 lbs. contain 46.51 lbs. of sulphuric acid, 32.56 lbs. of lime, and 20.93 lbs. of chemically combined water. The value of gypsum as a manure has been erroneously attributed to its absorbent properties in attracting and retaining moisture. Extended experiments have proved that it is almost destitute of any absorbing power; 100 parts of gypsum will absorb only 1 part of water in 12 hours, while loamy clay absorbs 25 parts, and ordinary soil 16 parts. These experiments were extended to 72 hours, but the gypsum absorbed no moisture after the first 12, which demonstrated that 1 part to 100 is the limit of its absorbent power; while loamy clay and ordinary soil absorbed in that time 35 and 23 parts, respectively. Professor Schuebler pertinently remarks, when speaking of this fact:—"Thus theories which are written down, often fall to nothing when tested by experiment."

The beneficial action of gypsum must be traced to some other cause. As it is composed of lime and sulphuric acid, the benefits resulting from its application must be due to one or both of these substances. Recent experiments of distinguished chemists, seem to prove that the action of gypsum is not due to its lime, except in a slight degree.

One great benefit derived from the use of gypsum, is in fixing the ammonia contained in the oil and the atmosphere. When gypsum and carbonate of ammonia are brought into contact, under certain conditions, double decomposition takes place, resulting in the formation of sulphate of ammonia, and carbonate of lime. These facts prove that the benefits derived from the application of gypsum are principally due to its sulphuric acid, which we have already treated under that head.

If lime is the substance needed, it can be applied more cheaply as quicklime. · The application of gypsum in small or large quantities is often attended with equally beneficial results. This can be explained by the fact that it requires from four to five hundred pounds of water to bring one pound of plaster into solution; hence only a small quantity of it can become available in a season, and only that amount need be applied.

## MAGNESIUM.

**Magnesium** is a white, malleable solid, resembling silver. It is not altered by dry air, at the ordinary temperature, but is tarnished when exposed to moisture. When heated to dull redness in atmospheric air or oxygen, it burns with a vivid light, and is converted into magnesia, or the oxide of magnesium.

**Magnesia** is the only oxide formed by magnesium; it contains in 100 lbs., 60.4 lbs. of magnesium, and 39.6 lbs. of oxygen. Its action on soils is somewhat similar to that of lime. It is uniformly present in variable quantities, in almost all limestones, and when they contain a large amount, they are called magnesian limestones; some varieties contain over fifty per cent. of this substance.

Should soils need magnesia, and not conveniently applicable in combination with lime as magnesia limestone, Epsom salts, or sulphate of magnesia, can be substituted; and many farmers have found it profitable to apply magnesia in this form. A crop of twenty-five bushels of wheat, with the straw, would require about 11lbs. of magnesia, or 63 lbs. of Epsom salts. Little more need be said about this element, and as it is found in nearly all soils, it seldom requires to be added as a fertilizer. It has been noticed by farmers, that lime which contains a notable amount of this substance, has a more favorable effect on a wheat crop than lime containing but little of it. Nevertheless, lime that contains a very large quantity of magnesia may be injurious if the soil already contains a sufficient quantity; because magnesia, in its caustic state, does not absorb carbonic acid nearly so readily as burnt lime, but remains in the soil in this state for a much longer period; besides, it will harden into a cement beneath the surface, and lessen the friability and porosity of the soil, and interfere with the growth of the rootlets.

Magnesia in large quantity might be applied to the soil in the form of ground magnesian limestone; the magnesia in such state would be gradually liberated by the acids of the soil, and rendered available for the wants of plants as it is needed.

## IRON.

**Iron** is a solid that is most widely distributed. There is scarcely a rock or soil, plant or mineral, but contains traces of it, and it scarcely ever becomes necessary to employ it as a manure. Iron unites with oxygen in two proportions, forming the protoxide and peroxide of iron. These combinations are gradually effected in a moist atmosphere.

**Protoxide of Iron**, when pure, is presented in the form of a black powder. The scale falling from heated iron is largely composed of it. Its presence in a large amount in a soil is very injurious to growing vegetation. Protoxide of iron is one equivalent of iron combined with one equivalent of oxygen.

**Peroxide of Iron**, or red rust, is composed of two equivalents of iron combined with three equivalents of oxygen, and is technically called "sesquioxide of iron." The presence of oxidizing iron in a soil liberates free hydrogen, which, uniting with the nitrogen contained in the soil, forms ammonia. As the rust of iron has slight acid properties, it has an affinity for ammonia, and fixes and retains this valuable substance in a soluble form in the soil. Quite probably the injurious effect of the presence of a large amount of iron in any cultivated soil, is due to its attraction of oxygen, thus interfering with the oxidation of organic substances in the soil. Such soils should be frequently cultivated, and the particles pulverized as fine as possible, so as to expose every part of it to the action of the oxygen of the atmosphere, which facilitates the formation of the peroxide or red rust of iron; hence soils containing a large amount of iron acquire a deeper red color under cultivation. Two advantages are gained by cultivating such soils: First, The hastening of the formation of the peroxide of iron; Second, The benefits derived by the action of this oxide, in absorbing certain kinds of plant-food present in the soil. Thus forming a storehouse of these substances for the future use of plants.

**Sulphate of Iron** is formed in soils that contain the elements of sulphur and iron. This compound, when present in large amount, is injurious to vegetation. And there are few soils that do not contain some of it; and it is often found in low, marshy lands. Soils that contain it in such quantity as to be injurious, are very much benefited by the addition of lime, or marl; the lime uniting with the sulphuric acid of the sulphate to form gypsum. Iron pyrites, reduced to a fine powder, may be applied in small quantity very advantageously to some soils, when iron and sulphuric acid are deficient, and the soil abounds in carbonate of lime. But, should the soil be deficient in lime, it should be applied at the same time either as quicklime or marl. The application of gypsum is not necessary to soils that contain iron pyrites, as by the application of lime to such soils it would be formed more cheaply.

## POTASSIUM.

**Potassium** is a solid; and was discovered by Sir H. Davy, in 1807. It is silver-white in color, and lighter in weight than water. If a globule of potassium be dropped upon the surface of water, it instantly takes fire, and burns with a beautiful violet colored flame. Potassium oxidizes readily in the air, and in water; in the latter case, the hydrogen being liberated, and the oxygen of the water uniting with the potassium, forms the *hydrate of potassa*—the *caustic potash of commerce.*

**Potash**, when strictly pure, is white and highly caustic, destroying both animal and vegetable substances, when brought in contact with it. It melts at a red heat, and assumes a crystalline appearance upon cooling. It requires half its weight of water to enter into solution, which is accompanied with the evolution of considerable heat. It is soluble also in alcohol. Solutions of potash are highly alkaline, neutralizing the strongest acids.

Potash is a valuable element in the composition of plants. The ash of cultivated plants is generally richer in this substance than is that of those growing spontaneously. Potash is found in most mineral waters, in most soils, and always in plants. Potash is often found in nature, in combination with nitric acid, forming nitre, or saltpetre, which, in some hot countries, forms incrustations on the surface. Such incrustations are found in India, Arabia, and South America; also in certain caverns in Ceylon, and some other parts of the world. Saltpetre, as found in these incrustations or deposits, is always contaminated with the nitrate of lime, magnesia, or soda, or with their chlorides and sulphates.

Potash, as before stated, exists in plants; in general, combined principally with organic acids. This potash may be extracted from the ashes of wood and plants, by lixiviation with lime and water. If the water of the caustic lye thus produced be evaporated, and the residue be calcined, in order to eliminate any organic matter remaining, crude caustic of potash is produced. This crude substance contains about 60 per cent. of potash, mixed with various impurities, together with a considerable amount of chloride of potassium (muriate of potash), and sulphate and silicate of potassa. This crude potash is largely used in the manufacture of soap and glass; and, until the recent discovery of extensive deposits of crude potash salts at Stassfurth, in Prussia, was the source of most of the salts of potassa used in the arts and in medicine.

The value of wood ashes as a manure was known at an early period. The old Roman farmers used it, and practised paring and burning the soil, and also burnt the stubble of their wheat fields, in order to enrich the succeeding crop; a practice which was also prevalent among the ancient Jews. Cato recommends the burning of leaves and branches of trees, and spreading the ashes upon the land. According to Pliny, the ancient Britons used to burn their wheat straw and stubble, and scatter the ashes upon the land.

On the farm, no substance containing potash should be allowed to go to waste. Every particle of wood ashes, leached and unleached, should be applied to the soil, together with the ashes of dead branches of trees, of weeds and of leaves, and of whatever contains potash. By this means the farmer may often obtain a supply, more cheaply than in any other shape.

## SODIUM.

**Sodium** is a solid; and was discovered by Sir H. Davy, in 1807. It is lustrous, and of a yellowish-white color, more nearly resembling silver than potassium, to which, in other physical properties, it is similar. When heated in air or oxygen, it burns with a bright yellow flame. Like potassium, it is lighter than water, which it decomposes with great rapidity, liberating the hydrogen and combining with the oxygen, thus forming soda, which, having an affinity for water, combines with a certain amount of it, and becomes the hydrate of soda—*caustic soda of commerce.* Soda was originally obtained from the ashes of marine plants, but is now obtained in large quantities by the decomposition of common salt.

**Nitrate of Soda**, like that of potash, occurs as an incrustation on the surface of the earth, in some places, especially in Chili and Peru, where it is found in beds of considerable thickness. Large quantities of this nitrate are used as manure to furnish nitric acid and soda to the soil. But as most soils contain soda in sufficient quantity for the wants of vegetation, the chief value of this product is due to the nitric acid which it contains, and which is a source of nitrogen.

**Soda** enters into the composition of plants, but in much less quantity than potash. Some think that if there is a deficiency of potash, soda may wholly take its place; but this opinion has not, so far as we are informed, been verified in practice. The cheapest mode of furnishing soda to soils is in the form of common salt.

**Common Salt** occurs abundantly in nature, both in the earth and in sea water. It is composed of *chlorine* and *sodium*; 100 parts, when pure, containing 60.68 of chlorine, and 39.32 of sodium. Salt has been applied as manure in all ages and countries; and yet there is no substance used as manure that has been the subject of so much controversy among practical farmers, some denying that it exerts any beneficial influence, while others ascribe to it wonderful manurial properties. Common salt may be detected in nearly all soils, and its elements are found in the ash of almost all plants.

**The action of Salt** in small quantity in soils, generally, is to assist in decomposing the vegetable and animal matter present. In large quantity it is very injurious, in fact, making the land completely sterile. Hence the practice in ancient times of sowing large quantities of salt upon the land surrounding conquered cities, thus indicating the will of the conqueror, that the land should be desolate and the conquered city no longer habitable.

Some plants and trees are injured by salt much more readily than others. When applied in excess to some fruit trees, as the apple, plum, cherry and apricot, the leaves wither and die within a short time; the willow, poplar and beech are affected in the same way. On the other hand, some species of oak, the mulberry, the pear, and the peach, and some other trees with deep roots, do not suffer from its application; neither do asparagus, onions, celery, etc.: indeed, the growth of these plants is improved by its use.

Salt acts as an exterminator of some kinds of insects in the soil. It has likewise been found effective in destroying the wire-worm, and in preventing mildew and rust. The danger of its

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application for the destruction of vermin is in the fact that, if the solution be strong enough to effect the object, it may destroy the vegetation also.

If there is sufficient salt in the soil to supply soda and chlorine to the plant, it is not advisable to add more for any physical effect it may produce in the decomposition of organic substances; and generally, as an excess is very injurious, it should in all cases be applied with great caution. As an example of the small amount generally required, we may state that a crop of 25 bushels of wheat, together with the straw, contains only a little more than 5 lbs. of soda, and 2½ lbs. of chlorine, which 10 lbs. of common salt will furnish.

If soda alone, and not chlorine is needed, it can be cheaply supplied in the form of sulphate of soda or salt cake, which is a by-product in the manufacture of hydrochloric acid, and in which the chlorine of the salt is replaced by sulphuric acid.

# CHAPTER III.

THE COMPOSITION OF PLANTS—SHOWING ALSO THE AMOUNT OF THE DIFFERENT ELEMENTS NECESSARY TO BE ADDED AS MANURES TO PRODUCE A GIVEN CROP.

**Plants** of the *same* kind have nearly a like composition; and the relative proportions of the elements that enter into the composition of *different* plants are almost always the same in each particular species. The ashes of the same kind of plants, though grown on different soils, closely resemble each other in chemical composition. There may be a slight diminution of some particular element, from a lack of it in the soil; but the variation can never be large enough to materially affect the value of the plant for food.

**Wheat and Corn,** if produced at all, must be produced of nearly a standard quality; that is, with a certain quantity of the different elements. If the grains of wheat or corn could grow and ripen without the aid of nitrogen or ammonia, they would lack one of the most essential elements of nutrition, viz., the power of renewing the blood, the nervous tissues and muscular fibre; or, if the plant could grow and the seed ripen without the aid of phosphoric acid, there would be no substance furnished to build up the bones; or, if it lacked the three elements of nitrogen, lime and phosphoric acid, it would afford scarcely anything to the animal body, except carbon, for furnishing animal heat. The wheat and seeds found in the catacombs of Egypt, where they have lain two or three thousand years, have almost an identical composition with those grown at the present time. The wheat grown in this country has very nearly the same composition as that grown in other parts of the world. Hence, as there can be but very little variation in the composition of each species of plants used for food, while the physical laws of nature remain as they now are, there can, consequently, be no variation in the kind and quantity of the elements required by plants to enable them to come to maturity.

When a knowledge of the nature of these elements is acquired, and the quantity necessary for a given crop ascertained, the accumulation of these materials is just as simple as that of furnishing the raw material for any manufacture. Accurate knowledge of those substances in soils that render them fertile when present, and barren when absent, should be the first lesson of the farmer who wishes to be successful in his business and pursue it on a rational basis.

The methods employed for manuring and cultivating lands vary in different countries, and in different sections of the same country. Certain local circumstances seem to control these differences; but in most cases they are only the result of custom or ignorance. Hence, if we inquire in what manner manure acts, we are likely to receive the following answer, even from otherwise intelligent men:—"Its action is a mystery; we know that we cannot raise crops without it, and hence we use it in our soils." The excrements of men and animals are supposed by them to contain a mysterious something, which assists the growth of plants, and increases the amount of production; and the more filthy and unsavory the substance, the more value it is supposed to contain.

Accurate knowledge of the constituents of different cultivated plants is all important; we should know what we are going to produce; otherwise how can we work intelligently to produce it.

All plants cultivated for the use of man may be classified as follows:

I. **Potash Plants**—the ash of which contains more than half its weight of alkaline bases—potash and soda. Among the cultivated potash plants, are indian corn, beets, turnips and potatoes.

II. **Lime Plants**—the bulk of the ash of which is composed of the salts of lime and magnesia. Among these are beans, peas, clover and tobacco.

III. **Silica Plants**—those in which silica predominates. Among these are wheat, rye, oats and barley.

This is only a general classification. The farmer should know the actual amount of each of the elements of fertility required by an average crop of any kind of plant he cultivates. A field properly prepared for culture ought to contain a *sufficient quantity* of *all* the inorganic materials required for the intended crop, and in *a form adapted for assimilation* by the plant; together with a certain amount of ammoniacal salts or nitrates and decaying vegetable matter. For instance, if it is the intention of the farmer to raise potatoes, he should know that both *lime* and *potash* are required, and what quantity of each; for the potatoe belongs to the *lime* plants, as regards its *leaves*, and the *potash* plant as regards its *tubers.* In raising beets, *phosphate of magnesia* is required, and only a small quantity of *lime;* but in growing turnips *much* phosphate of lime is required, and only a *small* quantity of magnesia.

To make this subject intelligible and of great value to the farmer, we shall give tables showing the composition of the grain and straw, and the roots and tops of the plants commonly cultivated. A study of these tables will amply repay him, by giving *accurate knowledge* of the composition of plants, which is the *only key* to what *is needed in manures* to produce them. It will also, in connection with a knowledge of the constituents of his soil, enable him to understand the philosophy of a rotation of crops, and to select that which is best suited to his land, and the manures at his command; and especially enable him to estimate the value of the waste products of his farm, and to apply them to the best advantage.

All plants and seeds cultivated for food contain albumen and starch; the starch and sugar are produced in the plant from carbonic acid and water; the albumen and gluten result from the mutual action of the same compounds, together with ammonia, or nitric acid, and certain sulphates and phosphates, but the manner by which this is effected is a mystery that has not been fully solved by the most laborious investigation. Plants are valuable as food in proportion to the amount of albumen and starch they contain.

Table showing the percentage of moisture; of albuminous and glutinous compounds; of starch, gum, sugar and woody fibre; and of ash and nitrogen, and the equivalent in ammonia contained in the different products. It also shows their relative value as food:

| | Moisture. | Albuminous and Glutinous Compounds. | Starch, Gum, Sugar, and Woody Fibre. | Ash. | Total. | Nitrogen. | Equivalent in Ammonia. |
|---|---|---|---|---|---|---|---|
| Common Grass......... | 48·00 | 2·06 | 47·74 | 2·20 | 100·00 | 0·33 | 0·40 |
| Clover Hay........... | 16·00 | 8·12 | 68·38 | 7·50 | 100·00 | 1·30 | 1·58 |
| Barley Straw.......... | 10·94 | 1·80 | 82·12 | 5·14 | 100·00 | 0·35 | 0·42 |
| Oat Straw............. | 8·25 | 2·15 | 84·50 | 5.10 | 100·00 | 0·39 | 0·47 |
| Wheat Straw.......... | 6·42 | 1·80 | 86·66 | 5·12 | 100·00 | 0·35 | 0·42 |
| Corn Stalks............ | 10·20 | 1·08 | 83·22 | 5.50 | 100·00 | 0·24 | 0·29 |
| Carrots................ | 85·20 | 1·50 | 12·40 | 0·90 | 100·00 | 0·24 | 0·29 |
| Turnips................ | 90·43 | 1·35 | 7·72 | 0·50 | 100·00 | 0·21 | 0·25 |
| Potatoes............... | 75·00 | 2·20 | 21·90 | 0·90 | 100·00 | 0·35 | 0·42 |
| Peas.................. | 10·80 | 23·40 | 62·70 | 3.10 | 100·00 | 3·74 | 4·54 |
| Beans.................. | 8·75 | 22·81 | 65·04 | 3·40 | 100·00 | 3·65 | 4·43 |
| Indian Corn........... | 15·00 | 11·25 | 70·75 | 3·00 | 100·00 | 1·18 | 1·43 |
| Rye..................... | 10·00 | 10·57 | 77.33 | 2.10 | 100·00 | 1·69 | 2·05 |
| Oats.................... | 10·10 | 14·20 | 67·20 | 3·50 | 100·00 | 2·27 | 2·75 |
| Barley.................. | 8·75 | 14·50 | 73·10 | 3·65 | 100·00 | 2·32 | 2·81 |
| Wheat.................. | 8·55 | 19·50 | 69·10 | 2·85 | 100·00 | 2·41 | 2·92 |
| Buckwheat............. | 5·20 | 9·50 | 83·10 | 2·20 | 100·00 | 1·52 | 1·84 |
| Rice.................... | 15·10 | 6·27 | 78·23 | 0·40 | 100·00 | 1·00 | 1·21 |
| Cotton Seed Cake...... | 12·00 | 35·00 | 34·50 | 4·50 | 100·00 | 5·60 | 6·80 |

**Albumen and Gluten** contain nitrogen; and this nitrogen renews the blood and builds up the lean muscular part of the body. Besides, albumen and gluten enter into the composition of the bones.

**Starch and Gum** contain no nitrogen, but are rich in carbon. This carbon is required to produce and keep up the animal heat of the body. Men and animals when healthy and taking plenty of exercise, by which their respiration is quickened, and especially in cold weather, require large amounts of carbon, which uniting with the oxygen of the atmosphere forms carbonic acid. This chemical union is, strictly speaking, a combustion of the carbon, similar to that of a slow fire, and produces the animal heat of the body. The chemical composition of starch, gum, and sugar are analogous. The fat of animals, if pure, contains no nitrogen, but it is composed of carbon, hydrogen, and oxygen. Should an animal be debarred from exercise and fed upon a substance rich in carbon, as indian corn or rice, it would rapidly increase in fat. Carnivorous animals are nearly destitute of fat, while domestic stall-fed animals acquire a large amount of it. If the fattened animal is allowed exercise, or set to work, the fat quickly disappears.

Dogs and cats, when fed on a mixed diet, accumulate fat; so that by feeding them with food containing a large amount of carbon, and a small amount of nitrogen, and allowing them but little exercise, the increase of fat can be controlled at pleasure.

**Woody Fibre** is rich in carbon, but it is not in a form to be readily assimilated on account of its insolubility. For this reason, the carbon contained in wheat, in corn, and in potatoes, in the form of starch and gum, is the principal source of supply for man. Woody fibre can be changed to starch and sugar in the laboratory of the chemist, but the digestive organs of men and animals are inadequate to the production of this result; otherwise, animals might be fattened on saw-dust or pine shavings.

The process of fattening depends upon the fact, that too small an amount of oxygen is taken into the system by respiration to consume the carbon in the food, the unconsumed part being in such case changed into fat. Hence it is, that animals at rest, or taking but little exercise, if fed upon food containing much starch or gum, fatten rapidly; because then respiration being less frequent and full, too small an amount of oxygen is taken into the lungs to consume the carbon. The foregoing Table also furnishes information as to the *relative value* of the several grasses and grains named for fattening.

**Table** showing the amount of inorganic and mineral substances usually found in 100 lbs. of the plants named in their marketable condition:—serves as a key to the application of the proper elements, as fertilizers.

| | Chlorine. | Lime. | Magnesia. | Silica. | Oxide of Iron. | Potash. | Soda. | Phosphoric Acid. | Sulphuric Acid. |
|---|---|---|---|---|---|---|---|---|---|
| Wheat............. | 0·01 | 0·09 | 0·31 | 0·07 | 0·02 | 0·80 | 0·08 | 1·00 | 0·12 |
| Wheat Straw........ | 0·07 | 0·40 | 0·17 | 4·77 | 0·05 | 0·79 | 0·11 | 0·37 | 0·17 |
| Rye................ | 0·02 | 0·07 | 0·23 | 0·52 | 0·02 | 0·57 | 0·09 | 0·91 | 0·50 |
| Rye Straw.......... | 0·07 | 0·41 | 0·15 | 3·01 | 0·04 | 0·80 | 0·11 | 0·27 | 0·10 |
| Barley............. | 0·02 | 0·05 | 0·17 | 0·53 | 0·01 | 0·44 | 0·14 | 0·67 | 0·12 |
| Barley Straw....... | .... | 0·44 | 0·14 | 3·44 | .... | 1·29 | 0·24 | 0·27 | 0·22 |
| Oats............... | 0.01 | 0·11 | 0·21 | 0·13 | 0·01 | 0·46 | 0·07 | 0·63 | 0·45 |
| Oat Straw.......... | 0·16 | 0·37 | 0·19 | 2·47 | 0·04 | 1·00 | 0·30 | 0·20 | 0·16 |
| Buckwheat.......... | .... | 0·13 | 0·20 | 0·02 | 0·02 | 0·17 | 0·40 | 1·00 | 0·44 |
| Buckwheat Straw.. | 0·46 | 1·10 | 0·21 | 0·33 | .... | 2·76 | 0·13 | 0·61 | 0·31 |
| Indian Corn........ | 0·08 | 0·03 | 0·27 | 0·08 | 0·02 | 0·52 | 0·26 | 0·89 | 0·10 |
| Corn Stalks........ | .... | 0·59 | 0·31 | 2·72 | 0·09 | 1·99 | 0·07 | 0·45 | 0·28 |
| Peas............... | 0·04 | 0·14 | 0·19 | 0·02 | 0·02 | 1·00 | 0·08 | 0·87 | 0·11 |
| Pea Straw.......... | 0·31 | 1·94 | 0·36 | 0·27 | 0·07 | 1·07 | 0·28 | 0·35 | 0·30 |
| Beans.............. | 0·02 | 0·25 | 0·17 | 0·24 | 0·09 | 1·34 | 0·05 | 0·96 | 0·13 |
| Bean Straw......... | 0·43 | 1·51 | 0·43 | 0·33 | 0·10 | 1·96 | 0·52 | 0·47 | 0·13 |
| Potatoes........... | 0·01 | 0·01 | 0·02 | 0·01 | 0·06 | 0·20 | ..... | 0·06 | 0·02 |
| Beets.............. | 0·01 | 0·03 | 0·04 | 0·02 | 0·04 | 0·21 | 0·05 | 0·06 | 0·02 |
| Carrots............ | 0·04 | 0·09 | 0·04 | 0·02 | 0·07 | 0·29 | 0·16 | 0·08 | 0·05 |
| Turnips............ | 0·03 | 0·08 | 0·02 | 0·01 | 0·02 | 0·32 | 0·06 | 0·07 | 0·08 |

The foregoing Table exhibits the average results of many analyses of the plants named, by the most distinguished agricultural chemists of this country and Europe. It must not be supposed that it gives the exact composition in every case. Still it is near enough for all practical purposes, and furnishes a very reliable guide to manuring.

We shall now show the different amounts of inorganic and mineral substances required by a good crop of different plants, on an acre of land. This information will show the relative value of manures and fertilizers in producing crops, and the kind and amount required.

It is a fact known to farmers, that if they can raise good crops of wheat on their land, they can raise a good crop of almost any other plant adapted to the climate and soil. Hence, a study of the wheat crop will serve to show all the essential elements of fertility. In 100 parts or pounds of wheat, about 97½ are combustible, being carbon and nitrogen, and the elements of water—hydrogen and oxygen; and of the straw from 92 to 94 parts are also combustible.

The grain and straw of wheat has the average chemical composition shown in the following Table:

| | Grain. | Straw. |
|---|---|---|
| Carbon | 46·10 | 48·48 |
| Hydrogen | 5·80 | 5·41 |
| Oxygen | 43·40 | 38·79 |
| Nitrogen | 2·29 | ·35 |
| Ash | 2·41 | 6·97 |
| | 100·00 | 100·00 |

The greatest proportional difference in the combustible part of wheat and its straw is in the relative amount of nitrogen. The reader will notice that there is in equal weights nearly seven times as much nitrogen in the grain as in the straw. If the farmer had to rely on decaying straw to furnish the necessary amount of nitrogen, it would require 700 lbs. of straw to furnish enough for 100 lbs. of the grain of wheat, and a crop of 25 bushels to the acre, or 1500 lbs. of wheat, would require over five tons of straw to furnish the nitrogen required. On the other hand, one half of this amount will furnish the phosphoric acid and the other elements required for the grain. But, if the farmer manured with pea straw, or clover, the case would be different, as the following analyses of clover and pea straw will show:

| | Pea Straw. | Clover Hay. |
|---|---|---|
| Carbon | 45·80 | 47·40 |
| Hydrogen | 5·00 | 5·00 |
| Oxygen | 35·57 | 38·60 |
| Nitrogen | 2·31 | 1·30 |
| Ash | 11·32 | 7·70 |
| | 100·00 | 100·00 |

Pea straw contains as much nitrogen, weight for weight, as wheat; and when cut in proper time and cured properly, it makes the best of fodder and the best of manure. Clover is very nearly as valuable for both purposes.

The ash left after carefully burning the seeds and straw or stems of cultivated plants, is very nearly the same in chemical composition for each variety. The variations found are no greater than might be expected from the influence of climate and soil. The farmer should uniformly determine to raise a maximum amount from each cultivated acre of his land. This result is nearly as much under his command, as that of the mechanic or laborer who commences the work of the day with a determination of performing a certain amount of work, and who but for that determination, and the proper use of his tools or hands, would accomplish much less.

The following amounts of different crops have been year after year raised from an acre of ordinary land, by the proper application of manures:

| | | | | | |
|---|---|---|---|---|---|
| Wheat...... | 25 | bushels. | Corn ...... | 50 | bushels. |
| Rye ......... | 30 | " | Oats ...... | 50 | " |
| Buckwheat.. | 30 | " | Barley..... | 30 | " |
| Potatoes .. | 100 | " | Two tons of Hay. | | |

"What has been done can be done again;" and why should it not? A *determination to do*, and the application of the proper means, are all that is required. Only when such crops are raised, can farming be said to be a successful and remunerative business. How common is the complaint among our farmers, that after allowing ordinary wages for their own labor, and paying expenses, they do not realize legal interest on the money invested in their land and improvements. This need not and should not be the case. In many parts of England, more is paid yearly as rent than would purchase land equally as good in this country; yet these renters not only live well, but frequently become wealthy. We will now show what quantity of the elements that can be applied as manures the above named crops contain.

## WHEAT.

Twenty-five bushels of wheat, of 60 lbs. to the bushel, the estimated product of an acre, weigh 1500 lbs.; the straw for this weight of grain will average 3000 lbs. The wheat and straw contain the following weights of the elements, which is the amount of each *taken from each acre of land by such a crop:*

| | Grain. | Straw. | Total. |
|---|---|---|---|
| * Ammonia........ | 41·71 lbs. | 10.18 lbs. | 51·89 lbs. |
| Phosphoric acid.. | 15·00 " | 11·10 " | 26·10 " |
| Sulphuric acid... | 1·80 " | 5·10 " | 6·90 " |
| Lime............ | 1·35 " | 12·00 " | 13·35 " |
| Magnesia........ | 4·65 " | 5·10 " | 9·75 " |
| Potash .......... | 12·00 " | 23·70 " | 35·70 " |
| Silica............ | 1·05 " | 143·10 " | 144·15 " |

The Table shows also the relative amounts of the different elements required to raise wheat.

* In this and similar cases the "elements of ammonia" are meant.

The reader will notice the large amount of *silica* required for the straw. Too little attention has been given to economizing this substance, silica, by wheat growers in this country. In building up the structure of the straw, *soluble silica* is indispensable. The straw and the roots constitute the chemical apparatus for the preparation and assimilation of the different elements required by the grain itself. Hence it is evident, that if there is not enough of soluble silica to give this preliminary structure its proper development. there will be only a small amount of grain produced, however rich the soil may be in the other elements required.

**Silica** to be available to the plant must be in a *soluble* condition; and, as the farmer must wait for the slow formation or liberation of this substance in the soil, the alternating of wheat with other crops that require but little of it, will allow time for it to accumulate in the soil for the raising of wheat crops at proper intervals.

## INDIAN CORN.

Fifty bushels of corn—the estimated crop of an acre—of 58 lbs. to the bushel = 2900 lbs. This weight of corn will require 3000 lbs. of stalk and cob (when dry), and will contain :—

| | Grain. | Stalk and Cob. | Total. |
|---|---|---|---|
| Ammonia | 34·22 lbs. | 6·00 lbs. | 40·22 lbs. |
| Phosphoric acid | 25·81 " | 13·50 " | 39·31 " |
| Sulphuric acid | 2·90 " | 8·40 " | 11·30 " |
| Lime | ·87 " | 17·70 " | 18·57 " |
| Magnesia | 7·83 " | 9·30 " | 17·13 " |
| Potash | 15·08 " | 59·70 " | 74·78 " |
| Silica | 2·32 " | 81·60 " | 83·92 " |

The reader will notice that Indian corn requires much more phosphoric acid and potash than wheat, while the amount of ammonia is only a little more than half as much; consequently, its nutritive properties as food are in about the same proportion; that is, in proportion to the ammonia. Corn stalks contain a large amount of potash and silica, and, when properly prepared as manures, will furnish these elements for other crops. From the comparatively small amount of ammonia required by the corn crop, it can be raised at less cost to the soil than wheat, because ammonia is one of the most costly of the organic elements.

## RYE.

Thirty bushels—the estimated product of an acre—of 50 lbs. to the bushel = 1500 lbs.; the same weight as 25 bushels of wheat. This crop requires at least 3000 lbs. of straw. The grain and straw contain:

| | Grain. | Straw. | Total. |
|---|---|---|---|
| Ammonia | 34·05 lbs. | 8·70 lbs. | 42·75 lbs. |
| Phosphoric Acid | 13·65 " | 8·10 " | 21·75 " |
| Sulphuric Acid | 7·50 " | 3·00 " | 10·50 " |
| Lime | 1·05 " | 12·30 " | 13·35 " |
| Magnesia | 2·25 " | 4·50 " | 6·75 " |
| Potash | 8·55 " | 24·00 " | 32·55 " |
| Silica | 7·80 " | 90·00 " | 97·80 " |

By comparing the above Table with the one giving the composition of wheat, the reader can understand why larger *continuous* crops of rye than of wheat can be raised from the same soil; because rye does not require so much of those elements which are first exhausted in soils as wheat does. In like manner, by studying the composition of different crops, and noting the amounts of the different elements required to produce them, we can understand why farmers should have a dollar for a bushel of wheat, when corn is selling at fifty cents, and rye at seventy-five. Such an examination shows that the quantity, and consequently the price of any crop, are naturally regulated by the amount of certain valuable substances required for its production.

## OATS.

Fifty bushels of oats—the estimated product of an acre—of 33 lbs. to the bushel = 1650 lbs. This amount of grain requires about 2000 lbs. of straw. The grain and straw contain:

| | Grain. | Straw. | Total. |
|---|---|---|---|
| Ammonia............ | 37·45 lbs. | 7·80 lbs. | 45·25 lbs. |
| Phosphoric Acid...... | 10·39 " | 4·00 " | 14·59 " |
| Sulphuric Acid....... | 6·62 " | 3·20 " | 9·82 " |
| Lime................ | 1·81 " | 7·40 " | 9·21 " |
| Magnesia............ | 3·47 " | 3·80 " | 7·27 " |
| Potash.............. | 7·59 " | 6·00 " | 13·59 " |
| Silica................ | 2·14 " | 45·40 " | 47·54 " |

The reader will note the large amount of ammonia required by this crop. This accounts for the nutritive properties of the grain and straw. The amount of phosphoric acid and potash is small compared with that of other cereals.

## BARLEY.

Thirty bushels of barley—the estimated product of an acre—of 48 lbs. to the bushel = 1440 lbs. The straw weighs 2000 lbs. The grain and straw contain:

| | Grain. | Straw. | Total. |
|---|---|---|---|
| Ammonia........ | 33·40 lbs. | 7·60 lbs. | 41·00 lbs. |
| Phosphoric Acid. | 9·64 " | 5·40 " | 15·04 " |
| Sulphuric Acid... | 1·73 " | 4·40 " | 6·13 " |
| Lime............ | ·72 " | 8·80 " | 9·52 " |
| Magnesia........ | 2·44 " | 2·80 " | 5·24 " |
| Potash.......... | 6·33 " | 25·80 " | 32·13 " |
| Silica............ | 7·63 " | 68·80 " | 76·43 " |

Oat and barley straw are good manures, as they are rich sources of nitrogen, containing, as they do, a large percentage of ammonia. From this cause also, they make good fodder for cattle. Only a small amount of phosphoric acid and potash is required for these straws, while the amount of silica is only one half of that required for wheat straw.

## BUCKWHEAT.

Thirty bushels of buckwheat—the estimated product of an acre—of 40 lbs. to the bushel = 1200 lbs. The straw weighs about 2000 lbs. The grain and straw contain:

| | Grain. | Straw. | Total. |
|---|---|---|---|
| Ammonia........ | 18·24 lbs. | 1·20 lbs. | 19·44 lbs. |
| Phosphoric Acid. | 12·00 " | 12·20 " | 24·20 " |
| Sulphuric Acid.. | 5·22 " | 6·20 " | 11·42 " |
| Lime......... ... | 1·56 " | 22·00 " | 23·56 " |
| Magnesia........ | 2·40 " | 4·20 " | 6·60 " |
| Potash............ | 2·04 " | 55·20 " | 57·24 " |
| Silica............ | 0·24 " | 6·60 " | 6·84 " |

The reader will notice that this crop requires a large amount of potash, while the amount of ammonia and phosphoric acid is comparatively small. The potash seems to take the place of silica in the formation of the straw, as only a small amount of that substance is required. As this straw contains very little ammonia, it is almost worthless as fodder; but as manure it is valuable for its phosphoric acid, lime and potash.

## POTATOES.

One hundred bushels of potatoes, of 60 lbs. to the bushel = 6000 lbs. of tubers. The tops, when dry, weigh about 3000 lbs.; and the tops and tubers of such a crop contain:

| | Tubers. | Tops. | Total. |
|---|---|---|---|
| Ammonia...... | 21·00 lbs. | 1·50 lbs. | 22·50 lbs. |
| Phosphoric Acid | 33·00 " | 18·00 " | 51·00 " |
| Sulphuric Acid. | 12·60 " | 15·50 " | 28·10 " |
| Lime.......... | 4·20 " | 55·00 " | 59·20 " |
| Magnesia....... | 7·80 " | 10·50 " | 18·30 " |
| Potash......... | 109·00 " | 70·00 " | 179·00 " |
| Silica.......... | 13·00 " | 30·00 " | 43·00 " |

Twenty bushels of wheat require 15 lbs. of phosphoric acid for the grain, and 11 lbs. for the straw; while 100 bushels of potatoes require double this amount. Hence, two medium crops of wheat exhaust only as much of this valuable element as one crop of potatoes. Also, only one-sixth the amount of potash required for potatoes is necessary for the wheat crop. In raising potatoes, few farmers supply a sufficient amount of phosphoric acid and potash. Hence, this plant and its tubers have become constitutionally deteriorated on most farms, and liable to speedy decay. A bushel of potatoes contains only about one-seventh the amount of nitrogen contained in a bushel of wheat, and its nutritive value for the production of blood and muscle is in the same proportion.

## CLOVER HAY.

Two tons, or 4000 lbs., of dried clover may be considered an average crop per acre. This amount contains:

| | | | |
|---|---|---|---|
| Ammonia | 52·00 lbs. | Lime | 75·00 lbs. |
| Phosphoric Acid | 19·76 " | Magnesia | 21·00 " |
| Sulphuric Acid | 7·50 " | Potash | 80·69 " |
| Silica | 18·65 lbs. | | |

Clover requires a large amount of potash and ammonia, while the amount of silica required is small. Great benefits are realized by growing this crop; it sends its roots deep into the soil, and brings up the phosphate and sulphate of lime, also potash and magnesia; and when the clover is plowed under, as a green manure, it furnishes a large amount of the nitrogen required for a heavy crop of wheat.

**All Root Crops** require a rich soil to do well. Twenty tons of Turnips or Carrots, with the tops, —which is a large crop for an acre,—require:

| | Turnips. | Carrots. |
|---|---|---|
| Ammonia | 42·00 lbs. | 48·00 lbs |
| Phosphoric Acid | 45·00 " | 39·00 " |
| Sulphuric Acid | 50·00 " | 57·00 " |
| Lime | 90·00 " | 197·00 " |
| Magnesia | 14·00 " | 29·00 " |
| Potash | 140·00 " | 134·00 " |
| Silica | 55·00 " | 60·00 " |

**Tobacco and Cotton** require a rich soil to grow luxuriantly, as the following Table, showing the amounts, in pounds, of inorganic elements contained in 1000 lbs. of the stems and leaf of tobacco, and the fibre, seed and stalk of cotton, in their air-dried state, will show:

| | Tobacco. | Cotton. Fibre. | Seed. | Stalk. |
|---|---|---|---|---|
| Phosphoric Acid | 8·6 | 8·3 | 14·8 | 5·5 |
| Sulphuric Acid | 9·3 | 5·6 | 1·6 | 0·5 |
| Lime | 88·8 | 25·7 | 2·4 | 7·0 |
| Magnesia | 25·0 | 14·5 | 5·6 | 2·2 |
| Potash | 73·7 | 54·0 | 14·4 | 8·8 |
| Silica | 23·0 | 1·3 | 3·4 | 2·5 |

We regret that we could not obtain reliable analyses of cotton and tobacco, showing the amount of nitrogen or ammonia required. The reader can see that in raising tobacco, a large amount of lime and potash is required, while the amount of phosphoric acid is small. The cotton plant requires more phosphoric acid, but either crop can be raised more readily and profitably from ordinary soils, where climate is suitable, than either wheat or corn.

The foregoing Tables are of great value to the farmer and planter, in showing them the amount of the different valuable elements required by different crops; also, how far the commercial manures of a known composition are able to supply the material for these crops. If the reader wishes to know how much of those elements which are not usually applied as principal constituents of manures, such as oxygen, hydrogen, chlorine, iron, soda, and carbon, is required by plants, he may refer to the Tables on pages 82 and 85, which will show him the percentage of these substances; and from these he can readily calculate the amount required by different crops for an acre.

Every crop should be supplied with the full amount of all the substances needed to bring it to maturity. That this vital principle is not understood, or at least attended to, is painfully evident from an examination of the statistics furnished in the reports of the Agricultural Department, at Washington. By these reports we find that the average of the amounts of the different crops raised on an acre in thirty States of the Union is, as follows:

| | | | |
|---|---|---|---|
| Wheat......11·56 bushels. | | Barley.....19·14 bushels. | |
| Indian Corn.28·00 | " | Buckwheat.17·68 | " |
| Rye..........13·30 | " | Potatoes...93·23 | " |
| Oats..........23·95 | " | Hay....... 1·28 tons. | |

The above averages show conclusively that there is a great necessity for a more extended use of manufactured manures.

Even Pennsylvania, that boasts of her fertile soils and the perfection of her system of agriculture, produces only the following average of the above named crops per acre:

| | | | |
|---|---|---|---|
| Wheat......12·8 bushels. | | Indian Corn...35·0 bushels. | |
| Rye.........13·0 | " | Oats ........ 27·8 | " |
| Barley..... .21·4 | " | Buckwheat. . 16·5 | " |
| Potatoes.....88·0 | " | Hay......... 1·3 tons | |

But this will favorably contrast with South

Carolina, which shows the lowest average production, as follows:

| | | | | | |
|---|---|---|---|---|---|
| Wheat........ | 5·6 | bushels. | Corn....... | 10·2 | bushels. |
| Rye .......... | 5·0 | " | Oats....... | 9·7 | " |
| Barley....... | 9·0 | " | Potatoes... | 101·0 | " |

The crop of potatoes exceeds the general average, but the amount of the other crops raised must afford a very inadequate remuneration to the farmer, barely exceeding the cost of seed, cultivation, and preparation for market. The principal cause of this state of things is the ignorance of the farmer of what substances he needs, in kind and quantity to produce the intended crop. A full knowledge of what and how much plants need to insure their healthy growth, will induce the farmer to use all care and economy in saving, preparing, and applying these substances. The Tables already given are invaluable in giving this information. But there are necessary conditions that must be complied with. A plant contains various substances, and every one of these must be present to enable it to come to maturity. Besides, these substances must be in a condition to become soluble in water, either alone or in combination with other substances with which they are brought in contact in the soil, during the time that intervenes between the planting and the gathering of the crop. This is a very intricate subject, and affords a broad field for speculation and research, and, when fully understood, will be a guide to the fixing of the relative values of the different elements essential to the growth of plants.

The reader who has carefully perused our work thus far, should have acquired a general knowledge of the different substances entering into the growth of plants. He should know why some soils will produce one crop and not another, and why two crops of the same kind cannot profitably be raised in succession, on the same land. Also, that some crops take from the land more of one substance than of another; and that wheat exhausts the soil of its most valuable constituents much sooner than corn, rye or oats. He should understand the true philosophy of the rotation of crops; also, why the straw of wheat may flourish and not the ear, as the straw contains comparatively little of the same ingredients required for the grain; and why good crops of wheat fall to the ground for want of proper strength in the straw to support the ears, as the straw requires a large amount of silica, with little lime, magnesia and phosphoric acid, and the grain a large amount of the latter substances. In a word, he should understand why some soils will grow good straw with small ears, and other soils large ears with little straw.

The amount of inorganic food required for plants may appear trifling, as shown by the analyses; but its value is startling when we consider it in the crops removed from an acre of land. The following case, given by Professor Johnson, will illustrate this in a striking manner:

In a four years' course of cropping, in which the crops gathered amounted per acre to—

1st year, turnips, 20 tons bulbs, and $6\frac{1}{3}$ tons tops;
2nd year, barley, 40 bushels, and 1 ton of straw;
3rd year, wheat, 25 bushels, and $1\frac{3}{4}$ tons of straw;
4th year, clover and rye grass, $1\frac{1}{2}$ tons each of straw;

the quantity of inorganic matter carried off in the four crops, supposing none to be consumed on the land, is a follows:

| | |
|---|---|
| Silica | 356 lbs. |
| Phosphoric Acid | 116 " |
| Sulphuric Acid | 108 " |
| Lime | 193 " |
| Magnesia | 55 " |
| Oxide of Iron | 15 " |
| Potash | 317 " |
| Soda | 54 " |
| Chlorine | 70 " |
| Total | 1284 lbs. |

Now, if the entire produce be carried from the land, and no manures be applied in the meantime, it will be necessary, to restore the land to its original condition, to add to each acre:

| | |
|---|---|
| Bonedust | 552 lbs. |
| Epsom Salts | 326 " |
| Dry Pearl Ash | 465 " |
| Quicklime | 70 " |
| Common Salt | 116 " |
| Total | 1529 lbs. |

The constant removal of such large quantities of the inorganic food of plants must, in time, exhaust a soil and render it barren, unless restored by a judicious system of manuring. The soluble salts, such as potash and soda, are also liable to leach through to the subsoil, and also to be washed away by rains. In general, however, all fertile soils contain a good store of the inorganic food of plants, so that the deterioration is often a slow process. In rare instances, a century may elapse before the change prove such as to make a sensible diminution in the rental value. Such slow changes are seldom recorded. Hence the practical man is occasionally led to despise the clearest theoretical principles, because he has not happened to see them verified in his own limited experience; as well as to neglect the suggestions and wise precautions which these principles lay before him. Illustrations of this sure, though slow decay, may be met with in the agricultural history of almost every country; but in none more strikingly than in the old slave States, Maryland, Virginia, North and South

Carolina—once rich and fertile. By a long continued system of forced and exhausting culture, these lands have become unproductive, and vast tracts have been abandoned to hopeless sterility. Such lands it is possible to reclaim; but at what an expense of time, labor, manure, and skilful management? It is to be hoped that the new States will not thus sacrifice their future power and prospects to present and temporary wealth; that these fine lands, which now yield immense successive crops of Indian corn and wheat, without intermission and without manure, will not be cropped till their strength and substance is gone; but that a better conducted and more skilful husbandry may be adopted, which will ensure unimpaired fertility to these naturally rich and productive soils.

Another instance of exhaustion may be seen in the West India sugar plantations. The cane, after having had its saccharine juice pressed out at the mill, serves as fuel for boiling down the syrup. The ash thus produced is rich in the mineral ingredients necessary to the prosperity of the plant. The neglect to return this valuable ash to the soil has not only occasioned a large importation of foreign manures, but also a serious deterioration of the soil.

# CHAPTER IV.

## THE ORIGIN AND COMPOSITION OF SOILS, SHOWING THE NATURAL SOURCES OF THE ELEMENTS AS CONTAINED IN PLANTS.

An accurate knowledge of the constituents of soils is equally important to the farmer and planter as a knowledge of the composition of different crops, and of the materials at his command to produce them. Notwithstanding the importance of this knowledge, the chemical composition of the land is rarely considered in the selection and purchase of a farm; the fact that it produces crops, the location, convenience to markets, and the money value of the improvements, are the principal considerations. If the land has hitherto produced good crops, it is taken as a guarantee that it will continue to do so; the soil is not examined, to see how far the stores of organic and mineral matter necessary to fertility have been exhausted.

It requires but a superficial examination of this subject, to demonstrate that lands should have a commercial value, other things being equal, in proportion to the quantity and condition of the valuable constituents of plants contained in an acre.

There are virgin soils that now raise large crops, but which will be soon exhausted, as their fertilizing ingredients are small in amount, though in an active soluble state. Other soils, probably less productive, contain an almost unlimited supply of fertilizing ingredients, which are being gradually liberated and given in soluble form to supply the wants of vegetation; the former may become sterile in less than twenty years, the latter be productive for centuries. The facts just stated show the importance of having soils analyzed, so that the farmer may know the amount of fertilizing substances he has on hand. This would be analogous to taking an account of stock by the merchant or manufacturer, only it need not be done so often. After once acquiring this knowledge, the farmer may easily estimate the amount of various substances removed by different crops, as well as what he has added in the shape of manures, and so arrive at a knowledge of the true condition and real value of his lands. Millions of dollars are expended annually by farmers in substances not needed, solely from the fact that they do not know what they already possess or need, nor the *constituents* of what they purchase.

To illustrate this matter fully, we give analyses of some fertile and sterile soils; and as it has been shown that all crops require silica, phosphoric acid, sulphuric acid, lime, magnesia, oxide of iron, potash, soda, chlorine, oxygen, hydrogen, and nitrogen, with a certain amount of decaying vegetable matter, the farmer can see why the soils given as fertile are so, and why the others are sterile. As a key to the amounts of the different substances contained in the soil of an acre of land, the farmer should know that every inch in depth of an acre of average soils, weighs about one hundred tons; hence a soil ten inches deep would weigh just one thousand tons.

The following is an analysis of a very fertile soil, in the vicinity of the Zuyder Zee, in Holland, as given by the celebrated chemist Mulder.

| | |
|---|---|
| Insoluble sand with Alumina...... | 57·646 |
| Soluble Silica..................... | 2·340 |
| Alumina, soluble.................. | 1·830 |
| Peroxide of Iron.................. | 9·039 |
| Protoxide of Iron................. | 0·350 |
| Lime.............................. | 4·092 |
| Magnesia.......................... | 0·130 |
| Potash............................ | 1·026 |
| Soda.............................. | 1·972 |
| Ammonia........................... | 0·060 |
| Phosphoric Acid................... | 0·466 |
| Sulphuric Acid.................... | 0·896 |
| Carbonic Acid..................... | 6·085 |
| Chlorine.......................... | 1·240 |
| Humus, or mould, vegetable remains and water chemically combined........................ | 12·000 |
| Loss.............................. | 0·828 |
| Total............................. | 100·000 |

This is a most remarkably rich soil, and few in the world can compare with it in furnishing the raw material for producing bread and meat. The farmer can see at a glance, that it contains every substance necessary for the growth of plants. As it would be interesting to know how much of each of the elements is contained on an acre of the above-mentioned soil, assuming the soil to be ten inches deep, and hence weighing one thousand tons, we give the result of the calculation, as follows:

| | | |
|---|---|---|
| Silica and Alumina | 576·0 | tons. |
| Soluble Silica | 23·0 | " |
| Soluble Alumina | 18·0 | " |
| Peroxide of Iron | 90·0 | " |
| Protoxide of Iron | 3·5 | " |
| Lime | 40·0 | " |
| Magnesia | 1·8 | " |
| Potash | 10·0 | " |
| Soda | 19·0 | " |
| Ammonia | 1200·0 | lbs. |
| Phosphoric Acid | 4·5 | tons. |
| Sulphuric Acid | 9·0 | " |
| Carbonic Acid | 61·0 | " |
| Chlorine | 12·5 | " |
| Vegetable remains and water | 83·0 | " |

The commercial value of these quantities of fertilizing elements can easily be estimated. The reader will notice that the amount of lime is four per cent., or forty tons to the acre. Allowing that 200 lbs. may be washed out and appropriated yearly by growing crops, it would last four hundred years; although the soil would cease to be fertile long before the last particle of lime was removed. The supply of magnesia is small in proportion to the other substances, and as most crops require more magnesia than lime, this compound would be the first exhausted in this soil. It will also be seen that there are four and a half tons, or 9000 lbs. of phosphoric acid. Supposing this to be in the shape of bone phosphate of lime, or associated with other bases in an insoluble form, and worth four cents a pound, we have three hundred and sixty dollars as the value of that article alone.

It is very probable that this soil has been cropped over a thousand years, and still contains within itself sufficient of every fertilizing substance to last at least two hundred years or more. Soils containing only a tenth in quantity of these necessary elements may be equally fertile, as only a given quantity can be assimilated by each yearly crop, but the difference in quantity should be an element in determining the commercial value of the land. The time must come, and is not very distant, when the price of lands will be rated by their composition, and not merely their present capacity for raising crops.

The following is an analysis of a remarkably sterile soil:

| | |
|---|---|
| Silica, with coarse Silicious Sand | 95·843 |
| Alumina | 0·600 |
| Protoxide and Peroxide of Iron | 1·800 |
| Lime in combination with Silica | 0·038 |
| Magnesia | 0·006 |
| Potash and Soda | 0·005 |
| Phosphate of Iron | 0·198 |
| Sulphuric Acid | 0·002 |
| Chlorine | 0·006 |
| Humus, Carbonic Acid and Water | 1·502 |
| Total | 100·000 |

The poverty of this soil is apparent from the small quantity of lime, magnesia, potash and phosphoric acid found in it. The addition of marl was found to have a marked effect upon it.

The following is the analysis of a soil that was supposed to be very barren, but which, after the application of land plaster or gypsum, produced large crops of red clover, peas, beans, etc. The surface is a fine-grained loamy soil. (A) is the analysis of the surface, (B) of the subsoil; 100 parts of each contained :

| | (A) | (B) |
|---|---|---|
| Silica, with Silicious Sand | 90·120 | 90·324 |
| Alumina | 2·106 | 2·262 |
| Peroxide and Protoxide of Iron | 3·951 | 2·914 |
| Peroxide of Manganese | 0·950 | 2·960 |
| Lime | 0·539 | 0·532 |
| Phosphoric Acid | 0·367 | 0·122 |
| Magnesia, with Silicate of Potash | 0·750 | 0·340 |
| Potash | 0·067 | 0·304 |
| Soda | 0·010 | trace. |
| Sulphuric Acid | trace. | 0·010 |
| Chlorine | 0·100 | 0·004 |
| Humus and decaying veg. matter | 0·900 | —— |
| Loss | 0·140 | 0·228 |
| Total | 100·000 | 100·000 |

The reader can see at a glance the lack of sulphuric acid in the above soil. This is the reason that the application of plaster had such a beneficial effect. Every other element of fertility was present, but without sulphuric acid it was impossible for plants to come to maturity.

Hundreds of analyses of different soils might be given, both fertile and barren, but they would only prove the one great fact, that soils, to be properly adapted to the growth of plants, must contain every element that enters into their composition. Plants must have the necessary food to live on, the same as animals, as they cannot create an atom of any substance to support themselves. Hence, when there is a falling off in the productiveness of a soil, the farmer should first ascertain what element is necessary to restore it, and then add that substance, in a definite quantity, because it is only a waste of money to apply what is not required.

Such a course would lead to an economy both of the money of the farmer, and also of the elements of fertility. How many farmers buy expensive manufactured manures, when perhaps the very things they need lie wasting at their own doors. The application of lime, marl, muck, wood and even coal ashes, is sometimes attended with better results than the most expensive phosphates. When these expensive manures are applied where something else is needed, the farmer loses the money invested, the labor of applying them, and oftentimes his crop, by not using the substance really required.

The bulk of all soils consists of *sand* and *clay*. These are general terms, and have no reference to the chemical properties of the different parts, as all granulated bodies in soils are termed sand, and all tenacious substances easily pulverized are termed clay.

Two specific terms are in use to denote the character of soils, viz:—alluvial and diluvial. Soils that have been washed from hills and mountains are termed alluvial, but if they cannot be traced to such a source, and are elevated plains, or the tops of hills and mountains, they are termed diluvial, and must be traced to the action of glaciers or the gradual disintegration of rocks by the action of the elements.

A knowledge of the chemical composition of the rocks, from which the sand and clay are formed, will enable us to judge correctly of the kinds of minerals to be found in the soil; and of their adaptability to the wants of agriculture; hence, the study of these rocks is quite as important as the study of the soil itself.

The rocks essential to the formation of fertile soils, and from which they are usually produced, are Granite, Felspar, Limestone, Gypsum, Phosphorite, Slate and Sandstone. The relative value of these rocks in soil formation can be seen when we examine the nature of their constituents.

**Granite** belongs to the most ancient family of rocks, which appear to have originally formed the basis of the solid structure of the globe. This mineral derives its name from its marked granular structure, and is a mixture, in variable proportions, of quartz, felspar, and mica. These grains vary considerably in size; in some varieties, the crystals are in uniform small grains, while in other varieties the laminæ of mica are some inches across.

**Quartz**, which forms the transparent grains in the granite, consists simply of silica (silicic acid).

**Felspar**, the dull cream-colored opaque grains in granite, generally contains silica, alumina, potash, soda and lime.

**Mica**, so named from the glittering scales which it forms in the rock, is a compound of silica, alumina and potash; but in some varieties the alumina is displaced by the peroxide or rust of iron, and the potash by magnesia.

By the long continued action of the atmosphere in connection with rain, the granite rock is gradually crumbled down and disintegrated, an effect due to both mechanical and chemical causes. Mechanically, the rock is continually worn by strong winds loaded with minute particles of sand; and by the freezing of water within its minute pores, small particles are split off by the expansion attending such congelation. Chemically, the action of rain water containing carbonic acid, would remove the potash from the felspar and mica, in the form of carbonate of potash, which removal, breaking the bond of connection between the different particles or grains, the quartz and silicate of alumina, on combining with a certain amount of water, would form clay. Every hundred pounds of granite yield about one pound of potash, which is the most valuable part of the rock for the purposes of vegetation.

A cubic foot of pure felspar is sufficient to supply half an acre of growing oak trees with the necessary potash required, for five years, if it was present in a soluble form. Each 100 lbs. of this pure felspar contains 16·17 lbs. of potash, equal to 24·52 lbs. of carbonate of potash, or, 26·44 lbs. of the muriate.

Still this potash in felspar requires a long time to become soluble when only acted on by atmospheric agencies.

The most important mineral ingredient of fertile soils is lime, in its different compounds of carbonate of lime, sulphate of lime (lime and sulphuric acid), and phosphate of lime.

**Cabonate of Lime** (common limestone) is the chief constituent of the shells of fishes and egg shells; corals also consist of carbonate of lime, derived from the skeletons of innumerable minute insects.

The origin of the common limestones is very remarkable. They are built up from deposits of the remains of shell-fish and coral insects, which lived in ancient seas, and which having been raised above the surface by submarine forces, have hardened into a rock by the slow infiltration of water holding carbonate of lime in solution, or by the rapid and more powerful effect of volcanic heat.

There are few limestones, in which the shells and corals cannot yet be seen in form, more or less perfect. They are not found in the purest and most crystalline marbles, because these have clearly been subjected to the action of heat with great pressure, which has obliterated the forms.

**Sulphate of Lime**, or Gypsum, is an important ingredient of fertile soils, as it furnishes two elements necessary to plants. In some localities, gypsum is found in immense beds or rocks, somewhat similar in appearance to limestone.

It is very generally distributed in small quantities in all soils. Most spring and river waters contain it, and in hard waters it is often abundant, rendering them unfit for washing and culinary purposes.

**Phosphorite** is a mineral phosphate of lime. The presence of phosphoric acid in all cultivated soils may be traced to this substance. Without it no cultivated plants can come to perfection. The source of this substance in soils must be from the many generations of animals that have lived on the earth, and whose bones have become scattered and mixed with the soil. It is also found in the ancient unstratified rocks, such as the apatites of Canada and Northern New York, the phosphatic guano beds of South Caro lina, and other places. Many of these rocks contain a larger amount of phosphoric acid than the same weight of bones. As these rocks slowly crumble down in the soil, the phosphates, if they become soluble, are taken up by plants.

**Sandstones** are a great source of the inorganic materials in soils. They are of various formations, and their composition is not at all arbitrary; alumina, silica, carbonate of lime, oxide of iron, and other substances, are found in various proportions in the different varieties. The cohesion of the particles is sometimes caused by a sort of semi-fusion, as in the common grit or burr stones, while in other varieties the cohesion is effected by the infiltration of some substance in solution. These are the freestones, red-sandstones, etc. Most sandstones are easily disintegrated by the elements, and form soils rapidly, the value of which is governed by the constituent elements of the stone.

**Soils** are named from the relative proportions of their constituents. One hundred parts of dry ordinary soil, containing only ten of clay, would be termed a *sandy soil.* If it contained from ten to thirty or forty parts of clay, it would be a *sandy loam ;* if from forty to seventy parts of clay, it would be a *loamy soil ;* from seventy to eighty-five of clay, a *clay loam ;* from eighty-five to ninety of clay, a *strong clay*, fit for making bricks; if it contains no sand it would be pure agricultural clay, or pipe-clay. If a soil contains more than five per cent. of lime, it is termed a *marly* soil; if more than twenty per cent., a *calcareous* soil. The rust of iron forms two or three per cent. of most sandy soils, and in red soils much more.

Farmers must have noticed that some soils assume a darker color or deeper red, under cultivation. These soils contain a large amount of the first oxide of iron, which is injurious to vegetation. The frequent exposure of such soils to the oxygen of the atmosphere, changes this first oxide to the peroxide, as previously stated.

The foregoing account of the sources of inorganic substances in soils, shows that the soil acquires from rocks alumina, silica or sand, phosphoric acid, sulphuric acid, lime, magnesia, oxide of iron, potash, soda; all being indispensable ingredients for the growth of plants. These substances are all termed *mineral or inorganic.*

**Mould** will now be considered. It is popularly supposed to be the organic portion of soils. If the leaves that fall from the trees, and the vegetation that dies yearly on the approach of winter, did not rot or decay, or become resolved into their original elements, the accumulation would interfere with the subsequent growth of plants. The decomposition of organic remains is governed by fixed laws. All plants after they die undergo two processes of decomposition; first, fermentation, then putrefaction or decay. These changes are somewhat analogous to those produced by a smouldering fire, and the product of this decay is very appropriately termed mould. This process of decay or mouldering is the imperceptible union of the oxygen of the air with the carbon of the plant; but it proceeds so slowly that it produces only in a very slight degree the effects of ordinary combustion, that is light and heat; still the results are the same, with the exception that it is not carried to the same extent.

The *complete* burning of vegetation leaves nothing but the *mineral or inorganic* elements in the form of *ash;* the carbon, oxygen, hydrogen, and nitrogen, passing off in a gaseous form; on the contrary, the slow combustion that takes place under the ordinary processes of decay, is limited by the small amount of oxygen that can come in contact with the carbon. A part of this oxygen is furnished by the decomposition of the water present; the oxygen thus liberated unites with the carbon to form carbonic acid, and the hydrogen unites with nitrogen to form ammonia.

Inasmuch as the decomposed remains of *all* the parts of any plant contain all the inorganic, with a portion of the organic elements originally contained in it, these remains would furnish a most efficient manure for the production of other plants of the same species. But if we desire to grow another kind of plant, requiring a larger amount of one or more of the elements, the deficiency must be supplied, or, if a part of the plants be removed from the soil, the elements contained in that part must be renewed by a manure. Wheat serves as an example. The *grain*, which contains the largest amount of the most valuable elements of fertility, is removed; and even should all the straw be returned to the soil in a decomposed state, it would evidently lack the amount of the elements contained in the grain. Hence the necessity of applying, in a cheaper form, the substances that will furnish the different elements removed in the grain is apparent.

**Humus** is the technical term used to designate the mould or brown *earthy part of* soils. As this substance has partially lost the power of assimilating oxygen, and giving forth carbonic acid gas, it is almost a fixed substance. Its special office is that of a mechanical medium for the absorption and retention of heat, moisture, and fertilizing gases; also that of a mechanical support to the structure of the plant.

The *bulk or mass* of vegetation is not furnished by the soil. Generally the largest part of the mass is water or its elements; a large part also is carbon. Many ingenious experiments have been made to determine the source of carbon in vegetation. They have resulted in establishing the fact that it is furnished almost entirely, if not wholly, by the carbonic acid in the atmosphere and soil. It is true that humic acid —a compound of humus and oxygen, containing 58 per cent. of carbon—will form soluble compounds with potash, soda and lime. Both Malaguti and Sprengel say that 1 lb. of lime combines with 12 lbs. of humic acid, and thus every pound of lime thus combined might be the vehicle to furnish 7 lbs. of carbon to the plant But as only 15⅓ lbs. of lime enter into the composition of 25 bushels of wheat, only 107 lbs. of carbon could possibly be furnished in this way. As there are 2377 lbs. of carbon in 25 bushels of wheat and the straw, not the one-twentieth part required could be thus supplied. We will ascertain what amount could be supplied by the agency of rain water. The rain-fall from the first of April to the first of October—the time during which plants are coming to maturity—is on an average about 1,000,000 lbs. to an acre. Now, experiments have demonstrated that 1,000,000 lbs. will render soluble only 10 lbs. of carbon; so that only 10 lbs. could be thus furnished, even if every pound of the water is taken up by the roots, which is far from being the case. The trees of the forest and the grass of the meadow rarely receive any carbon in the shape of manure; and yet there is no lack of it, though carbon is taken away every year in the form of wood and hay. From all this we conclude that manures are not needed to furnish carbon, and that the atmosphere is capable of furnishing all that vegetation requires.

Immense quantities of carbonic acid are constantly supplied to the atmosphere by our fires and furnaces, by fermentation and the decay of animal and vegetable substances, as well as by the respiration of men and animals. Is it not wonderful that this carbonic acid, so fatal to animals, though largely produced by them, is so necessary to plants that they may almost be said to subsist upon it; absorbing it from the air, and decomposing it by their leaves in the sunshine, in such a manner as to retain the carbon and liberate the oxygen, which thus becomes fitted for the purposes of combustion and respiration. Were it not for the absorption of carbonic acid by plants, the air would become unfit for respiration, and all animal life would perish from the face of the earth.

Since carbonic acid is so important as food for vegetables, it is interesting to know how much of it is available in the atmosphere—in other words, to estimate the *stock on hand.* The amount in weight is nearly the one-thousandth part of the weight of the atmosphere, and according to the calculation of Liebig, the amount of carbon contained is more than 3081 billions of pounds—a weight exceeding that of all the vegetation and all the strata of mineral and brown soil on the face of the earth. Nor has this vast amount been perceptibly lessened since the method of estimating its amount was discovered, because it is being constantly supplied from the sources previously stated, as fast as it is appropriated by vegetation.

The physical condition of soils, and their capacity for retaining heat and moisture, is a subject too often neglected in this country. Some rich soils fail to produce good crops, from a deficiency in these properties. The addition of lime, marl, clay, and swamp-muck, will greatly improve such soils. Should there be an excess of moisture, as in low swampy land, surface applications cannot benefit it much, and the farmer must resort to drainage to remove the difficulty. These are important considerations, and are deserving of a more extended notice than we can give them in this book.

Sandy soils have been greatly benefited by the addition of even small amounts of clay, thus correcting their porosity and leaching tendency, and verifying the truth of the old saying, that

> "Clay upon sand
> Makes very good land."

On the contrary, very little benefit results from the application of sand to heavy tenacious soils, as the amount required to produce any real change is so large, that the farmer could not possibly be repaid for his labor; or, as expressed in the following equally terse saying,

> "Sand upon clay
> Is money thrown away."

# CHAPTER V.

THE MONEY VALUE OF FERTILIZERS, CALCULATED FROM THE MARKET VALUE OF THE RAW MATERIALS AND COST OF MANUFACTURING; WITH GENERAL REMARKS ON THE BUSINESS.

THIS book, being intended to guard the interest of the farmer, and expose the frauds practised by unscrupulous manufacturers and dealers in commercial fertilizers, the first step towards effecting this much desired object is, to show the value of those essential elements of fertility, the quantity and condition of which, in fertilizers, should properly fix their price.

The prices of different commercial fertilizers range from $30 to $75 per ton. These various prices are erroneously supposed to represent their value, estimated from the cost of the raw material, cost of manufacturing, and a fair margin of profit. There has been but little fluctuation in the prices of these fertilizers. It has made no difference whether wheat was worth $2.50 or $1.50 per bushel, they have still maintained the same prices. But as this manufactured article may properly be regarded as a raw material for the production of commodities that have a fluctuating price, regulated by the general laws of demand and supply, the price of this raw material should be regulated by the price of the products of the farm. A little consideration will convince any one of the justness of this course. The price of labor naturally fluctuates with the price of bread; at one time it was customary in this country to consider a bushel of wheat, or its equivalent in money, a fair price for a day's labor. As the price of the other necessaries of life fluctuates in about the same proportion as farm produce, the condition of the laborer was unchanged by any rise or fall in the price of wheat. Although this rule is not strictly followed at the present time, still the price of labor is regulated, in a great degree, by the varying prices of bread.

Now, as there are unlimited quantities of the raw material required for the manufacture of fertilizers, their price when manufactured should be regulated by the cost of the labor required to procure and manufacture them. The earth contains vast stores of the elements of fertility; all that is needed is labor and capital to develop and utilize them. And as this business is identical with other mining and manufacturing enterprises, the parties engaged in it should be satisfied with legitimate profits. But as those engaged in the mining of these raw materials for fertilizers are rarely manufacturers, justice demands that we should state that the prices demanded for them barely covers the cost of production, and that the producers are in no manner benefited by the *exorbitant prices realized* by the manufacturers. The recent discoveries of phosphatic guanos in various places have led to a sharp competition between the parties engaged in mining this raw material. This competition is a great advantage to the manufacturers, and annually puts a large amount of money into their pockets; and besides, they are the only parties benefited, as they charge just as much for a superphosphate of lime manufactured from Charleston guano, that costs them from eight to twelve dollars a ton, as they formerly charged for the same article manufactured from bones, costing from twenty to thirty dollars a ton.

As yet, our farmers have derived no benefit from these valuable discoveries of mineral guanos, which, if properly applied, will restore our impoverished lands to their virgin richness and fertility. *But the interests of the public imperatively demand a change.* The farmer need not pay manufacturers exorbitant prices for their manures. He should and can procure the crude guanos from the miners and dealers; the grinding and subsequent preparation is easily performed. Thus, a saving of nearly fifty per cent. of the money now paid to these manufacturers might be effected. The application of a manufactured manure is very often considered an experiment by farmers; they use it doubtingly, not expecting to be benefited in proportion to the amount invested. This lack of confidence is caused by the high prices charged, and the suspected immense profits of the manufacturers. For these reasons many who really need fertilizers, and who would be benefited by their use, even as they are now made, and at their present exorbitant prices, look on them with distrust and try to get along without them. It requires no stretch of fancy to picture the condition of this country, which has not unaptly been termed the granary of the world, if those needed fertilizers were manufactured honestly, and fair prices asked, so as to make them popular with all the farming community. So far their use has been comparatively confined to a few, and hence commercial fertilizers have not that effect on the prosperity and productiveness of the country they should have. Besides, if a good article had been generally made, and sold at a fair price, the amount used would be enormous, and the aggregate amount of money made by the manufacturers much greater than it is; and the farmer, at the same time, would have been correspondingly benefited. But in their haste to get rich by exorbitant profits, these manufacturers have displayed the wisdom of the old woman of the fable, who "*killed the goose that laid the golden eggs.*"

The reader has been shown that the elements of fertility supposed to be furnished by these manures, form but a small portion of the produce of an acre. He has been shown that 28 lbs. of phosphoric acid, 40 lbs. of potash, and 58 lbs. of ammonia, are the amounts of these substances needed to produce 25 bushels of wheat with the straw, and if none of these substances were contained in the soil, the above amounts must be applied in some shape to insure the raising of such a crop. If the reader will turn to the Tables of Analyses in Chapter VII., he will there see that even 800 lbs. of some of the most celebrated manures of these manufactures, do not contain a sufficient amount of the above substances in proper condition.

But would it pay the farmer to apply 800 lbs. of a manure that costs $50 per ton, to raise 25 bushels of wheat? Certainly not; 800 lbs. would cost $20, and after paying for seed and labor, and allowing interest on the money invested in the land, his profit would be reduced to a very small amount—to nothing—or less than nothing;—he would be in debt.

Some farmers, being accustomed to think of manures as a bulky article, cannot see that a large crop should be expected from the application of 400 lbs. of so-called concentrated fertilizers to an acre; and if it perchance happens, it excites their wonder. We intend to prove that the application of large bulks of manure is not necessary to the raising of large crops. A little of the *substance needed* is better than a good deal of *what is not needed.* A system of intelligent manuring would greatly lessen the labor of its application, and save large sums of money expended in transporting what is worthless; 400 lbs. is not required for an acre, if the manure is properly prepared. We will show conclusively that 100 lbs. of bones can be made more valuable as a manure, than 400 lbs. of many of the leading fertilizers. But we regret to say that the farmers themselves encourage these impositions; they want bulk and weight for their money, and overlook the quality of the article. The manufacturers are accommodating, and *they give it*, i.e., *a good deal* (*in bulk*) *for their money.* There are several manures in the market that have a good reputation for quality, and the manufacturers of which have a *fair* reputation for honesty, and yet their manures will not yield 10 lbs. in the 100 of the substances really needed, and in proper condition to benefit the growing crop. Nay, some of them, not even 6 lbs. to the 100, and are barely worth the price of the bags and transportation; the good results that sometimes attend their use can only be accounted for by a favorite expression of a leading manufacturer of just such manures, well known to the writers, viz: ***"Nature does a great deal for us."*** Our farmers too often give these manures the credit for doing what is done by the ingredients contained in their soil; just as the patient oftentimes has far more faith in the medicine than the doctor, who generally trusts to nature and a strong constitution to effect a cure. How much better would it be to purchase the 6, 10 or 20 lbs. of the really valuable and only needed part of these *dilute, milk-and-water* fertilizers; and if it is desired, increase the bulk at home, thus saving the cost of bags and transportation?

These manufacturers are very careful *to tell you* how much *soluble* phosphoric acid, and how much *insoluble* that will become *soluble* in the soil (they forget to say in ten to twenty years), and how much potash and ammonia their article contains, or more correctly speaking, *should* contain; but they are careful *not to report* the amount of water, salt cake, and land plaster that is mixed with it. Like the Pharisee, they loudly proclaim their good qualities, but the much *needed* and appropriate invocation of the Publican is never practised by them.

The writers are fully cognizant of the fact, that some manufacturers have realized thousands of dollars yearly, by the sale of the water alone contained in their product; and that gas-lime, costing four cents a bushel, has been mixed with what was called superphosphate of lime, and sold for two to three cents per pound. In this case, it is difficult to tell whether most to condemn their consummate dishonesty, or pity their superlative ignorance. It is almost beyond belief, that men in this enlightened age, should be so ignorant of the requirements of their business, as to spend large sums of money in the purchase of sulphuric acid to render phosphoric acid soluble, and also pay a high price for Peruvian Guano to ammoniate; and then apply semi-caustic lime, thus sending the little *soluble* phosphoric acid produced back into its *insoluble* state, and at the same time dissipating the ammonia, thus rendering the manure *almost worthless.* The reader who has fully considered the theory of the manufacture or preparation of superphosphate of lime, will readily see the pertinence of the above remarks.

During the past two or three years, the common expressions of these manufacturers have been, "the day of large profits is past—the farmers are getting more careful and cautious in purchasing fertilizers—they must know what it contains before they buy." We shall show the reader the *cost* to the manufacturer, and *real value* to the farmer, of the so called *improved manures*, manufactured to suit the increased caution of buyers, and causing, as the manufacturers say, greatly *reduced profits*. When we have done this, one can readily imagine what the profits of this fertilizing business was, in the good old times of salt cake, land plaster, gas-lime, marl, and even coal ashes. The reader can see from the analyses of many of these improved manures, that the greedy appetite for extortionate gain manifested by manufacturers, has grown by what it fed on.

But if this investigating and cautious spirit exhibited by the farmer has not materially benefited him, by inducing the manufacturers to make a better article, it has had one good effect, that of greatly reducing their sales; thus proving that though fraud and deceit may flourish for a season, yet a day of reckoning *will come:* "The mills of the gods grind slow, but exceeding fine." The present condition of some of these manufacturers who, last winter, made large preparations for heavy sales in the South, and increased sales in the Eastern and Middle States, this spring, and whose factories and storehouses are now groaning under the weight of the raw and manufactured material, that was expected ere this to have been sold, and the profits pocketed, should disarm the resentment of the heretofore cheated purchasers, and leave nothing more to be desired even by the most vindictive spirit.

These wholesale Peter Funks have too long imposed their bogus compounds upon a confiding community. We hope and believe that the information given in our book will have its effect, in depriving them of the opportunity for further wrong doing; and we may even hope against hope, that they themselves may be brought to a proper sense of their dishonesty. As for ourselves, we have only a common interest in performing a common duty; for when a wrong is perpetrated on communities or the people at large, no private person has the right to cover up or condone the offence; but it is the duty of all alike, to the full extent of their knowledge and ability, to aid in bringing the offenders to justice and punishment, and especially is it a duty in a case like this, which affects the most vital interests of all—the production of the necessaries of life. And besides this, the deserved prejudices that have been produced against the use of commercial fertilizers, if not intelligently directed, will undoubtedly prove a national calamity.

Our agricultural reports, showing the average produce of an acre in the States, is quite a sorry comment on our boasted system of agriculture. What a waste of ill-requited labor! What a return on the capital invested! It is calculated that two-thirds of our population are engaged in cultivating the soil, and that three-fourths of the capital of the country is invested in farm lands, and the stock and implements of husbandry. It is of momentous national interest, that this vast amount of labor and capital should be adequately remunerated. How is this to be done? The answer is plain: By an intelligent and economical system of manuring.

The reason why our lands do not produce as much as those of other countries, the following facts will fully explain: Last year, England, that does not contain a much larger area of cultivated land than the State of Pennsylvania, imported, of

| | | |
|---|---|---|
| Peruvian Guano | 150·000 | tons |
| Nitrate of Soda | 33·216 | " |
| Bones and Bone Ash | 73·231 | " |
| Phosphatic Guano | 100·000 | " |
| Total | 356·447 | tons. |

In addition to the above, there were large quantities of muriate of potash imported from Germany. If to this we add the large amounts of sulphate of ammonia produced at home, and the immense amount of concentrated manures prepared from the bones, night soil, and other waste products of the kingdom, it will swell the grand total of commercial manures used by the farmers of England, to over 800,000 tons a year—a larger amount than is used in the whole United States of America. That the use of this large amount of the elements of fertility applied to the soil amply repays the farmer, we cannot question for a moment. We quote the following from the last year's report of a leading manufacturer in England:

"Most wonderful strides have been made within the past few years in the use of bone material for manurial purposes. Manure manufactories have sprung up in all parts of the country, where formerly they were unknown; and notwithstanding that there is no decrease in the average importations of the past five years, the keen competition that exists among manufacturers for supplies of the raw material, has at length forced prices to the most extreme point which they have yet attained. Towards the close of last season, the utmost difficulty was experienced in getting supplies to meet the most moderate requirements, and the stocks of manufacturers were entirely cleared. The new season was ushered in with great excitement in the trade; fears being generally entertained that the supplies would fall far short of the demand, and consequently a large amount of business was done at even higher prices than what prevailed before the close of last season. This advance has been fully maintained, and as there cannot be a doubt that the supplies will fall far short of the requirements of manufacturers, a further advance is imminent before the consumptive demand sets in."

How different is the condition of our manufacturers, whose factories are glutted with their old stock, notwithstanding the extraordinary inducements offered to purchasers. The reason of this state of things may be traced to two causes: First, The exorbitant prices asked; Second, The inferior quality of the fertilizers.

We shall now proceed to a discussion of the value of commercial manures, estimating from the amount and condition of the fertilizing substances contained in them. Their value has commonly been estimated from the prices of the same substances in Peruvian Guano. Professor Way, in an article published in the Journal of the Royal Agricultural Society, England, says, that the money value of a ton of Peruvian Guano is $58.58; its ammonia being worth $46.95, the phosphate of lime $8.16, and the potash $1.12. He says that ammonia is worth 12 cents a pound for producing wheat at $1.25 a bushel. Bone-phosphate of lime is worth 1½ cent per pound, and potash 6¼ cents for agricultural purposes. This celebrated chemist has confined his calculations to the amount of these materials as found in Peruvian Guano. But at this time, this is too limited a basis from which to estimate their value, as there are other sources from which these three substances can be procured; and as respects phosphoric acid and potash, more cheaply than in Peruvian Guano.

Professor Way has estimated 10½ cents per pound as a fair price for soluble phosphoric acid; Dr. Vœlcker, of the Royal Agricultural College, of England, and Dr. Stœckhardt, the distinguished Saxon Agricultural Chemist, give it a value of 12½ cents per pound. These prices are deduced from the prices of the best commercial superphosphates. Dr. Johnson, in his essay on manures, in commenting on these prices, says: "This, I believe, is considerably more than it is really worth, but is probably the lowest rate at which it can now be purchased." This remark would seem to imply an utter helplessness on his part to suggest any remedy for the prices demanded. We shall review these opinions respecting the value of phosphoric acid. Dr. Vœlcker's and Dr. Stœckhardt's mode of fixing the price of soluble phosphoric acid, from the amount of this substance contained in, and the prices asked for, the best commercial superphosphates, might do for England and Saxony, where manufacturers have done all they can to improve and perfect manures and superphosphates, and make as good an article as possible for the money. But to take such a standard to estimate the value of general American superphosphates, where an entirely different state of things prevails, would be simply ridiculous; hence, we shall proceed to estimate from a different basis.

At the present time the valuable materials used in the manufacture of commercial manures and superphosphate of lime, are Bones, Mineral Guanos or Phosphorite, Peruvian Guano, Crude Sulphate of Ammonia, Muriate and Sulphate of Potash.

There are only three substances that serve as a basis for fixing the value of commercial manures. These are Phosphoric Acid, Ammonia and Potash. Most of the other substances used, such as Salt Cake, Gypsum, etc., are a source of *actual loss* to the farmer, because he has to pay 2½ cents or more per lb. for them when mixed with superphosphate of lime; whereas, if he needs them, he can buy them unmixed for ¾ of a cent per lb.: hence, every pound of them in the superphosphate, involves a loss of at least 1¾ cent. They are added by the manufacturer only to give bulk and increase his profits. As to organic substances, such as blood, fish scraps, horns, hair, etc., in these manures, they have a value proportioned to the amount of nitrogen or ammonia contained in them; but as they are usually mixed with a considerable amount of water and other ingredients, of *no value*, that costs the buyer as much as the nitrogen or ammonia is worth, they may be left out of the estimate; thus leaving only phosphoric acid, ammonia and potash as a basis of value. We shall examine them in the following order: Phosphoric Acid—insoluble and soluble; Ammonia—actual and potential; Potash—the Muriate and Sulphate.

**Insoluble Phosphoric Acid**, or Bone Phosphate of Lime, enters largely into the composition of bones, as the following analysis of cattle bones, in their natural dry state, will show.

| | | | |
|---|---|---|---|
| Gelatin | 30·58 lbs. | contain nitrogen | 5·00 lbs. |
| Phosphate of Lime | 58·30 " | " Phosphoric Acid | 26·71 " |
| Carbonate of Lime | 7·07 " | | ..... |
| Fluoride of Calcium | 1·96 " | | ..... |
| Phosphate of Mag. | 2·09 " | " " " | 1·13 " |
| | 100·00 lbs. | Total Phosphoric Acid | 27·84 lbs. |

A ton of such bones contains 556 lbs. of phosphoric acid, and 100 lbs. of nitrogen. If this insoluble phosphoric acid be estimated at 4½ cents per lb., and the nitrogen at 15 cents, we have $40.02 as the real value of these bones. Such bones usually cost, in their rough state, from $20 to $25 per ton; the grinding costs about $5. The above value of $40.02 given to a ton of ground bones, allows a profit of from $10 to $15 per ton to the manufacturers.

There are only two available sources of phosphoric acid: First, the bones of animals; Second, mineral guanos, known as Phosphorite, Apatite, and Coprolites. The use of bones as a source of phosphoric acid is limited; the trouble and expense of collecting them, and the general ignorance of their value, will at all times render them an uncertain supply, as raw material for the manufacture of fertilizers. But with the second source—mineral phosphates—the case is different. There seems to be scarcely any limit to the amount.

As a raw material for the manufacture of *soluble phosphoric acid* or superphosphate of lime, it is very valuable. If it is as free from the carbonates of lime and magnesia, and of other foreign matter, as bones are, equal amounts of sulphuric acid will liberate the same amount of soluble phosphoric acid from it, as from bones. Hence, other things being equal, this mineral guano is fully as valuable as bones for preparing soluble phosphates. As before remarked, there is scarcely any limit to the supply of these mineral phosphates. The largest known deposit on this continent, and perhaps in the world, is near Charleston, in South Carolina. The country is indebted to Dr. N. A. Pratt, of that city, for discovering the value, and aiding in the development of this great source of national wealth. He says, in his report on this subject: "This bed has long been known in the history of the geology of South Carolina, as the 'Fish bed of the Charleston Basin,' on account of the abundant remains of marine animals found in it—Professor Holmes, of Charleston, having not less than 60,000 sharks' teeth alone, some of them of enormous size, weighing from two to two and a half pounds each. The bed outcrops on the banks of the Ashley, Cooper, Stono, Edisto, Ashepoo, and Combahee rivers; but is developed most richly and heavily on the former, and has been found inland forty or fifty miles. Near the Ashley river, it paves the public highways for miles; it seriously impedes and obstructs the cultivation of the land, affording scarcely soil enough to hill up the cotton rows; and the phosphates have for years past been thrown into piles on the lawns and into the causeways over ravines, to get them out of the reach of the plows. It underlies many square miles of surface continuously, at a depth ranging from six inches to twelve or more feet, and in such quantities, that from five hundred to a thousand tons underlie each acre. In fact, it seems there are no rocks in this section which are not phosphates.

"The area of this bed, containing phosphates of good quality and in workable quantity, so far as known and examined by the writer in person, is not less than 40 to 50 square miles, though, from samples I have examined from beyond these limits, I am led to believe that the rock will be found of good or indifferent quality, and in greater or less quantity, over an area of several hundred square miles. When of inferior quality, they contain more sand, carbonate of lime, oxide of iron, and phosphate of iron and alumina, and proportionately less pure phosphate of lime."

As the amount of this material is so large, it will doubtless be the chief source of supply for many years to come, and there will probably be little variation in its price; and as there are no drawbacks or checks to the mining and economical transportation of it to all parts of the Atlantic coast, we will estimate the value of insoluble phosphoric acid from it. We give the following table from Dr. Pratt's interesting pamphlet on the "History of the Discovery and Development of the Native Bone Phosphates of the Charleston Basin," giving analyses of different samples of this guano, and of some other leading commercial guanos, for comparison.

| | | Phosphate of Lime. | Phos. of Iron and Alumina. | Carb. Lime and Magnesia | Organic Matter. | Sand. |
|---|---|---|---|---|---|---|
| South Carolina, | No. 1 | 34·40 | | | | 29·32 |
| " | " 2 | 55·52 | 1·50 | 10·33 | 6·50 | 10·31 |
| " | " 3 | 63·30 | 1·32 | 8·20 | | 9·01 |
| " | " 4 | 68·03 | 5·02 | 8·03 | 7·50 | 9·91 |
| " | " 5 | 66·36 | 3·01 | | | 11·70 |
| " | " 6 | 61·93 | 1·04 | 11·21 | | |
| " | " 7 | 64·07 | ·84 | 11·00 | | |
| " | " 8 | 69·00 | | | | |
| " | " 9 | 59·07 | ·65 | 5·68 | | |
| " | " 10 | 49·35 | 1·84 | 25·70 | | |
| " | " 11 | 49·87 | ·86 | 4·73 | | |
| " | " 12 | 50·07 | ·69 | 10·14 | | |
| Navassa Guano, | | 49·12 | 12·00 | | | |
| Swan Island Guano, mean of two analyses | | 53·08 | 12·33 | | 20·60 | 15·40 |
| Bolivian, | | 53·20 | 9·23 | | 18·24 | 4·08 |
| Patagonian, | | 44·00 | phos. iron and alum'a combined. | | 18·30 | 35·60 |
| Chilian, | | 31·00 | | | 18·60 | 43·17 |

The average amount of bone phosphate of lime in the twelve analyses, is 57·58. The writers have been informed that the company who have control of this deposit have adopted the following tariff, viz: Twenty cents for each unit or per centage of bone phosphate contained in 100 lbs. represents the value of a ton. The average per centage by above Table is 57·58, which at 20 cents per unit would make the price of this quality of the article $11.51 per ton. The reader can appreciate the justice and fairness of a business conducted on such an equitable basis; and the farmer should refuse to purchase the manufactured article, until a similar honest arrangement for fixing its price is adopted by the manufacturers. One ton of mineral phosphate containing 57.58 per cent. of bone phosphate of lime, contains 527 lbs. of phosphoric acid, costing 2.16 cents per lb. to the manufacturer, as delivered in its rough state. When ground, assuming it to be worth 4½ cents per lb. (the price claimed), the following statement will show the actual cost and profits, if put up in bags and sold in that state:

| | |
|---|---|
| One ton of Mineral Phosphate...... | $11.50 |
| Cartage, grinding and labor......... | 5.00 |
| Bags............................ | 2.00 |
| Total cost.......................... | $18.50 |

This article in its ground state is sold for $25.00 per ton to farmers, at a profit of $6.50 per ton. But its use, as we will now show, gives no return for the money expended.

Manures, no matter what they contain, are valuable only in proportion to the solubility of their fertilizing constituents. There is absolutely no proof that this mineral phosphate, which has been exposed to the action of water for thousands of years, has parted with any of its phosphoric acid through this agency. On the contrary, it is more rich in phosphoric acid than ordinary bones, which fact is accounted for by the removal of the gelatin originally contained in the bones of marine animals of which the mineral phosphate is made up. Again, we do not find that this mineral phosphate has any noticeable effect upon the vegetation of the soils in which it is found, in such immense quantities as to require removal in order that the land may be cultivated. The above facts are in strict accordance with the results attained by the experiments of celebrated chemists upon mineral phosphates. These experiments have demonstrated that pure water has no appreciable effect on them, and that solutions of salts of ammonia and of soda, much stronger than can be found in soils, have but a very slight effect upon them. Hence, as organic and mineral acids exist only as traces in soils, we may safely assert that they have no appreciable effect upon them, but that crude ground mineral phosphates must remain inert and useless in the soil; their only possible value in the crude insoluble state consists in the carbonate of lime they contain, which can be purchased at one tenth the price paid for in mineral phosphates.

**Soluble Phosphoric Acid** is produced by the action of sulphuric acid on bone phosphate of lime, phosphate of magnesia, and phosphates of iron and alumina. As carbonate of lime and fluoride of calcium are always found in bones and mineral phosphates, the sulphuric acid first decomposes these substances and produces sulphate of lime, before any phosphoric acid is liberated or rendered soluble, because the above named compounds are held together by a feebler affinity than phosphoric acid with its base. Hence, if an insufficient amount of acid is used to effect both, the phosphoric acid is left in its inert insoluble state. Through the cupidity and ignorance of the manufacturers in purchasing mineral phosphates that contain a large amount of these substances, this is often the case, and thus they neglect their own, as well as the interest of the farmer. Again, as all mineral phosphates contain peroxide of iron and alumina, some as much as 15 per cent., a much larger amount of sulphuric acid is required to render the phosphoric acid soluble than otherwise, because the phosphoric acid first liberated combines with the peroxide of iron and alumina and becomes insoluble, and an additional amount of acid is required to again liberate it from this peroxide of iron and alumina. Hence, the importance of the buyer knowing the percentage of these substances in the mineral phosphate, and the amount of sulphuric acid used. Here again buyers are defrauded, in consequence of the manufacturer using an insufficient quantity of acid. (See page 55.)

Sulphuric acid being the agent used to render phosphoric acid soluble, we shall now show how much is required. Oil of vitriol, or the strongest sulphuric acid of commerce, known as 66° acid, contains 75 per cent. of anhydrous sulphuric acid.

Each per cent. of the following compounds will require, to render them soluble, the following amounts of 66° acid, or oil of vitriol:

| | | |
|---|---|---|
| 1·00 Carbonate of Lime requires.... | 1·066 | Sulphuric Acid. |
| 1·00 Bone Phosphate of lime........ | 0·688 | " |
| 1·00 Basic Phosphate of Magnesia. | 0·810 | " |
| 1·00 Fluoride of Calcium.......... | 1·367 | " |
| 1·00 Alumina...................... | 3·110 | " |
| 1·00 Protoxide of Iron............ | 1·480 | " |
| 1·00 Peroxide of Iron............. | 2·000 | " |

The above Table is very valuable both to the manufacturer and the farmer. The manufacturer can readily calculate how much acid is required by bones or any mineral phosphates, of a known composition, to render all the phosphoric acid soluble. And when a superphosphate of lime is represented to contain a certain percentage of soluble phosphoric acid, the farmer can very nearly estimate the amount of sulphuric acid used, and also the expense incurred by the manufacturers. The application of sulphuric acid to carbonate of lime or fluoride of calcium, dissipates the carbonic acid and fluorine gases, causing a loss of weight, as follows:

| | | |
|---|---|---|
| 1·00 Carbonate of lime loses.... | 0·44 | Carbonic Acid. |
| 1·00 Fluoride of Calcium....... | 0·512 | Hydrofluoric Acid. |

To illustrate this matter fully, we will take for example 100 lbs. of ox bones, which have the following composition:

| | | | Sulphuric Acid. | Loss in gas. |
|---|---|---|---|---|
| Gelatin................ | 30·58 lbs. | | | |
| Phosphate of Lime.... | 58·30 " | require | 40·165 lbs. | |
| Carbonate of Lime.... | 7·07 " | " | 7·536 " | 3·11 lbs. |
| Fluoride of Calcium.... | 1·96 " | " | 2·689 " | 1·00 " |
| Phosphate of Magnesia. | 2·09 " | " | 1·692 " | |
| | 100·00 lbs. | | 52·082 lbs. | 4·11 lbs. |

The resulting compounds, formed by the addition of the sulphuric acid, are as follows:

| | |
|---|---|
| Hydrated Sulphate of Lime or Plaster..... | 81·17 lbs. |
| Superphosphate of Lime.... ............ | 44·00 " |
| Superphosphate of Magnesia............. | 1·73 " |
| Hydrated Sulphate of Magnesia........... | 3·91 " |
| Gelatin .................................. | 30·58 " |
| Carbonic Acid gas liberated and lost......... | 3·11 " |
| Hydrofluoric Acid " " " ...... | 1·00 " |

The above fully explains the theory of converting insoluble phosphates into superphosphates.

The following Table shows the average cost of the materials, and the weight produced. As the sulphate of lime produced requires two equivalents of water for its formation, if the bones be perfectly dry, it would be necessary to add water in about the proportion shown below.

This water should be thoroughly mixed with the bones before the acid is applied.

| | | |
|---|---|---|
| 100 lbs. | Bones, at $1\frac{1}{4}$ cents per lb. | $1.25 |
| 52 " | Sulphuric Acid, at $2\frac{1}{2}$ cents | 1.30 |
| 25 " | Water | |
| 177 " | | $2.55 |
| 4·11 " | Loss in Gases. | |
| 172.89 " | | |

From the above Table we find that the material of one ton of such superphosphate of lime costs the manufacturer $29.50. As the 100 lbs. of bones contain 28.05 lbs. of phosphoric acid, the 172.89 lbs. of the combination would contain the same with 5 lbs. of nitrogen; and one ton would contain 324 lbs. of soluble phosphoric acid, and 57 lbs. of nitrogen, showing the ton of superphosphate to be worth to the farmer as follows (assuming $12\frac{1}{2}$ and 15 cents. per lb. as the value of soluble phosphoric acid and nitrogen):

| | | |
|---|---|---|
| 324 lbs. | of Soluble Phosphoric Acid, at $12\frac{1}{2}$ cents | $40.50 |
| 57 " | of Nitrogen in organic matter, at 15 cents | 8.55 |
| | Bags | 2 00 |
| | | $51.05 |

The cost to the manufacturer is, as follows:

| | | |
|---|---|---|
| 1157 lbs. | of Bones, at $1\frac{1}{4}$ cents | $14.47 |
| | Grinding, at $5 per ton | 2.89 |
| 602 lbs. | Sulphuric Acid, at $2\frac{1}{2}$ cents | 15.05 |
| 288 " | Water | |
| 2047 " | Labor and Bags | 5.00 |
| 47 " | Loss in Gases | |
| 2000 " | Total cost | $37.41 |

This superphosphate of lime would show, by analysis, the following percentage of the substances named below:

| | |
|---|---|
| Nitrogen in organic matter | 2·85 |
| Soluble Phosporic Acid | 16·20 |
| Equal Superphosphate of Lime | 26·70 |
| Equal to Bone-phosphate rendered sol. | 35·37 |

The reader will observe that a superphosphate of the above quality can be manufactured at a cost of $37.41 per ton, and is worth $51.05 to the farmer; and if sold at $50, allows a profit of 33⅓ per cent. on its cost—quite enough for any honest business. He will also observe that 12½ cents per lb. for soluble phosphoric acid (the value we have assumed in our calculations), is a fair valuation, inasmuch as that assumed value allows a large profit. We shall show hereafter that 15 cents per lb. is a fair valuation for nitrogen in organic matter; and further, he will observe by turning to the analyses of leading manures given in Chap. VII., and comparing the percentage of valuable ingredients in them, with that of the phosphate above described, that *one ton* of the latter is really worth *two tons* of any of them, which are sold at from $50 to $55 per ton. How great then are the profits of manufacturers, and the imposition upon purchasers!

We shall now show what soluble phosphoric acid costs the manufacturer, when he uses South Carolina mineral phosphate as a raw material. To illustrate this, we will take for example No. 12 on the Table of Analyses, page 142. This analysis is very near the general average, and 100 lbs. of such phosphate will require the following amount of sulphuric acid; the amount of gas liberated is also shown.

These analyses are very imperfectly rendered, the carbonates of lime and magnesia, and the phosphates of iron and alumina being given altogether, with no statement of the amount of phosphoric acid combined with them. As these guanos contain but a small amount of magnesia, we shall estimate the carbonates as carbonate of lime, and estimate the phosphate of iron and alumina given, as phosphate of iron.

| | | | Sulphuric Acid. | Gas liberated. |
|---|---|---|---|---|
| 50·07 lbs. | Phosphate of Lime, | require | 34·448 | |
| 0·69 " | " " Iron, | " | ·730 | |
| 10·14 " | Carbonate of Lime, | " | 10·819 | 4·46 |
| 39·10 " | Organic matter, Sand, etc., | | | |
| 100·00 " | | | 45·997 | |

A ton of superphosphate of lime manufactured from this guano, would cost, as follows; as in the case of dry bones, should this guano be in a very dry state, about the same amount of water should be used:

| | | |
|---|---|---|
| 1207 lbs. | of Mineral Phosphate, at 20 cents per unit..... | $5.62 |
| 553 " | of Sulphuric Acid, at $2\frac{1}{2}$ cents.............. | 13.45 |
| 289 " | of Water.................................. | |
| | Cost of Grinding and other labor, at $5 per ton... | 3.01 |
| | Labor of mixing, and Bags.................... | 5.00 |
| 2049 " | | $27.08 |
| 49 " | Loss in Carbonic Acid Gas. | |
| 2000 " | | |

This ton of superphosphate of lime contains 280 lbs., or 14 per cent. of soluble phosphoric acid; and estimating the value of the ton from the value of this article at $12\frac{1}{2}$ cents per lb., gives

| | |
|---|---|
| 280 lbs. of Soluble Phosphoric Acid, at $12\frac{1}{2}$ cents.... | $35.00 |
| Bags.................................. | 2.00 |
| Value to farmer.................. | $37.00 |

This value allows a profit of $9.92 per ton to the manufacturer, which is nearly 33 per cent., if it is sold to the farmer at its real value. But if sold at $50 per ton, the usual price, the manufacturer makes $22.92, which is a profit of $84\frac{1}{2}$ per cent. on the cost of the article; and the purchaser is cheated out of $13 on every ton he purchases, because the manufacturer exacts for it $13 more than it is really worth.

But the real state of the case is much worse than this. The above shows what are the profits to the manufacturer when *the best possible article is made,* and the loss to the farmer when he pays $50 per ton for it. The manufacturers make an article much inferior to the above, by using an insufficient amount of sulphuric acid, and as much water as possible.

For the sake of illustration, we will show the value of a superphosphate of the following composition, which is a better one than is usually furnished by manufacturers, as a comparison of the analysis we give of it, with that of the analyses of celebrated manures given in Chap. VII., will show.

| | | |
|---|---|---|
| 1512 lbs. | Mineral Phosphate, at $10 per ton.... | $ 7.31 |
| 250 " | Sulphuric Acid, at 2½ cents per lb.... | 6.25 |
| 300 " | Water ............................ | |
| 2062 " | | |
| | Grinding, Labor, Bags, etc............ | 8.50 |
| 62 " | Loss in Gas. | |
| | Total cost.......... | $22.06 |
| 2000 " | | |

This *attempt* at making a superphosphate would, on analysis, show very nearly the following composition :

| | |
|---|---|
| Soluble Phosphoric Acid.............. | 6·32 per cent. |
| Equal to Superphosphate of Lime..... | 10·41 " " |
| Insoluble Phosphoric Acid............ | 10·97 " " |
| Equal to Bone Phosphate............ | 24·00 " " |

A ton of this contains 346 lbs. of phosphoric acid, 126½ lbs. of which is soluble and 219½ lbs. insoluble; and the value of a ton to the farmer would be as follows :

| | |
|---|---|
| 126½ lbs. Soluble Phosphoric Acid, @ 12½ cents.......... | $15.81 |
| 219½ " Insoluble, of no value as shown, (see page ) | |
| Bags........................... | 2.00 |
| | $17.81 |

Here we have an article of absolutely less value than the materials and labor used in preparing it—the cost being $23.06, and the real value, only $17.81. But the manufacturer in selling it at $50 per ton, more than double the cost, makes $27.94, which is a profit of 111¾ per cent.; and the farmer who pays $50 for it, and to whom it is worth only $17.81, is cheated to the amount of $32.19 in every ton he purchases. The farmer must bear in mind that he gets in many cases, as the analyses in Chap. VII. show, even a poorer article than the above, and hence, is cheated to a still greater extent.

Most of the superphosphates (so called) that are now in the market contain only from a tenth to one-half of the phosphoric acid in a soluble condition, because an insufficient amount of sulphuric acid is used; the balance, being insoluble, is of no value to the farmer, if it is contained in mineral phosphate, though it may have a value of 4½ cents per lb. to the manufacturer, as a raw material to make soluble phosphoric acid from. They would fain make the farmer believe that it is worth 4½ cents per lb. to him; but if we did not attempt to correct this idea, we should consider ourselves a party to the frauds of the manufacturers in their attempts to reap enormous profits by statements which both science, experiments and observation prove to be false. Insoluble phosphoric acid, exceeding 3 or 4 per cent. in any manufactured superphosphate, is proof positive of ignorance of the requirements of his business, cupidity or dishonesty, or it may be all three, on the part of the manufacturer.

Some manufacturers in giving analyses of their fertilizers, use the term "Soluble Bone Phosphate." There is no such substance as soluble bone phosphate. There is *Bone Phosphate*, and 14 parts of it equal only 6·41 parts of phosphoric acid. By using the term "Soluble Bone Phosphate," they desire to convey the impression that the purchaser gets more than double the amount of soluble phosphoric acid that he really does. If the manufacturer uses the term "Soluble Bone Phosphate," 5¾ cents is the measure of value for it per lb., instead of 12½ cents, as for phosphoric acid, and the farmer should be careful in purchasing to note this. No honest manufacturer who understands his business uses the term.

**Ammonia and Nitrogen**, as found in manures, are technically called Actual Ammonia and Potential Ammonia. In most manures, and especially those mai. factured from organic substances, the amount of actual ammonia is very small. It requires no reasoning to prove that actual ammonia is far more valuable than nitrogen in the form of so-called potential ammonia, as the first named as found in Peruvian Guano, fermented dung, and urine has a marked effect upon the growth of plants, while other substances that are not quickly and readily decomposed, such as wool, horns, hoofs, etc., may contain an equal amount of nitrogen, and yet have no apparent effect upon the growth of vegetation.

Manufacturers in giving analyses of their manures make no distinction between nitrogen as actual ammonia, and nitrogen in organic matter; but both are given as actual ammonia. But as we have determined the amount of each in the manures analyzed (Chap. VII.), we shall give them a value as nearly in accordance with the condition in which they are found as possible. We shall be guided by the same rule in the valuation of this article, as we were with phosphoric acid, viz:—the cost of production and preparation, and its value in the different materials from which the manufacturers obtain it. Nitrogen is usually procured from the following sources of supply:—Peruvian Guano, bones, hoofs, horns, blood, and other organic remains, also from the crude sulphate of ammonia. All the salts of ammonia are soluble in water, and are directly available as plant food. Ammonia is contained in Peruvian Guano, as actual and potential, in about equal proportions.

Professor Johnson says, "Peruvian Guano is genuine and good when it contains 15 per cent. of ammonia, and the same amount of phosphoric acid." About one-third of this acid is soluble in water; it also contains an average of 3 per cent. of potash; and at the prices quoted below a ton would show a value, as follows:—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7½ | per cent. of | Potential Ammonia, | = | 150 lbs. | @ 15 | cents,.... | $22.50 |
| 7½ | " " | Actual Ammonia, | = | 150 " | @ 25 | " .... | 37.50 |
| 5 | " " | Soluble Phosphoric Acid | = | 100 " | @ 12½ | " .... | 12.50 |
| 10 | " " | Insoluble, as in bones, | = | 200 " | @ 4½ | " .... | 9.00 |
| 3 | " " | Potash | = | 60 " | @ 8 | " .... | 4.80 |
| | | | | | | | $86.30 |

The price of the first grades of Peruvian Guano is now from $70 to $75 per ton; but as that which is now offered in the market contains about 3 per cent. less of ammonia than the above, this difference in the percentage of ammonia would lessen the value $12 per ton, thus making the calculated value, and the present price asked by dealers, very nearly the same. But when farmers pay $75 per ton for Peruvian Guano, they should be very careful to know the amount of ammonia, phosphoric acid and potash it contains; and from the amount of these, calculate its real value, in order to know whether they are getting the worth of their money.

**Crude Sulphate of Ammonia** is sold at about 6 cents per lb., and contains, on an average, about 25 per cent. of actual ammonia, which would cost for actual ammonia per lb., in this form, about the same as in Peruvian Guano. But it has advantages in this shape. As sulphate of ammonia is a fixed neutral salt, there is no loss by volatilization, as is the case with the guano; it also becomes fixed in the soil, and can be assimilated by plants in the proper proportions needed; and there is no unnatural stimulation, as is often the case with Peruvian Guano.

These are the most important sources of actual ammonia, and are the most convenient and economical medium of applying it as a manure; and from these deductions we shall fix the price of nitrogen, as contained in bones, blood, fish scrap, etc., at 15 cents per lb., and the actual ammonia that is found in commercial manures, guano, or in sulphate of ammonia, at 25 cents per lb. The justness of these prices will be readily admitted by any one who will give the matter a little thought.

Nitrogen, as potential ammonia, is contained in all manures that are prepared from organic substances, such as bones, dried meat, hoofs and horns, wool, hair, etc. The nitrogen contained in these substances is given out during their decomposition as actual ammonia, and the value of this nitrogen may be calculated by the amount of time required for their decomposition. That nitrogen in this shape is not immediately available as food for plants, and consequently is not so valuable as a manure containing ready formed ammonia, is a fact that requires no reasoning on our part. The decomposition of nitrogenous substances, and the formation of ammonia, is a work of time, and time is money; practical experiments have satisfactorily proved this to be the case. Therefore this potential ammonia cannot be near so valuable as the actual.

The cost of nitrogen in green ox bones can be readily ascertained; if 100 lbs. of these bones contain 26·35 per cent. of insoluble phosphoric acid, and 4·00 per cent. of nitrogen, as this phosphoric acid and nitrogen are the only substances that give bones a value as a manure, we can easily calculate the cost of nitrogen in this form. According to the percentage given, each ton of these bones would contain and show the following value:

| | |
|---|---|
| 527 lbs. Insoluble Phosphoric Acid, at 4½ cents........ | $23.71 |
| 80 " Nitrogen, at 15 cents.......................... | 12.00 |
| Total.................................. | $35.71 |

This is a fair price for ground bones, and hence 15 cents per lb. should be a fair price for the nitrogen contained in them. Fertilizers are sometimes prepared from horns and hoofs; as these substances contain 12 to 15 per cent. of nitrogen, such preparations would command a high price if estimated on the amount contained at 15 cents per lb.; but nitrogen as contained in such substances is very inert, and may remain in the soil for years and not become decomposed, or afford any ammonia to plants. Feathers, wool, hair, and similar substances, contain nitrogen in the same condition. These substances are often found in manures, and it would be very unjust to assign the same value to the nitrogen in such condition as to the actual ammonia contained in Peruvian Guano, sulphate of ammonia, or even the nitrogen contained in bones. From what has been said, the reader can readily see that 15 cents per lb. for nitrogen in organic matter, and 25 cents for actual ammonia, are fair prices to the farmer, and remunerative to the manufacturer.

**Potash** is an essential ingredient of plants, and recently some manufacturers have made it an especial feature of their manures. It is usually applied as crude muriate of potash. This salt is obtained from Germany, where it is found in immense beds similar to rock-salt. It contains about 54 per cent. of actual potash, and costs nearly 8 cents per pound.

Potash is sometimes used in manures as a crude sulphate of potash, this is generally very impure, and contains only 16 to 17 per cent. of potash, and can be purchased in bags for $30 per ton; this would make the pure potash about 8 cents per pound.

Potash salts can be purchased in New York for $70 per ton, guaranteed to contain 80 per cent. of muriate of potash, making the price of pure potash nearly the same as above; consequently we shall estimate the potash as contained in fertilizers at 8 cents per pound, which price is evidently remunerative to the manufacturers.

So that the prices we have adopted to estimate the value of the following substances are for,

| | | |
|---|---|---|
| Insoluble Phosphoric Acid as in bones.... | 4½ | cents. |
| Soluble Phosphoric " " .... | 12½ | " |
| Actual Ammonia........................ | 25 | " |
| Nitrogen in organic matter............. | 15 | " |
| Potash............ .................. | 8 | " |

The above prices are for the strictly pure anhydrous substances; but as many manufacturers in giving analyses of their manures give the following combinations, which are calculated to deceive the farmer, by producing an impression that there is a larger amount of the different substances present, the following Table will be useful in showing the relative value of these combinations with the above prices:

| | |
|---|---|
| Soluble Bone Phosphate................ | $5\frac{3}{4}$ cents. |
| Hydrated Phosphoric Acid.............. | $9\frac{1}{2}$ " |
| Hydrate of Ammonia.................... | $12\frac{1}{7}$ " |
| Muriate of Potash..................... | 5 " |
| Sulphate of " ..................... | $4\frac{1}{3}$ " |

From the difference in the relative prices of the different substances, the farmer can realize the importance of knowing what are the combinations given by the manufacturers, as a basis for computing the value of their fertilizers. And for his assistance, we suggest the following line of questioning to the manufacturer or the dealer, when the farmer intends making a purchase of fertilizers:

## MANUFACTURER'S CATECHISM.

First. What percentage of phosphoric acid (anhydrous), soluble in cold water, do you *warrant* your fertilizer to contain?

Second. What percentage of insoluble phosphoric acid (anhydrous), do you *warrant* your fertilizer to contain?

Third. What percentage of nitrogen, as it exists in raw bone, blood, etc., do you *warrant* your fertilizer to contain?

Fourth. What percentage of *actual* ammonia, do you *warrant* your fertilizer to contain?

Fifth. What percentage of potash, do you *warrant* your fertilizer to contain?

Sixth. What percentage of uncombined water, do you *warrant* your fertilizer to contain?

Seventh. What percentage of *pure* potash is there in the "salts of potash" contained in your fertilizer?

Eighth. What percentage of phosphoric acid is there in the "soluble phosphates" contained in your fertilizer?

If purchasers would make it a rule to propound these questions to manufacturers and dealers, should they not succeed in acquiring the information sought, they would, in most cases, be fully convinced of one thing, viz., the supreme ignorance of both manufacturers and dealers, of the nature of the constituents of what they make and sell.

# CHAPTER VI.

THE NATURE AND VALUE OF NATURAL MANURES—THE NECESSITY OF THIER ACCUMULATION AND PREPARATION—COMPOSTING—HOW IT SHOULD BE DONE—AND THE CHEMICAL ACTION NECESSARY TO BE PRODUCED

There are many substances highly beneficial to vegetation, which are often neglected from ignorance of their value. The excrements and litter of the animals kept on a farm, if properly preserved and prepared, will afford a large amount of valuable manure, and will restore to the soil a considerable portion of the elements of the food on which these animals were fed. But as most farmers raise cattle for sale, the bulk of the most valuable elements of the plants on which they were fed, is removed. Every animal raised, fattened and sold, represents a definite amount of the vital elements of fertility removed from the soil; and the practical farmer should, in order to preserve its average productiveness, return an equal amount in some other form.

Stable manure and litter from the animals kept on a farm, contain all the elements of plants; but if all these materials were saved with scrupulous care, the amount would be insufficient to preserve the normal fertile condition of the soil, and deterioration, with reduced crops, must ensue. It is folly to suppose that the straw and chaff—the least valuable portion of a crop of wheat—will grow another crop of equal amount, or that the excrements of a growing animal are sufficient to grow enough plants to raise another such animal. Therefore the prudent father, who has a care for the interest and prosperity of his children, should endeavor by the best and cheapest means to preserve the fertility of his land. In order to effect this object, he should know the value of all the materials that can be cheaply accumulated on the farm and utilized as manures, as well as of those he has to procure from abroad.

All organic substances contain a portion of all the necessary elements of the plants cultivated; but the amount in some varieties is so small, that the advantage gained would not pay for the labor of collecting and preparing them. The leaves of some trees are rich in some of the inorganic elements of plants, and would amply repay the farmer for collecting and applying them; while others are nearly worthless, and their use as a manure would merely involve a loss of time and labor.

The different manurial substances will be discussed in the following order: Stable manure and cattle dung—night soil—swamp muck—leaves—wood and coal ashes—marl—green manuring, and liquid manures.

**Stable or Barn-Yard Manure** consists of the solid excrements and urine of horses and cows, mixed with the substances used as bedding. Like other substances used as manures, this has two values: one in its natural fresh condition—the other when it is properly fermented. This manure in its natural condition contains every thing necessary for plant food, in an insoluble condition; but as every constituent is in a finely divided state, the action of the carbonic acid generated during fermentation will render silica, phosphoric acid and potash in a condition for assimilation by plants. The nitrogen in organic matter, also, becomes changed to actual ammonia. The value of the straw or other litter can be readily calculated from the Tables on pages 82 and 85. The excrements of animals when fermented, being more active as a manure than when in the natural state, prove conclusively the advantages gained by fermentation. The value of these manures is influenced by other causes. If the food is very rich, the manure will be rich in proportion. The excrements of a growing animal are not nearly as valuable as those of one that is fattening, because the growing animal requires nitrogen to make blood and muscular fibre, also phosphoric acid for the bones. On the contrary, the fattening animal requires but little of these substances. Full grown animals when in good condition require only sufficient food to renew the waste of the system. Horse manure is more valuable than that of the cow, as the latter has to furnish milk, which almost exhausts the food of its nitrogen; also an animal with young will nearly exhaust its food, as it requires not only materials for its own sustenance, but also a sufficient amount to build up its young. Hence the food will be exhausted not only of its nitrogen, but also of phosphoric acid. In fact, the excrements of animals, like other substances used as manures, are valuable just in proportion to the amount of ammonia, phosphoric acid and potash they contain. The reader has been shown how varying circumstances will affect the amounts of these elements; hence it is impossible to arrive at any strictly correct estimate of the value of a given weight of any animal manure. A general average based on extended experiments is given in the following Table, which shows the amount of water, and of the valuable constituents only, contained in 1000 lbs. in its natural undried state:

| | Water. | Phosphoric acid. | Potash. | Nitrogen. | = Ammonia. |
|---|---|---|---|---|---|
| Pig Dung. | 840 lbs. | 8·0 lbs. | 5·0 lbs. | 7·0 lbs. | = 8·5 lbs. |
| Horse " | 743 " | 12·2 " | 28·0 " | 5·4 " | = 6·5 " |
| Cow " | 864 " | 5·2 " | 10·7 " | 3·5 " | = 4·2 " |
| Chicken " | 850 " | 15·2 " | 5·5 " | 21·5 " | = 26·1 " |
| Sheep " | 670 " | 22·7 " | 7·0 " | 7·1 " | = 8·5 " |
| Human " | 750 " | 3·3 " | 1·0 " | 15·0 " | = 18·2 " |

The following Table shows the amount produced annually by a single animal of the kind named, and its value, assuming the phosphoric acid to be soluble, and the nitrogen as actual ammonia.

| | Amount. | Phosphoric acid. | Potash. | Ammonia. | Value. |
|---|---|---|---|---|---|
| Pig | 200 lbs. | 1·6 lbs. | 1·0 lbs. | 1·7 lbs. | = $0.62 |
| Horse | 2000 " | 24·4 " | 56·0 " | 13·0 " | = 9.94 |
| Cow | 2000 " | 10·4 " | 21·0 " | 8·5 " | = 5.15 |
| Chicken | 5 " | 0·076 " | 0·03 " | 0·13 " | = .04 |
| Sheep | 50 " | 1·27 " | 0·35 " | 0·42 " | = .40 |
| Human | 100 " | 0·33 " | 0·10 " | 1·80 " | = .50 |

By the above Tables, the farmer can ascertain the value of the excrements derived from the stock he keeps; they will also show to some farmers the money-value of substances they allow to go to waste, and will serve to correct the extravagant ideas of others, who attribute to stable manure and droppings of animals a higher value than it really possesses.

**City Stable Manures.**—A cart load of the stable manure, usually purchased by farmers from the dealers in cities, and for which they pay $1, should weigh at least 1000 lbs.; it usually weighs only from 500 lbs. to 800 lbs.

The average value of 1000 lbs. of this manure, if as good as ordinary barn-yard manure, *which is not the case,* is as follows:

| | | | |
|---|---|---|---|
| Pure dung............. | 150 lbs., | worth...... | $0.70 |
| Straw or other litter.... | 400 " | " ...... | 0.49 |
| Water and useless matter | 450 " | " ...... | 0.00 |
| | 1000 " | " | Value $1·19 |

If the farmer gets 1000 lbs. of a quality equal to barn-yard manure, for $1, it costs him as much as the same amount of the fertilizing elements would in Peruvian Guano; but when the greater cost of transportation and application to the soil is counted, it costs him much more.

The great object of the parties engaged in this *dung business* in cities, is to buy the largest possible loads for the smallest amount of money from the stable keepers, and then to sell the smallest possible loads for the largest amount of money to the farmers. To accomplish this, they have carts of two sizes; when they buy they use the large size, when they sell they use the small. When they buy, they pack in as much as their large carts will hold; when they sell, the small carts are filled as lightly as possible, by trained men who understand the art of filling a cart with a very small amount of material. Nor is this all. After collecting from the stable keepers, they work directly against the interest of the buyer, by sprinkling their heaps with water and then shaking them out to check fermentation, and thus loss of bulk. This practice of watering and shaking out, besides preventing fermentation, lessens greatly the value of the manure by washing out the elements of the urine—the most valuable part of it—and also by removing the ammonia and soluble salts of the solid excrement. By such means many of these *dung merchants* accumulate large fortunes in a few years; and the farmer in this, as in some other forms of manure, confounds bulk with quality, and prefers a large mass of almost worthless matter to a little of what is valuable.

We shall now show the value of 1000 lbs. of well-rotted and air-dried stable manure, calculated from the analysis of Dr. Vœlcker:

| | | |
|---|---|---|
| Water and organic volatile matter | 670 lbs. | |
| Ammonia | 30 " | $7.50 |
| Phosphoric Acid | 18 " | 2.25 |
| Potash | 20 " | 1.60 |
| | Total | $11.35 |

A ton would be worth $22.70, or equal in real value to a ton of many of the commercial fertilizers sold for $40 or $50. The importance of the fermentation and rotting of manures, and subsequent drying, cannot be overestimated. It saves in the cost of transportation and labor of applying, as well as presents the valuable salts in soluble form, directly available for the wants of the plant to give it a vigorous and healthy start; while plants manured with unfermented, unrotted manure, are deprived of what they need until these operations have taken place in the soil. Oftentimes by this cause they are so stunted in the beginning, that no subsequent application will make amends for the injury then done.

We shall now give the value of the urine of different animals, as shown by the fertilizing salts contained in 1000 lbs. of each :

| | Water. | Phosphoric Acid. | Potash. | Nitrogen. | = | Ammonia. |
|---|---|---|---|---|---|---|
| Pig Urine, | 9·29 lbs. | trace, | 6·0 lbs. | 11.8 lbs. | = | 14·3 lbs. |
| Horse " | 9·40 " | trace, | 2·8 " | 15·4 " | = | 18·7 " |
| Cow " | 9·23 " | trace. | 4·5 " | 4·4 " | = | 5·3 " |
| Sheep " | 9·65 " | 1·3 lbs. | 7·2 " | 13·1 " | = | 15·9 " |
| Human " | 9·57 " | 4·0 " | 2·0 " | 14·2 " | = | 17·2 " |

The following Table shows the amount produced annually by a single animal of the kind named, and its value as manure, when fermented :

| | Yearly amount. | Phosphoric Acid. | Potash. | Ammonia. | Value. |
|---|---|---|---|---|---|
| Pig Urine | 1000 lbs. | trace, | 6·0 lbs. | 14·3 lbs. | $4.00 |
| Horse " | 2000 " | trace, | 5·0 " | 37·4 " | 9.79 |
| Cow " | 2000 " | trace, | 9·0 " | 8·8 " | 2.92 |
| Sheep " | 500 " | 0·6 lbs. | 3·6 " | 8·0 " | 2.35 |
| Human " | 750 " | 3·0 " | 1·5 " | 10·7 " | 3.16 |

The solid and liquid excretions taken together, will show the following annual value:

| | | | | |
|---|---|---|---|---|
| Pig Excrements, | solid | and liquid, | ........ | $ 4.62 |
| Horse | " | " | ......... | 19.73 |
| Cow | " | " | ......... | 8.07 |
| Sheep | " | " | ......... | 2.75 |
| Human | " | " | ......... | 3.66 |

From these Tables, it is plain that too much care cannot be exercised in preserving the excrements of man and animals. Every pound of ammonia that is lost or evaporates, represents the amount required for a bushel of corn; and every pound of the urine of a horse or man, will furnish sufficient ammonia for a pound of wheat; and two and a half pounds of the urine of man will furnish the phosphoric acid, and more than half of the potash required for a pound of wheat.

The foregoing Tables will also show the farmer the value of the manure, and its capacity for raising crops, as estimated from the average amount of stock kept on his farm.

When we consider the great value of the excretions of man and animals, it is astonishing that so little attention is paid to preserving them. These substances, which are comparatively lost in our large cities and towns, represent a value of millions of dollars annually. If the average value of the excretions of the inhabitants of large cities be set down at two dollars for each, which is a low estimate, the reader can readily see the immense value of what is yearly wasted.

**Swamp Muck** is a deposit of vegetable matter in low swampy places; it is in fact partially formed peat. It is usually formed of mosses, grasses, leaves, and branches of trees, partially decomposed, and in a very condensed form. As the most of these deposits have been accumulating for centuries, they have become valuable stores of the fertilizing elements—often much more valuable than stable manure. Professor Johnson gives the average potential ammonia in 33 samples, in the dry state, examined by him, as 3·14 per cent. This alone would make the dried muck worth $6.34 per ton. He did not determine the valuable inorganic matters, such as phosphoric acid, potash, etc.; but it should contain a large amount of them.

As many farmers have deposits of this kind on their farms, they will see the importance of utilizing them. Every opportunity should be taken to procure and dry as much of this substance as possible. When in a dry state, the absorbent properties of dried muck is remarkable. The most putrid and offensive liquids may be filtered through it, and the water will come through perfectly pure and tasteless, the muck absorbing all the soluble salts and volatile gases.

This shows the advantages gained by using dried muck, around stables and enclosures where cattle, sheep or hogs are kept, thus absorbing and deodorizing the liquid and solid excrements.

Sometimes the application of muck in its natural state, is not followed by any beneficial effects, and in some cases it has been positively injurious. This may be explained as follows: All vegetable substances undergoing oxidation or decomposition attain a seeming inert or fixed state; and without the application or action of some powerful agency, such as lime, will remain in that condition for long ages; and when subjected to certain influences, such as heat and great pressure, while in that state, will eventually form coal. We are indebted to this property of decaying vegetable matter, for the vast stores of peat and coal that are stored up in the earth. Without this property, all organic substances would be speedily dissipated, as carbonic acid gas, ammonia, etc.; and even the mould, or organic portion of soils, would be resolved into a gaseous state and be dissipated in the atmosphere. Although this property of partially decayed organic matter is the cause of its preservation, it materially unfits it for the production of cultivated plants, as it cannot, in this inert condition, give out enough to support them; and it is not improbable that it imparts, to some extent, the same property to the soils to which it is applied in large amount, and besides, favors the growth of many noxious weeds. A similar condition exists in old meadow lands that have lain fallow for years, which the farmer terms sour, and which are invariably benefited by the application of lime. Hence the importance of *composting* swamp muck and peat, to effect what may be termed the second stage of decomposition, which will render it available as food for cultivated plants. Some authorities recommend the burning of peat, and the subsequent application of the ashes, as a manure. Those who recommend such a course have but a superficial knowledge of its composition; the most valuable portion of it is the nitrogen or potential ammonia, which would be entirely lost by this process; and besides, the value of the ash in furnishing the organic elements of plants, would not repay the farmer for his trouble.

**Mud**, as found in the bottoms of ponds, ditches, and sunken places, has a very different composition from swamp muck. Still some deposits of mud are valuable as manure, and would amply repay the farmer to collect and apply it. As it contains only a small amount of organic remains, it has but little value in composting.

**Dried Earth.**—The absorbent and deodorizing properties of dried earth, and the benefits that would be derived from its use around stables and cattle-sheds, by catching and absorbing the liquid droppings of animals, is too little understood or appreciated by farmers. A large amount of valuable manure could be prepared yearly by this means alone, without much trouble or expense, as the urine of animals—the most valuable portion—is too often allowed to go to waste.

**The Leaves of Trees**, when well rotted in the compost pile, is a very valuable source of fertilizing elements, as the following Table, showing the amount of the substances named, contained in different varieties in their dry state, demonstrates:

| | | Phosphoric acid. | Potash. | Lime. |
|---|---|---|---|---|
| Mulberry | Leaves. | 0·36 per cent. | 0·69 per cent. | 0·90 per cent. |
| Horse-chestn't | " | 0·61 " | 1·47 " | 3·04 " |
| Walnut | " | 0·28 " | 1·86 " | 3·76 " |
| Beech | " | 0·28 " | 0·35 " | 3·03 " |
| Oak | " | 0·40 " | 0·17 " | 2·38 " |
| Fir | " | 0·23 " | 0·14 " | 0·58 " |
| Red Pine | " | 0·48 " | 0·09 " | 0·88 " |

From the above Table the farmer can readily estimate the value of these substances, and see how far they will enable him to produce valuable crops. To render them immediately available as plant food, they should be intimately mixed with the other ingredients of the compost heap.

**Wood and Coal Ashes** contain a variable amount of potash and phosphoric acid. The former would amply repay the farmer for applying them; but to render them more immediately available as food for plants, they should be thoroughly incorporated with the compost pile, as will be shown; 100 lbs. of the varieties of wood and coal ashes given, contain the following amounts of potash and phosphoric acid, with its value for agricultural purposes annexed, estimating the phosphoric acid as insoluble, at 4½ cents per lb.

| | Phosphoric acid. | Potash. | Value of 100 lbs. |
|---|---|---|---|
| Beech | 5·3 lbs. | 16·1 lbs. | $1.51 |
| Birch | 8·5 " | 11·6 " | 1.45 |
| Oak | 5·5 " | 10·0 " | 1.05 |
| Walnut | 12·2 " | 15·3 " | 1.77 |
| Poplar | 13·1 " | 14·0 " | 1.71 |
| Apple | 4·6 " | 12·0 " | 1.16 |
| Red Pine | 5·1 " | 5·2 " | .64 |
| Coal Ashes (*anthracite*) | ·5 " | 0·15 " | .3 |
| Peat " | 2·0 " | 0·2 " | .11 |

The phosphoric acid contained in ashes, is combined with peroxide of iron, magnesia and lime; but as it is in a finely divided state, the action of the carbonic acid generated in the compost pile will liberate it from its bases, and render it immediately available to plants in a soluble state, worth 12½ cents per lb. The leaching of wood ashes does not remove *any* of the phosphoric acid, nor all of the potash; this fact explains the value of what is termed spent ashes as a manure. Hence, farmers can see the importance of emptying their old ash gums and barrels, and thereby getting a return for their contents in the shape of wheat and corn. The reader can also see, from the Table given, that wood ashes is worth as much, pound for pound, as many of the leading commercial fertilizers that cost the farmer $50 per ton.

Coal and peat ashes do not furnish much of the ingredients required as food by plants, but their application would have a beneficial physical effect on some heavy compact soils; and as these substances cannot possibly do injury to any soil, farmers should spread them over their land, and not let them lie in unsightly piles about their houses and yards.

**Soot** from our chimneys and stove-pipes has a value as manure, but it is entirely neglected in this country. English farmers have derived great benefit from its application. Where wood and bituminous coal are used for fuel, thousands of tons are yearly wasted. The following Table shows the quantity of fertilizing elements generally contained in 1000 lbs. of soot, and their value.:

| | | |
|---|---|---|
| Gypsum or Plaster........ | 50 lbs. | $0.75 |
| Phosphoric Acid.......... | 7 " | 0.87½ |
| Potash.................... | 10 " | 0.80 |
| Ammonia................. | 17 " | 4.25 |
| Total .................... | | $6.67½ |

**Marl** is a term used to designate earthy substances containing a variable amount of carbonate of lime, supposed to be derived principally from the shells of fishes. The amount of carbonate of lime is usually from 10 to 20 per cent. There is a great variety of substances designated as marl, but they may all be reduced to four general kinds: clay, stone, shell, and green-sand marl. The first very nearly resembles clay; this variety usually contains from 10 to 20 per cent. of carbonate of lime, and its value as a manure must be attributed to the action of that substance. Stone marls are generally richer in carbonate of lime than the clay varieties, and are a nearer approach to the ordinary carbonate of lime. Shell marl contains a large amount of shells partially decomposed; its action on soils is more immediate, because it is more soluble than the clay and stone varieties. Green-sand marl is most valuable of all; it generally contains a small percentage of carbonate of lime, seldom exceeding 5 per cent., while it contains potash in an insoluble condition in amounts varying from 2 to 7 per cent. It is by some considered quite as valuable, weight for weight, as wood ashes; it also generally contains a small amount of insoluble phosphoric acid, and its application on what were considered worn out lands has been followed by remarkable results. Where these marls abound, they are a cheap and efficient manure for the farmer, and should not be neglected; marl also forms a valuable adjunct to the compost pile.

**Green Manuring** consists in plowing under any crop that has been grown for that purpose. It has been recommended and practised for centuries. Spent or worn out soils are especially benefited by this operation, and no soils can be so far reduced, unless they refuse to grow any kind of vegetation, that they cannot be improved by this means. The least thought devoted to the subject will convince the reader of its superiority over paring and burning, or leaving the land fallow. In the former case, the act of burning dissipates all the nitrogen, the most valuable part, and the ash contains the other fertilizing substance in an *insoluble* condition, potash excepted, because the greater part of the carbonic acid formed, which is naturally the principal agent in rendering them soluble, is dissipated; while, on the other hand, when plowed under, the carbonic acid is slowly given out during the process of decay, and so makes the elements soluble. The gradual decay of vegetation on the surface of the land produces a like result, though in a less degree.

By growing plants with long roots, such as clover and some kinds of grasses, and root crops, such as beets, carrots, etc., the fertilizing elements often contained in the subsoil are brought to the surface; and then by plowing the crop under it soon decays, and the fertilizing elements contained are stored up for future crops. In practising green manuring, the farmer has to sacrifice an immediate benefit for a greater future good, which may sometimes be considered of doubtful advantage. But when he has once tried the experiment, and noted its effects on future crops, he will find not only the value of the crop plowed under returned to him, but a large percentage in addition. Besides all this, the previous plowing is paid for, in making subsequent cultivation easier, and in rendering the soil in a more finely divided state, which is a very important consideration in growing all kinds of crops.

To derive the most benefit from green manuring, the plowing should be performed before the formation of the blossom, or seed, as the blossoms give off nitrogen, and the seeds may become a subsequent source of trouble; also, the plowing should be shallow, so as to keep the vegetable matter near the surface, and within easy access of the oxygen of the atmosphere. But the reader must not think for a moment that green manuring *alone* is sufficient to keep his land in a fertile condition. The benefits derived from this treatment of the land can exist only for a limited period, and the subsoil must eventually become exhausted as well as the surface. The prudent farmer must anticipate this state of things, by the application of other manures.

Finally, we may remark that mere rest, without plowing; or the non-production of any vegetable substances on a soil, does not benefit it. It is growing vegetation that effects the needed chemical changes in the soil. Hence the farmer should endeavor by all means to promote the growth of as many plants as possible, on the land he intends to plow under for the production of another crop.

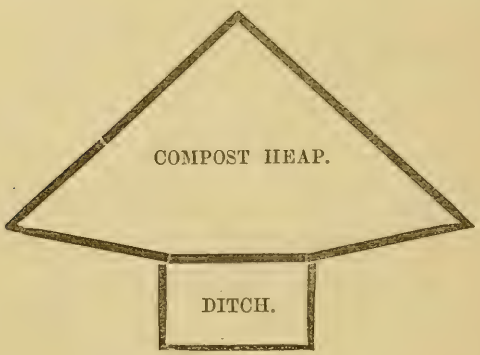
**Liquid Manures** are held in high repute in some countries, on the principle that it is better to manure the plant than the soil. It may be employed advantageously in truck farming, but is not at all suited to the general agriculture of this country. If the farmer has a valuable liquid or semi-liquid fertilizing substance, it is much better to mix it with dried muck, or mould, and apply it in as dry a state as possible; thus divesting its application of its disagreeable features, and preventing the escape of the most valuable portion of it—the ammonia.

**Composting.** This highly important operation is too often neglected by our farmers. This neglect very probably results from ignorance of the great benefits that can be derived from it. The reader has acquired a knowledge of the value of the waste substances accessible to the farmer, and which can be economically applied as manures. He has also been informed of the necessity of having these substances in a decomposed state, in order to make them efficient.

To be successful in composting, it is necessary for the farmer to have correct ideas of the chemical changes and effects to be produced, and of the means and appliances by which these changes can be economically effected; he should also know the conditions that promote or impede these changes. In the proper management of a compost heap, two leading points are to be attained; First, the hastening of the decomposition of the substances used; Second, the fixing of the fertilizing gases as they are formed. No offensive odors should escape. When such escape, some substance should be applied at once to check it.

Some persons have recommended making the heap in a circular conical shape, with a well in the centre to catch the drainage, and with a common wooden pump set in it, so that as the drainage collects, it can be pumped up and allowed to trickle over the top of the heap, and thoroughly permeate it. There are two vital disadvantages attending this method, which we will point out: First, the amount of heat produced is a correct index of the rapidity with which the decomposition is being effected; and any application of water operates to diminish the heat already generated, and consequently to retard the decomposition. All the substances commonly used in compost heaps, contain a much larger amount of water than is needed to aid decomposition; it is the oxygen of the atmosphere, not water, that is most needed. The second disadvantage attending this pumping and sprinkling operation, is the *loss* of the free ammonia contained in the water, which escapes into the atmosphere. This should not be assisted by agitating the water, but should be prevented by the proper agencies.

We recommend the following mode of operation, which obviates all the disadvantages of the former method, and which will recommend itself by saving a great deal of labor in the subsequent working:—An elevated piece of ground, as near to the materials as convenient, should be selected—the side of a gradual incline, if possible. The intended compost heap should be from ten to fifteen feet wide at the base, with both sides regularly inclining toward the centre, like the roof of a house; the heap to extend lengthwise, as far as needed, up and down the incline. This arrangement prevents any accumulation of water around the heap, and also lessens the labor of turning over, as the heap may be turned downhill. The next consideration is to prepare the bottom, or the drainage. Of course none of the fertilizing moisture contained in the material should be lost, neither should there be any additions to it in the shape of rain water. To effect this, a ditch should be dug lengthwise of the intended heap. This drain, at the lower end, should extend several feet beyond the heap, and be six inches below the level of the ground. It should have a gradual ascent of one or two feet, according to the length of the heap. The bottom should incline towards the ditch, the dirt taken from which will generally be sufficient for this purpose. The following plan is an end view of the compost heap, showing the shape of the bottom, and the ditch for drainage:




The sides and bottom of the centre drain should be boarded, and the top covered with any rough pieces of board or wood, with apertures close enough to prevent the compost from falling through, and still give free passage to the drainage water into the ditch. The farmer would also consult his interest by having the floor of the heap covered entirely with boards.

Everything being prepared for constructing the heap, we will make a few suggestions about the collection and depositing the materials preparatory to mixing. Barn-yard manure and muck are the principal ingredients. Every cart load of barn-yard manure should be mixed with two cart loads of swamp muck, or with any other deposit that contains plenty of vegetable matter, except weeds that have gone to seed. The muck should be dug in a dry season, and spread out, so that it may be deprived of a great deal of its water, which will greatly lessen the labor and expense of hauling it to the compost heap; and when there, it will be in much better condition for fermentation and consequent decomposition. The materials should be hauled to the heap in the proper proportions, so that they can be thoroughly mixed, and the work of piling up be commenced at one end, and the heap be finished to the top as fast as sufficient material is procured. The advantage gained by this course, over that of putting layer upon layer over the whole ground plan of the heap, is that if the heap is finished as you proceed, fermentation sets in sooner; and as the pile gradually lengthens, the fermenting process passes the whole length of it; so that by the time the farmer has collected all his material and finished the heap, that part of it which was first completed, will probably be ready to turn over. The heap, when finished, should be covered with a temporary roof, to keep out the rain.

When the farmer is collecting material for his compost, nothing should be overlooked. In addition to his stable manure, his hog pens should be thoroughly cleared, and all the night soil, chicken dung, wood and coal ashes, sawdust, leaves, corn-stalks, straw, soap suds, fish or meat brine, and even old mortar, should be thoroughly mixed together in the heap; and to every load of material, 20 to 25 lbs. of plaster or gypsum should be added, for reasons that will be presently shown. When the farmer has brought all together, he will astonish even himself by the amount he has procured; and if he attends to our directions, he will be far more astonished at the results, as shown in greatly increased crops.

The most valuable substances contained in the material of the compost heap are Silicate of Potash, Phosphate of Lime, and Nitrogen as Potential Ammonia. The chemical changes effected on these substances by fermentation may be briefly stated, as follows: Fermentation and putrefaction are generally considered distinct processes, but the chemical operation of each is precisely the same; it is simply a union of the carbon contained in the dead vegetable or animal matter, with the oxygen of the atmosphere, or the oxygen of the water present in the substance. This chemical union of oxygen and carbon produces carbonic acid gas, the properties of which have been fully explained. The action of this gas on the silicate of potash, separates the potash from the silica and forms carbonate of potash, the silica being liberated, as hydrated silica. This change renders both substances immediately available, as food for plants. Before the change, they were in an insoluble condition, and, if contained in unrotted straw, might remain in the soil a year or more, without benefiting growing vegetation. As the phosphate of lime contained in plants is in the most finely divided state, the carbonic acid attacks and decomposes this compound, forming carbonate of lime, and liberating the phosphoric acid in a soluble condition, for the use of the plant.

There is a remarkable chemical law, namely: that some elements have no affinity for each other, and hence will not form compounds unless *one or the other* is present in what is termed the *nascent state*, that is, the state in which it exists at the *moment* it is separated from a previous state of combination. For example; the two gases, nitrogen and hydrogen, the elements of ammonia, may be mechanically mixed, but no chemical combination will ensue. But should nitrogen be present when water is being decomposed, the hydrogen being in the nascent state, actual ammonia will at once be formed.

As sulphate of lime or land plaster—which is a compound of sulphuric acid, lime and water—is present in the heap, the carbonate of ammonia formed, decomposes the above compound, producing carbonate of lime and sulphate of ammonia, which is a stable compound, very soluble in water. The formation of this salt prevents loss from the volatilization of the ammonia. This is the object in applying it in the heap. From this the farmer can realize the importance of applying plaster to his compost heap. Still, it must be added with discretion, and not in larger quantity than we have recommended; if too much is added, it will check the fermentation, and thus defeat the object to be attained by composting; 100 lbs. of ordinary unburnt ground gypsum will fix nearly 20 lbs. of ammonia. The sulphuric acid of the gypsum will also act beneficially, in decomposing the mineral substances contained in the vegetable remains. The ammonia formed in the compost heap oftentimes undergoes another change, which may be termed oxidation; being changed from an alkali to an acid, forming nitrates of potash, soda, and lime, if these bases are present. Some chemists hold the opinion that the nitrogen contained in these compounds, is far more valuable than as it is presented in ammonia; but this is a difficult matter to decide, and more extended experiments are required, to enable us to give a positive opinion on the subject. As far as our present knowledge of the matter goes, they are equally valuable, although it is proved that the ammonia is more permanent in the soil than nitric acid.

A valuable addition to the compost heap, is ground bones. This substance furnishes both phosphoric acid and nitrogen; and if the bones are mixed with an equal weight of finely ground gypsum, and fully incorporated with the heap, the farmer will produce his own soluble phosphoric acid, at less than half the cost he would have to pay for it, if purchased from the manufacturers. Again, when the pile is turned over —an operation that must be attended to in order to produce good results—should the farmer detect the smell of escaping ammonia, another light sprinkle of plaster must be applied.

The time required to produce fermentation, varies with the season; in summer, the heap may commence heating in from six to ten days; but in winter, it will require as many weeks.

When it sets in, the heat gradually increases until it has reached a certain point; then it decreases, until it is imperceptible. The pile should then be shovelled over, and a second fermentation will take place as before; this cooling of the pile being caused by the exhaustion of available oxygen in the mass. If the farmer has attended to applying gypsum as directed, there will be no loss or damage produced by overheating.

A great deal of vapor is formed during the fermentation, and a part of it escapes into the atmosphere. The farmer should be careful to note whether it contains any ammonia, which he can do by the smell. If it does, a light sprinkle of gypsum, with a little dry earth, will prevent loss. Part of the vapor condenses as it approaches the surface of the heap, and will gradually find its way into the drain; and as it flows out, it can be mixed with earth or muck, and a little plaster, and thrown on the heap.

One great mistake commonly made by our farmers, is in not allowing the compost heap a sufficient time to become thoroughly decomposed, before applying it. The time required to effect complete decomposition is from one to two years; and should it be used before decomposition is completely accomplished, the farmer does not get that return for his labor in collecting, mixing, and turning over, that he would realize if he waited until the mass is in the most efficient condition.

The practice of mixing up a mass of heterogeneous materials, and letting it stand three, four, or six months, and then applying it to the soil, will not pay for the labor and expense; rather than compost in that manner, it would be better to apply the materials at once to the soil. This quick method of composting—necessarily followed by unsatisfactory results—has brought composting into discredit and disuse by many farmers, who might derive great benefit if they complied with the conditions necessary to success. A still more reprehensible practice than that above stated, is that of using quicklime in compost heaps; *it should never be done.* It has the effect to dissipate the nitrogen and ammonia; besides, it absorbs the carbonic acid, and leaves the organic substances in their original insoluble condition.

It is very necessary that the farmer should know the value of the compost, and the amount that should be applied to an acre. In order to know this, he should keep an account of the loads of barn-yard manure and other substances used; and then, the Tables we have given in this book will enable him to approximate very nearly to the value of the heap, and the amount that should be applied to an acre to produce a given crop.

## CHAPTER VII.

### GENERAL REMARKS—ANALYSES OF COMMERCIAL FERTILIZERS, WITH COMMENTS AND CRITICISMS—METHODS OF ANALYSIS—CONCLUSION.

The general reader, and particularly farmers, should carefully note what is contained in this chapter, as it vitally affects their interests. It will show how unprincipled men, from selfish motives, and by dishonest practices, are stripping them of the hard-earned fruits of honest industry; and will give a limited idea of the extent of the frauds that have been unblushingly practised for years, unchecked and almost unheeded. We have already indicated the cure for these wrongs; and now, when we picture them in their true colors, thinking men, we doubt not, will at once apply the remedy by preparing their own fertilizers, and leaving those of dishonest manufacturers alone.

We have fully proved the justice of the values assigned to the fertilizing constituents of commercial manures by us, and have also shown that the best authorities in this and other countries have set their valuations lower than we have done.

It is possible that manufacturers may object to our allowing them nothing for the insoluble portion of the phosphoric acid contained in their so-called superphosphates. But we have shown by the best authorities, that phosphoric acid as contained in mineral phosphate (the chief ingredient in their phosphates), or even in bones, is not available *as plant food* for many years,—ten, twenty or more,—and the statements of the manufacturers themselves on this subject show that they are right in theory, if not in practice. The most limited knowledge of finance will show that no value should be assigned to it, because if it takes only 10 years to make it available as plant food, the interest would amount to as much as the purchase money; and if it takes 15 years to make it available, the interest with the purchase money amounts to more than the value of phosphoric acid in soluble form. Besides, no farmer would knowingly purchase a fertilizer that requires 10 to 20 years to give him a return for his money. The loss by the use of such a manure is not confined to the loss of the interest on the purchase money, but, in addition, the farmer loses his time and the profitable use of his land, which of itself involves many other losses. Independent of all this, such inert substance should manifestly have no place in a high-priced fertilizer, the very name of which implies that it does not contain it.

The products of the farm are closely scrutinized, and the quality graded, when they are brought to the market, and from this cause many a farmer has not realized from his produce as much as he anticipated. No farmer is allowed to sell the chaff with the wheat, nor portions of the cob with the corn. Butter must be properly made, as the quality fixes the price; and should there be an extra amount of salt used, dishonest motives are at once attributed to the farmer, as intending to make up weight; and should the same butter be found a little deficient in weight, it is at once confiscated. "It is a bad rule that wont work both ways." Hence, should the farmer want crude mineral phosphate, it should be sold to him *as such*, at a cost of $12 to $20 a ton, and not be palmed upon him under the false name of superphosphate at $40 to $60 per ton. We have hitherto dealt in generalities. Having spoken of frauds practised, in the mass, we shall now treat them in detail, and we hope the reader will examine the analyses, and carefully compare them with the statements of these manufacturers. If this be done, our remarks about their frauds will add no additional force to the damning testimony which they themselves have furnished.

## ANALYSES OF WATSON & CLARK'S SUPER-PHOSPHATE.

*Percentage, or amount contained in* 100.

| | 1st Sample. | 2d Sample. | Mean. | |
|---|---|---|---|---|
| Water (expelled at 212° Fah.) | 12·67 | 12·89 | 12·78 | |
| Nitrogen. | 0·17 | 0·19 | 0·18 = 0·22 | of Actual Ammonia. |
| Nitrogen in organic matter. | 0·57 | 0·62 | 0·60 | |
| Potash. | trace | trace | trace | |
| Phosphoric Acid (anhydrous), *soluble* in water at 60° to 70° F. | 5·61 | 5·56 | 5·59 = 9·21 | of Superphosphate of Lime. |
| Insoluble Phosphoric Acid (anhydrous.) | 7·22 | 7·18 | 7·20 = 15·72 | of Bone Phosphate of Lime. |

From the mean of the above analyses, we deduce the following amounts contained in a ton, or 2000 lbs., together with the value of a ton to the farmer:

| | | | | |
|---|---|---|---|---|
| 255·60 lbs. | Water | @ $0.00 | per lb. | $0.00 |
| 4·40 " | Actual Ammonia | @ 0.25 | " | 1.10 |
| 12·00 " | Nitrogen in organic mat. | @ 0.15 | " | 1.80 |
| 111·80 lbs. | Soluble Phos. Acid | @ 0.12½ | " | 13.97 |
| 144·00 " | Insoluble " " | @ 0.00 | " | 0.00 |

Total value as Superphosphate .......... $16.87
Value of bags (say) .......... 2.00

Total value to farmer .......... $18.87

The above phosphate is sold at $45 per ton, involving a loss of $26.13, or 138 per cent., to the farmer on every ton he purchases. He pays for it very nearly 2½ times what it is worth.

## WATSON & CLARK'S SUPERPHOSPHATE.

The above fertilizer, from which the samples for analyses were selected, was purchased from the manufacturers at their office in Philadelphia. It is put up in 200 lb. bags; the one purchased weighed 201½ lbs. Its mechanical condition was good; the mineral phosphate from which it was manufactured had been finely ground, and there were no hard lumps to interfere with its application by drilling. The circular of these manufacturers is a model of its kind. They frankly state the kind of material used, and the source from which it is procured. They give no analyses of their article, which they should do, but say they manufacture a superphosphate of lime—

"Under the supervision of PROF. JAMES C. BOOTH of the U. S. Mint, and every parcel made is analyzed by him or his partner, DR. GARRETT, in order to ascertain if it comes up to the required standard."

They do not inform us what this standard is, but as they profess to manufacture a *super-phosphate*, the required standard should be *that*. The analysis shows by the Insoluble Phosphoric Acid how far they fail. But if we take the price at which it is sold into account, it is one of the cheapest fertilizers in the market; *i. e.*, the farmer gets more of what he needs for his money than in many other fertilizers more strongly recommended.

## ANALYSES OF RHODES' SUPERPHOSPHATE.

*Percentage, or amount contained in* 100.

| | 1st Sample | 2nd Sample. | Mean. | |
|---|---|---|---|---|
| Water (expelled at 212° Fahrenheit). | 7·67 | 7·79 | 7·73 | |
| Nitrogen ............ | trace | trace | trace | |
| Nitrogen in organic matter. | trace | trace | trace | |
| Potash, soluble in acidulated water. | trace | trace | trace | |
| Phosphoric Acid (anhydrous), soluble in water at 60° to 70° F. | 3·63 | 3·40 | 3·52=5·80 | Superphosphate of Lime. |
| Insoluble Phosphoric Acid (anhydrous.) | 15·16 | 15·34 | 15·25=33·29 | Bone Phosphate of Lime. |

From the mean of the above analyses, we deduce the following amounts contained in a ton, or 2000 lbs., together with the value of a ton to the farmer:

| | | | |
|---|---|---|---|
| 154·60 lbs. Water.................. | @ $0.00 | per lb. | $0.00 |
| Trace Nitrogen .................... | @ 0.15 | " | 0.00 |
| 70·40 lbs. Soluble Phos. Acid..... | @ $0.12\frac{1}{2}$ | " | 8.80 |
| 305·00 " Insoluble " " | @ 0.00 | " | 0.00 |
| Total value, as Superphosphate............... | | | $8.80 |
| Value of bags (say)........................ | | | 2.00 |
| Total value to farmer........................ | | | $10.80 |

The above phosphate is sold at $50 per ton, involving a loss of $39.20, or 363 per cent. to the farmer on every ton he purchases; or, in other words, he pays for it $4\frac{3}{5}$ times as much as it is worth.

## RHODES' SUPERPHOSPHATE.

The above fertilizer, from which samples for analyses were selected, was purchased from Messrs. Yarnall & Trimble, Philadelphia. It is put up in bags, marked 200 lbs; the one purchased weighed 201 lbs. The mechanical condition of the fertilizer was good. The manufacturer's circular gives the following analyses, said to be furnished by Prof. Johnson in 1859.

RHODES' SUPERPHOSPHATE OF LIME.

| | | |
|---|---|---|
| Water (expelled at 212°) | 22·25 | 22·34 |
| Matter volatile at red heat | 20·17 | 20·00 |
| Sand and insoluble matters | 1·82 | 2·57 |
| Lime | 14·90 | 15·85 |
| Phosphoric Acid, soluble in water | 13·78 | 13·85 |
| " " insoluble " | ·64 | ·67 |

The above analyses of Prof. Johnson widely differ from our analyses of Rhodes' Superphosphate. We do not question the correctness of the analyses given by Prof. Johnson in 1859, but there is evidently a marked falling off in the quality since that time; and to publish these analyses with his or any other eulogistic statement, at the present time, is a great injustice to the Professor, and shows an evident disposition on the part of the manufacturer or agents to deceive and defraud their customers. As the fertilizer is now manufactured, in connection with the price demanded for it, we cannot characterize it as being anything short of a fraud and a cheat.

### ANALYSES OF BERGER & BUTZ'S EXCELSIOR SUPERPHOSPHATE OF LIME.

*Percentage, or amount contained in* 100.

| | 1st Sample. | 2nd Sample. | Mean. |
|---|---|---|---|
| Water (expelled at 212° Fahrenheit). | 9·15 | 9·08 | 9·12 |
| Nitrogen. | trace | trace | trace=Actual Ammonia |
| Nitrogen in organic matter. | 1·42 | 1·46 | 1·44 |
| Potash soluble in acidulated water. | trace | trace | trace |
| Phosphoric Acid (anhydrous), soluble in water at 60° to 70° F. | 5·23 | 5·18 | 5·21 = 8·59 Superphosphate of Lime. |
| Insoluble Phosphoric Acid (anhydrous). | 8·19 | 8·36 | 8·28 = 18·08 Bone Phosphate of Lime. |

From the mean of the above analyses, we deduce the following amounts, contained in a ton, or 2000 lbs., together with the value of a ton to the farmer.

| | | | | |
|---|---|---|---|---|
| 182·40 lbs. | Water.................... | @ | $0.00 per lb. | $ 0.00 |
| 28 80 " | Nitrogen in organic matter | @ | 0.15 " | 4.32 |
| 104·20 " | Soluble Phosphoric Acid.. | @ | 0.12½ " | 13.03 |
| 165·60 " | Insoluble Phosphoric Acid. | @ | 0.00 " | 0.00 |
| | Total value as fertilizer..................... | | | $17.35 |
| | Value of bags (say)......... .............. | | | 2.00 |
| | Total value to farmer.................... | | | $19.35 |

The above phosphate is sold at $50 per ton, involving a loss of $30.65, or nearly 159 per cent. to the farmer, on every ton he purchases; or, in other words, he pays nearly 2⅗ times as much for it as it is worth.

## BERGER & BUTZ'S EXCELSIOR SUPER PHOSPHATE OF LIME.

The above fertilizer, from which samples for analyses were selected, was purchased at the manufacturers' office, Philadelphia. It is put up in bags marked 200 lbs.; the bag purchased weighed 201 lbs. Its mechanical condition was bad, the mineral phosphate from which it is made had seemingly been ground fine, but the finished product had dried in hard lumps in the bag, which would be a great inconvenience to the farmer if he wished to apply it with a drill. It is strange that these manufacturers do not see the importance of reducing their fertilizers to a powder, before sending them to the farmer, who naturally expects it fully prepared to apply to the soil, either by drilling or by hand. When the farmer has to reduce these lumps to a powder, he is doing the work of the manufacturers for which he pays, and which could be done by them at far less cost.

Messrs. Berger & Butz issue a very *modest* circular. They give no analysis of their fertilizer, which every manufacturer should do, as it alone is the only guarantee of its quality. The amount of soluble phosphoric acid and nitrogen it contains, is far more than in some other fertilizers that are more strongly recommended.

ANALYSES OF "THE MAGNUM BONUM SOLUBLE PHOSPHATE," DUGDALE & GIRVIN SOLE PROPRIETORS, BALTIMORE, MD.

*Percentage, or amount contained in* 100.

| | 1st Sample. | 2nd Sample. | Mean. |
|---|---|---|---|
| Water (expelled at 212° Fahrenheit). | 12·57 | 12·48 | 12·53 |
| Nitrogen ........... | 0·15 | 0·17 | 0·16=0·20 Actual Ammonia. |
| Nitrogen in organic matter. | 0·72 | 0·73 | 0·73 |
| Potash, soluble in acidulated water. | 0·84 | 0·82 | 0·83 |
| Phosphoric Acid (anhydrous), soluble in water at 60° to 70° F. | 4·45 | 4·48 | 4·47=7·37 Superphosphate of Lime. |
| Insoluble Phosphoric Acid (anhydrous). | 6·95 | 6·62 | 6·79=14·82 Bone Phosphate of Lime. |

From the mean of the above analyses, we deduce the following amounts contained in a ton, or 2000 lbs., together with the value of a ton to the farmer :

| | | | | | |
|---|---|---|---|---|---|
| 250·60 lbs. | Water.................... | @ | $0.00 | per lb. | $0.00 |
| 4·00 " | Actual Ammonia.......... | @ | 0.25 | " | 1.00 |
| 14·60 " | Nitrogen in organic matter. | @ | 0.15 | " | 2.19 |
| 16·60 " | Potash.................... | @ | 0.08 | " | 1.33 |
| 89·40 " | Soluble Phosphoric Acid .. | @ | 0.12½ | " | 11.17 |
| 135·80 " | Insoluble " " .. | @ | 0.00 | " | 0.00 |

Total value as fertilizer........................$15.69

Value of bags (say)............................ 2.00

Total value to farmer ..........................$17.69

The above named fertilizer is sold at $52 per ton, involving a loss to the farmer of $34.31, or 194 per cent. on every ton he purchases, or, in other words, he pays for it very nearly 3 times as much as it is worth.

## "THE MAGNUM BONUM SOLUBLE PHOSPHATE."

The above fertilizer, from which samples for analyses were selected, was purchased at the office of Messrs. Dugdale & Girvin, Baltimore, Md. It is put up in bags, marked 167 lbs.; the bag purchased weighed 170 lbs. Its mechanical condition was very bad, being composed almost entirely of coarse, hard lumps, that were pulverized with considerable difficulty, and we should think it would cause considerable trouble to the farmer to prepare it for drilling. Messrs. Dugdale & Girvin are comparatively modest in recommending this fertilizer. They furnish an analysis as follows:

ANALYSIS.

*Made by Prof. W. LeRoy Broun, formerly of Va.*

| | |
|---|---|
| Soluble Bone Phosphate | 13·79 |
| Bone Phosphate, soluble in the soil | 27·94 |
| Ammonia | 3·82 |
| Potash | 4·24 |
| Soda and Magnesia | 2·79 |

This article contains the most valuable constituents in large proportions, and I have no doubt will prove a very valuable Fertilizer. W. LeRoy Broun.

*December* 3*d*, 1870.

We would characterize the above as a garbled analysis, calculated to deceive the purchaser. There is no such compound as "Soluble Bone Phosphate;" the term is absolutely hypothetical. There is Bone Phosphate of Lime, 13·79 parts of which contain 6·32 parts of Phosphoric Acid. But perhaps 6·32 per cent. might not so favorably impress the buyer as 13·79 would; and "Bone Phosphate," with the prefix "Soluble," is used by the dealer to favorably impress the farmer (unacquainted as he generally is with scientific terms) that he is getting more than twice the value he actually receives.

Our analyses and that of Prof. W. LeRoy Broun differ widely. We do not say his is not conscientiously made, because there is a possibility, not to say probability, that manufacturers and dealers submit a sample of one quality to the chemist for analysis, and palm off a greatly inferior quality upon purchasers. Certain it is, that the bag we bought shows no such result as that given by Prof. W. LeRoy Broun.

The Professor's analysis gives 27·94 per cent. of "Bone Phosphate, soluble in the soil;" he does not say in how long, whether it requires ten, twenty, or thirty years. These indefinite statements are calculated to deceive any one who is not fully informed on the subject, and the motives for giving them cannot be too strongly reprehended.

This fertilizer is represented to be composed of Dissolved Bones, Ammonia and Potash; and "entirely free from any adulterative matter." The analyses show that it contains a great deal of something that is not accounted for. The large percentage of water might seem unnecessary to the *uninitiated*. The reader will notice that there is far more of this substance than Superphosphate of Lime, and if he compares the price of this fertilizer with the value, he will naturally come to the conclusion that it is the "Magnum Bonum" (*the great good*) to the manufacturers and dealers, and the "Magnum Malum" (*the great evil*) to the farmer.

Messrs. Dugdale & Girvin say that this "Magnum Bonum is the great GENERATOR and nourisher of Corn, Oats, Grass, Wheat, Tobacco, and other crops and plants." This must be a most wonderful property of this fertilizer, the inference being that the farmer need not use any seed to produce the above crops—the manure itself being a generator.

There might, however, be a great disadvantage connected with its use; the farmer naturally would have a desire to raise a specified crop, the generator might beget corn when he wanted wheat, or oats when he wanted tobacco, or might produce them all heterogeneously. We make these suggestions for the benefit of Messrs. Dugdale & Girvin, so that in future they may be more careful or more specific in giving the qualities of this wonderful manure.

"Consistency is a jewel;" and to show that the proprietors of this wonderful fertilizer are slightly lacking in this virtue, we give the following analysis of the "Magnum Bonum," as given in Messrs. Dugdale & Girvin's advertisement in the "Journal of the Farm," which analysis the reader is requested to compare with the analysis furnished by Prof. W. LeRoy Broun, formerly of Va.

| | |
|---|---|
| Soluble Bone Phosphate of Lime | 15·33 |
| Bone Phosphate of Lime | 19·64 |
| Ammonia (equal to 12 per cent. of Sulphate) | 3·16 |
| Potash | 4·62 |

The laws of the State of Maryland require an analysis of every fertilizer to be plainly marked on each package. The bag of "Magnum Bonum" purchased by us had some blurred and half obliterated marks, which we charitably supposed were intended for an analysis, but we failed to decipher it after expending considerable time endeavoring to do so; this showing conclusively that the intention was to conform with the letter and not the spirit of the law of Maryland. We would suggest to Messrs. Dugdale & Girvin the propriety of using larger letters and figures, thus saving considerable trouble to their customers, as well as saving their own credit.

## ANALYSES OF WHANN'S RAW BONE SUPER-PHOSPHATE.

*Percentage, or amount contained in* 100.

| | 1st Sample. | 2d Sample. | Mean. | |
|---|---|---|---|---|
| Water (expelled at 212° Fahrenheit). | 9·92 | 10·06 | 9·99 | |
| Nitrogen. | 0·37 | 0·42 | 0·40 = 0·49 | Actual Ammonia. |
| Nitrogen in organic matter. | 0·91 | 0·98 | 0·94 | |
| Potash, soluble in acidulated water. | 0·21 | 0·19 | 0·20 | |
| Phosphoric Acid (anhydrous), soluble in water at 60° to 70° F. | 3·47 | 3·25 | 3·36 = 5·54 | Superphosphate of Lime. |
| Insoluble Phosphoric Acid (anhydrous). | 14·30 | 14·46 | 14·38=31·39 | Bone Phosphate of Lime. |

From the mean of the above analyses, we deduce the following amounts contained in a ton, or 2000 lbs., together with the value of a ton to the farmer:

| | | | | | |
|---|---|---|---|---|---|
| 199·80 lbs. | Water.................... | @ | $0.00 | per lb. | $0.00 |
| 9·80 " | Actual Ammonia......... | @ | 0.25 | " | 2.45 |
| 18·80 " | Nitrogen in organic matter. | @ | 0.15 | " | 2.82 |
| 4·00 " | Potash.................... | @ | 0.08 | " | 0.32 |
| 67·20 " | Soluble Phos. Acid........ | @ | 0.12½ | " | 8.40 |
| 287·60 " | Insoluble " " ........ | @ | 0.00 | " | 0·00 |
| | Total value as Superphosphate................. | | | | $13.99 |
| | Value of bags (say)......................... | | | | 2.00 |
| | Total value to farmer......................... | | | | $15.99 |

The above Phosphate is sold at $52 per ton, involving a loss of $36.01, or 225 per cent., to the farmer on every ton he purchases; or, in other words, he pays 3¼ times what it is worth.

## WHANN'S RAW BONE SUPERPHOSPHATE.

The above fertilizer, from which samples for analyses were selected, was purchased from the manufacturers' agents, Messrs. Cruft and Young, Philadelphia. It is put up in 200 lb. bags; the one purchased weighed 203 lbs. The mechanical condition of the fertilizer was only middling; it had not that homogeneous appearance that a first-class fertilizer should present. This condition may be caused by a portion of the Charleston Guano, or other mineral phosphate, of which it is largely composed, being treated with sulphuric acid, and then mixed with another portion of phosphate in its crude state; and the superphosphate, taken as a whole, did not present the appearance of being prepared from substances of "*animal origin.*" For the benefit of our readers we have collated the following extracts from the circulars of the manufacturers of this superphosphate.

No. 1. "Plants during their germination and development require a constant supply of food, and it is necessary that this nourishment be furnished in such a form as to be at once assimilable, and capable of being immediately useful in sustaining their growth."

No. 2. "The experience of the most capable agriculturists throughout the civilized world points to the use of concentrated manures; those which afford all the elements of plant food in a readily soluble form."

No. 3. "The phosphate of lime, as it exists in bones, is insoluble in water, although when placed in the soil it becomes soluble to a very limited extent."

No. 4. "*Quick manures increase the business capital of the farmer.*"

No. 5. "Unlike Peruvian Guano, it (Whann's Raw Bone Superphosphate) does not exhaust the soil, but, on the contrary, it insures a supply of valuable nutriment lasting through several seasons."

No. 6. "The ingredients which enter into the composition of WHANN'S RAW BONE SUPERPHOSPHATE (raw bones, guano, sulphuric acid, potash and soda), are all subjected to thorough chemical analysis before they are purchased. No inert substances are used. The phosphate *is warranted free from adulteration.*"

No. 7. "With the exception of the sulphuric acid, potash, and soda, *every ingredient entering into its composition* is of animal origin."

No. 8. "Our works are under the daily control and supervision of an experienced chemist, and are furnished with a completely appointed analytical laboratory, where analyses are made of every ingredient used in the phosphate."

No. 9. "Dollar for dollar, Whann's Raw Bone Phosphate will go nearly twice as far as Peruvian the first year."

No. 10. "Instead of resorting to indiscriminate puffing for the purpose of forcing sales, the manufacturers have contented themselves with allowing it to speak for itself."

The reader is aware that the qualifying name of this fertilizer is "Raw Bone." We are anxious to know how much of this substance is used by the manufacturers. On a careful examination we found what might be styled a sprinkling of *bone*, but not sufficient for the most limited excuse for giving it the name of "Raw Bone Phosphate." From the amount of soluble phosphoric acid present in a ton, the amount of sulphuric acid used must be very small.

Mr. Whann says, that guano is used, but he does not state the kind or kinds, or the proportions. We hazard the assertion that there is a large amount of Charleston, with a very small amount of Peruvian.

He also notifies us that potash and soda are used. The reader will notice by the analyses, that a ton of his superphosphate contains 4 lbs. of potash, worth 32 cents. The benefits resulting from such an amount cannot be very marked, as it requires 40 lbs. of potash for 25 bushels of wheat with the straw. No adulteration is said to be practised in preparing this superphosphate, but Mr. Whann admits to using soda. We presume he means salt cake or sulphate of soda, usually sold for $10 per ton, or he may apply salt or chloride of sodium. In either case, when Mr. Whann can prove the necessity of the use of soda in any form in a superphosphate, or that a large amount of crude mineral phosphate, which when ground could not possibly cost him over $17 per ton, should be found in a high-priced fertilizer represented to be made from "Raw Bone," and sells for $52 per ton, we will admit that there has been no adulteration practised; and when he can satisfactorily account for the presence of 267·60 lbs. of insoluble phosphoric acid in a ton of his "Superphosphate," and prove that this large amount is of immediate benefit to the farmer or to his crops, we will give WHANN'S RAW BONE SUPERPHOSPHATE all the merit claimed for it; until then we shall consider ourselves as cheated in our purchase of this fertilizer, and claim the right of expressing our opinion freely.

Our farmers should take a lesson from Mr. Whann, and use a little of his caution in making their purchases, by assuring themselves of the quality of what they buy. As Mr. Whann says he keeps a chemist, we think it is due to himself, and to the public, that he should publish a full analysis of his "Superphosphate."

Were the manufacturers of fertilizers who resort to indiscriminate puffing to push forward their products, to inform the farmer as to their quality in a frank manner, by analysis we mean, a different state of affairs would now exist. And if the parties professing to make a Superphosphate from Raw Bones, had fully informed the farmer of the value of Mineral Phosphates, and candidly admitted to using the latter as a raw material, they would at the present time have little occasion to blush, perhaps, over their petty deceits and subterfuges.

## ANALYSES OF SOLUBLE PACIFIC GUANO.

*Percentage, or amount contained in* 100.

| | 1st Sample. | 2d Sample. | Mean. | |
|---|---|---|---|---|
| Water, (expelled at 212° Fahrenheit). | 14·20 | 14·26 | 14·23 | |
| Nitrogen. | 0·83 | 0·87 | 0·85 = 1·03 | Actual Ammonia. |
| Nitrogen in organic matter. | 1·58 | 1·44 | 1·51 | |
| Potash, soluble in acidulated water. | 0·46 | 0·49 | 0·48 | |
| Phosphoric Acid (anhydrous), soluble in water at 60° to 70° F. | 3·87 | 3·74 | 3·81 = 6·28 | Superphosphate of Lime. |
| Insoluble Phosphoric Acid (anhydrous). | 11·03 | 11·23 | 11·13=24·30 | Bone Phosphate of Lime. |

From the mean of the above analyses, we deduce the following amounts contained in a ton, or 2000 lbs., together with the value of a ton to the farmer:

| | | | | | |
|---|---|---|---|---|---|
| 284·60 lbs. | Water ................ | @ | $0.00 | per lb. | $0.00 |
| 20·60 " | Actual Ammónia...... | @ | 0.25 | " | 5.15 |
| 30·20 " | Nitrogen in organic mat. | @ | 0.15 | " | 4.53 |
| 9·60 " | Potash................ | @ | 0.08 | " | 0.77 |
| 76·20 " | Soluble Phos. Acid..... | @ | 0.12½ | " | 9.53 |
| 222·60 " | Insoluble " " ..... | @ | 0.00 | " | 0.00 |
| | Total value as a fertilizer.................... | | | | $19.98 |
| | Value of bags (say)........................ | | | | 2.00 |
| | Total value to farmer ...................... | | | | $21.98 |

The above fertilizer is sold at $50 per ton, involving a loss of $28.02, or 128 per cent. to the farmer on every ton he purchases; or, in other words, he pays more than 2¼ times as much as it is worth.

## SOLUBLE PACIFIC GUANO.

The above fertilizer, from which samples for analyses were selected, was purchased at the office of the agent of the manufacturers, Philadelphia. It is put up in bags marked 200 lbs.; the one purchased weighed 195 lbs., being 5 lbs. deficient weight on the bag, or 50 lbs. on the ton. Farmers in purchasing fertilizers should pay particular attention to this matter; as this fertilizer is sold at 2½ cents per lb., this deficiency in weight is a direct loss of $1.25. We have estimated the value of a ton of 2000 lbs.; this shows a greater value than the deficient weight could demand. As there is a deficiency of 2½ per cent. in the weight, to be just, we should deduct the same from the value. The mechanical condition of the fertilizer was good as regards fineness, and can be easily applied with a drill. It contains a large percentage of water, which is a very objectionable feature; every ton contains 284·60 lbs., which the farmer pays 2½ cents a pound for, amounting to $7.11; to which if we add the $1.25 paid for deficient weight, would make $8.36 paid for what is a direct loss. As this company is represented to sell 20,000 tons yearly, the reader can readily calculate what is made from the sale of the water alone. But this is not a strictly correct showing of what the farmer pays for the water.

We have shown what 136·60 lbs. of the ton is worth to the farmer, as ammonia, nitrogen, potash, and soluble phosphoric acid. Hence, he pays $28.02 for 1863·4 lbs. of water, sand, and other inert substances, which is over 1½ cents per lb.

We give the following quotations from the circular of the wholesale agents of this Fertilizing Company

1. "A beneficent Providence has *aggregated the crude elements of fertility* in exhaustless quantities all over the world—upon islands of the sea, and in the sea and elsewhere. Nature, however, does not yield her treasures without an equivalent. Coal is found embedded in mountains; the precious metals are held bound in the quartz rock, and are adapted to the uses for which nature designed them, only at the *cost of labor, enterprise* and capital. So also these deposits in their natural state are not in condition for practical utility, but modern science has developed methods by which they are capable of the highest utility to the most important of all interests. Hence, while nature furnishes the crude material, and science the *method*, still *capital, skill, enterprise and labor* are required to adapt them to the purposes designed by nature."

2. "An intelligent pursuit of this business requires a knowledge of the science of chemistry, *especially as applied to agriculture;* a knowledge of the physiology of plants, their vital forces, their structure and organism; a knowledge of the constituent elements of vegetable nutrition, of their natural sources of supply, as to whether they be of organic or inorganic origin; a knowledge of the constituents of the atmosphere and their relations to cultivated plants, of the nature of soils and the conditions in which the elements of fertility may exist; a knowledge of the nature and character of the elements which should enter into the composition of a concentrated fertilizer, their relative proportion etc.; a knowledge of the *difference*

and *value* and quality of certain elements which professional chemists call by the same names; for example, phosphate of lime, whether *mineral* or *organic*, is called phosphate of lime; potash, whether supplied from felspar or in soluble form, is called potash. In making a report of analyses, chemists are not expected and do not make note of these important differences. They take no note of the fact as to whether *ammonia* in a fertilizer be in the form of salts, or be generated from animal organic matter; hence, *published analyses* may not give a correct basis of value, for all these questions enter in the consideration."

3. "If the business be pursued without these proper qualifications it becomes the subject of quackery, as is the case in other professions. A quack is he who pursues a profession under the guidance of rules and examples, without knowledge of *laws* or *principles*, and is therefore liable to constant blunders and mistakes. No business partaking of the nature of a profession has been more subject to the intrusions of quackery than this very business of manufacturing fertilizers; hence it is, that so many fertilizers have been placed upon the markets which have proved so nearly worthless, as on the one hand to involve loss of money and time to the consumer, and on the other to create distrust in their minds of those articles that are brought into market by parties possessing all the requisite qualifications as to knowledge of principles involved, and the facilities afforded by ample material resources."

Little need be said on these stilted quotations, they speak for themselves; and if the reader will compare them with the analyses of their fertilizer, he will be satisfied that they know their duty, but do it not—hence the greater the condemnation.

Rival manufacturers should feel obliged to this company for showing them the qualifications requisite for a successful prosecution of their business; and, of course, rather than be stigmatized as *quacks*, they will at once qualify themselves accordingly, and then we hope they will feel the additional accountability they have imposed on themselves, and make a better use of their knowledge than the Soluble Pacific Guano Company.

Their remarks on the practices of Anlytical Chemists are very exceptionable, and demand a few words of explanation. We don't wish to be considered apologists for these chemists—they are getting all they deserve—but it is not right that their profession should be made disreputable on their account. In too many instances they have made willing tools of themselves to advance the interests and further the dishonest practices of these manufacturers; but after it is done, these manufacturers, in common with other leading swindlers, shoulder all the responsibility on their subordinates. No honest chemist, in rendering an analysis of a fertilizer, would confound the potash as existing in the sulphate or muriate with that of felspar, or with felspar itself; neither would he make use of the combining numbers of gaseous ammonia with one equivalent of water, nor of the combining numbers of hydrate of ammonia for those of gaseous ammonia without an explanation, or use such a term as "Soluble Bone Phosphate of

Lime," *per se;* when this is done, it is the manufacturer or his agent, not the chemist, that should be accountable.

This Company can very properly be styled the ***"Veneerings"*** of the fertilizing business. The large resources of the Company ($1,000,000) are prominently placed before the public; they breathe in every line of their circular; they are reflected from the plate glass and gilt letters of the luxurious office of their principal agent; they shine on the face of the porter that handles the bags; they are on the tongue of every one employed by the Company. But with all these resources, these men defraud the farmer of the fruits of his labor. In speaking of the potash used, they say:

"Although the existing war between France and Prussia may interrupt commercial intercourse, supplies already received by the Company are sufficient to meet its wants.

"This additional element of value is made at considerable additional cost, but in pursuance of the policy to furnish the best article at the lowest possible cost to consumers, there will be no advance in the price of the Guano."

"A great cry, but little wool." If the reader will refer to the analyses, he will see that each ton contains a little over 9½ lbs. of potash, worth 77 cents. This is only a sample of the high-sounding representations of these men, and shows the margin that should be allowed on their statements. It is due to the public that they furnish an analysis of their fertilizer.

## ANALYSES OF BAUGH & SONS' RAW BONE SUPERPHOSPHATE.

*Percentage, or amount contained in* 100.

| | 1st Sample. | 2d Sample. | Mean. | |
|---|---|---|---|---|
| Water (expelled at 212° Fahrenheit). | 7·71 | 7·50 | 7·61 | |
| Nitrogen. | 0·21 | 0·22 | 0·22 = 0·27 | Actual Ammonia. |
| Nitrogen in organic matter. | 0·95 | 1·04 | 1·00 | |
| Potash, soluble in acidulated water. | trace | trace | trace | |
| Phosphoric Acid (anhydrous), soluble in water, at 60° to 70° F. | 3·36 | 3·34 | 3·35 = 5·52 | Superphosphate of Lime. |
| Insoluble Phosphoric Acid (anhydrous). | 9·25 | 9·46 | 9·36 = 20·43 | Bone Phosphate of Lime. |

From the mean of the above analyses, we deduce the following amounts contained in a ton, or 2000 lbs., together with the value of a ton to the farmer:

| | | | | | |
|---|---|---|---|---|---|
| 152·20 lbs. | Water.................. | @ | $0.00 | per lb. | $0.00 |
| 5·40 " | Actual Ammonia....... | @ | 0.25 | " | 1.35 |
| 20·00 " | Nitrogen in organic mat. | @ | 0.15 | " | 3.00 |
| " | Trace Potash........... | @ | 0.08 | " | 0.00 |
| 67·00 " | Soluble Phos. Acid..... | @ | 0.12½ | " | 8.38 |
| 187·20 " | Insoluble " " .... | @ | 0.00 | " | 0.00 |
| | Total value as a fertilizer.................... | | | | $12.73 |
| | Value of bags (say)........................ | | | | 2.00 |
| | Total value to farmer....................... | | | | $14.73 |

The above Superphosphate is sold at $50 per ton, involving a loss of $35.27, or more than 239 per cent. to the farmer on every ton he purchases; or, in other words, he pays more than 3⅓ times what it is worth.

## BAUGH AND SONS' RAW BONE SUPER-PHOSPHATE.

The Superphosphate, from which the samples for analyses were selected, was purchased at the manufacturers' office, Philadelphia. This fertilizer is put up in bags marked 160 lbs.; the bag purchased weighed 158 lbs. The mechanical condition of this fertilizer was bad; it had formed in hard lumps in the bags, requiring considerable force to pulverize.

We make the following quotations from the circulars of the manufacturers, and from the "Journal of the Farm," published also by them:

1 "That the standard of our Raw Bone Superphosphate has never been impaired, but that we have constantly sought to improve its value as a *permanent* Bone Manure by every facility at our command."

2. "It is better than Peruvian Guano, because it does not over-stimulate the soil. It has less Ammonia than Peruvian, but it has Ammonia enough for all the purposes of a crop, and more Ammonia than this does more harm than good."

3. "It is better than any Guano, or mixture of Guanos, or any Superphosphate we are acquainted with, because being made of *Bone*, it remains active in the soil, and continues to produce crops year after year, which farmers well know is not the case with other quick-acting and easily exhausted Phosphates."

4. "It has never been the policy nor aim of the manufacturers of Baugh's Raw Bone Phosphate to push forward their article by any extraordinary means, nor by disparaging any of the other excellent manures and guanos in the American market."—*Journal of the Farm.*

5. "BONE IS THE NATURAL FERTILIZER, intended by Providence to keep up the fertility."

6. "THE BEST MANURE IS THE CHEAPEST. . . . At the present high price of all kinds of fertilizers, it is very poor economy to remain uninformed of the quality and character of the manures used."

7. "The price of the article, at the present rate of the raw material, is placed as low as it is possible to afford a manure of like standard; the constant desire of the manufacturers being to furnish to farmers an article of a high quality, at as low rate as the most prudent and economical could not object to."

8. "IT IS THE CHEAPEST FERTILIZER NOW BEFORE THE PUBLIC.—This is substantiated by the careful experiments of thousands of practical farmers in the United States, and the same conclusion may be arrived at by those who will compare the percentage and price of any fertilizer offered in the market."

9. "It must be borne in mind, however, in making this calculation, that Phosphate of Lime is valuable only in such form or combination as will act directly and effectually upon the soil. There are many fertilizers said to contain a large percentage, which are almost useless or inoperative, by reason of this insolubility or connection with deleterious substances."

10. "In Baugh's 'Raw Bone Phosphate,' the Phosphate of Lime is in its purest and most effective form, and acts immediately and directly without any counteracting influence."

11. "The reason of this is, that it is made from *pure bones;* the original animal matter being present, and not having been extracted by burning, steaming, or any of the processes to which nearly all the bones sold to farmers are subjected."

12. . . "In the process of manufacturing, the animal matter of the '*Raw Bone*' is converted into Ammonia, and the *Phosphate of Lime* which it contains is rendered sufficiently soluble to act upon the growing plant."

13. "And these two important agents begin to act at once, the Ammonia making the leaf and stalk, and the Phosphate of Lime making the grain."

14. "Neither '*Stable Manure*,' '*Guano*,' nor any '*Superphosphate*,' or other preparations with which we are acquainted,

will at all compare with 'BAUGH'S RAW BONE PHOSPHATE' in its lasting effects, as *a crop producer* and *permanent improver* of the soil."

Messrs. Dugdale and Girvin, of Baltimore, are the wholesale agents for Baugh's Raw Bone Phosphate. We quote the following from their circular in relation to this fertilizer:

"In again offering to the agricultural community this well known Fertilizer. it is only necessary for us to say that it is HIGHLY IMPROVED AND BETTER THAN EVER."

"*The basis of its manufacture is, as formerly, pure* RAW BONE."

"*It has more Soluble Phosphate—hence is quicker in its action.*"

"*Although second to none, and superior to many other Fertilizers, its price is lower than most articles of similar value.*"

ANALYSIS!

| | |
|---|---|
| Soluble Bone Phosphate ................ | 14·10 |
| Soluble in the soil ....................... | 19·64 |
| Ammonia ................................ | 3·16 |

The reader will notice that the chemist's signature is wanting; and as no honest, capable chemist would make use of such terms as "Soluble Bone Phosphate," or "Soluble in the soil" without an explanation, the above "*analysis*" is open to very grave suspicion.

NOTE.—One of the authors having been in the employ of Messrs. Baugh & Sons for a number of years, the authors, from a feeling of delicacy, forbear criticising or censuring either their circular or product; otherwise, they might do so with great propriety.

### ANALYSES OF E. FRANK COE'S SUPERPHOSPHATE OF LIME.

*Percentage, or amount contained in* 100.

| | 1st Sample. | 2d Sample. | Mean. | |
|---|---|---|---|---|
| Water (expelled at 212° Fahrenheit). | 13·00 | 13·11 | 13·06 | |
| Nitrogen ........... | 0·55 | 0·51 | 0·53=0·64 | Actual Ammonia. |
| Nitrogen in organic matter ......... | 1·35 | 1·43 | 1·39 | |
| Potash, soluble in acidulated water. | trace | trace | trace | |
| Phosphoric Acid (anhydrous), soluble in water at 60° to 70° F..... | 6·39 | 6·53 | 6·46=10·64 | Superphosphate of Lime. |
| Insoluble Phosphoric Acid (anhydrous).......... | 8·29 | 8·32 | 8·31=18·14 | Bone Phosphate of Lime. |

From the mean of the above analyses we deduce the following amounts contained in a ton, or 2000 lbs., together with the value of a ton to the farmer:

| | | | | | |
|---|---|---|---|---|---|
| 261·20 lbs. | Water.................. | @ | $0.00 | per lb. | $0.00 |
| 12·80 " | Actual Ammonia....... | @ | 0.25 | " | 3.20 |
| 27·80 " | Nitrogen in organic mat. | @ | 0.15 | " | 4.17 |
| 129·20 " | Soluble Phos. Acid..... | @ | 0.12½ | " | 16.15 |
| 166·20 " | Insoluble " " .... | @ | 0.00 | " | 0.00 |

Total value as fertilizer........................ $23.52
Value of bags (say)............................. 2.00

Total value to farmer ......................... $25.52

The above Superphosphate is sold at $52 per ton, involving a loss of $26.48, or nearly 104 per cent. to the farmer on every ton he purchases; or, in other words, he pays more than twice as much as it is worth.

## E. FRANK COE'S SUPERPHOSPHATE OF LIME.

The above Superphosphate, from which samples for analyses were selected, was purchased from Graham, Emlen & Passmore, the manufacturer's agents, Philadelphia. Its mechanical condition was good, and we should think it could be easily applied with a drill. We select the following analyses from the manufacturer's circular; the first was made by Dr. G. A. Liebig, Baltimore, dated August 3d, 1854. The second was made by Professor S. W. Johnson, of Yale College, dated May 23d, 1865. If the reader will compare these analyses with the analyses of this Superphosphate as purchased by us, he will see how this celebrated fertilizer has gradually deteriorated in value; comment is unnecessary:

### ANALYSIS BY DR LIEBIG, GIVES:

| | | |
|---|---|---|
| Phosphoric Acid contained in Biphosphate of Lime, | 12·11 | |
| Phosphoric Acid free (anhydrous) | 4·80 | |
| Total Phosphoric acid (soluble) | | 16·91 |
| Phosphate of Iron and Ammonia | | 0·34 |
| Alkaline Salts | | ·41 |
| Organic matter capable of producing Ammonia | | 3·65 |
| Water as Moisture and Loss | | 15·87 |

### ANALYSIS BY PROFESSOR JOHNSON, GIVES:

| | |
|---|---|
| Water expelled at 212° | 12·18 |
| Soluble Phosphoric Acid | 9·43 |
| Insoluble Phosphoric Acid | 1·65 |
| Ammonia in organic and volatile matters | 2·76 |

## ANALYSES OF MORO PHILLIPS' PHUINE.

*Percentage, or amount contained in* 100.

| | 1st Sample. | 2nd Sample. | Mean. | |
|---|---|---|---|---|
| Water (expelled at 212° Fahrenheit). | 7·88 | 7·76 | 7·82 | |
| Nitrogen ............ | 0·17 | 0·18 | 0·18=0·22 | Actual Ammonia. |
| Nitrogen in organic matter. | 0·93 | 0·95 | 0·94 | |
| Potash, soluble in acidulated water. | 0·94 | 0·88 | 0·91 | |
| Phosphoric Acid (anhydrous), soluble in water at 60° to 70° F. | 2·71 | 2·65 | 2·68=4·42 | Superphosphate of Lime. |
| Insoluble Phosphoric Acid (anhydrous). | 13·89 | 13·97 | 13·93=30·41 | Bone Phosphate of Lime. |

From the mean of the above analyses, we deduce the following amounts contained in a ton, or 2000 lbs., together with the value of a ton to the farmer:

| | | | | | | |
|---|---|---|---|---|---|---|
| 156·40 | lbs. | Water.................... | @ | $0.00 | per lb. | $0.00 |
| 4·40 | " | Actual Ammonia ......... | @ | 0.25 | " | 1.10 |
| 18·80 | " | Nitrogen in organic mat.... | @ | 0.15 | " | 2.82 |
| 18·20 | " | Potash.................... | @ | 0.08 | " | 1.46 |
| 53·60 | " | Soluble Phos. Acid........ | @ | 0.12½ | " | 6.70 |
| 278·60 | " | Insoluble " " ........ | @ | 0.00 | " | 0.00 |

Total value as fertilizer........................... $12.08
Value of bags (say)................................ 2.00

Total value to farmer............................... $14.08

The above Fertilizer is sold at $50 per ton, involving a loss of $35.92, or 255 per cent., to the farmer on every ton he purchases; or, in other words, he pays for it 3½ times as much as it is worth.

ANALYSES OF MORO PHILLIPS' GENUINE IMPROVED SUPERPHOSPHATE OF LIME.

*Percentage, or amount contained in* 100.

| | 1st Sample. | 2d Sample. | Mean. | |
|---|---|---|---|---|
| Water (expelled at 212° Fah.) | 12·40 | 12·42 | 12·41 | |
| Nitrogen. | 0·26 | 0·21 | 0·24=0·29 | Actual Ammonia. |
| Nitrogen in organic matter. | 0·39 | 0·42 | 0·41 | |
| Potash, soluble in acidulated water | 0·80 | 0·74 | 0·77 | |
| Phosphoric Acid (anhydrous), soluble in water at 60° to 70° F. | 4·63 | 4·54 | 4·59= 7·56 | Superphosphate of Lime. |
| Insoluble Phosphoric Acid (anhydrous). | 13·21 | 13·40 | 13·31=29·06 | Bone Phosphate of Lime. |

From the mean of the above analyses, we deduce the following amounts contained in a ton, or 2000 lbs., together with the value of a ton to the farmer:

| | | | | | |
|---|---|---|---|---|---|
| 248·20 lbs. | Water | @ | $0.00 | per lb. | $0.00 |
| 5·80 " | Actual Ammonia | @ | 0.25 | " | 1.45 |
| 8·20 " | Nitrogen in organic mat. | @ | 0.15 | " | 1.23 |
| 15·40 " | Potash | @ | 0.08 | " | 1.23 |
| 91·80 " | Soluble Phos. Acid | @ | 0.12½ | " | 11.48 |
| 266·20 " | Insoluble " " | @ | 0.00 | " | 0.00 |

Total value as fertilizer........................ $15·39

Value of bags (say)........................ 2.00

Total value to farmer........................ $17·39

The above Superphosphate is sold at $50 per ton, involving a loss of $32.61, or 188 per cent. to the farmer on every ton he purchases; or, in other words, he pays for it nearly $2\frac{9}{10}$ times as much as it is worth.

## MORO PHILLIPS' GENUINE IMPROVED SUPERPHOSPHATE OF LIME.

The above Superphosphate, from which the samples for analyses were selected, was purchased from the manufacturer at his office in Philadelphia. It is put up in bags marked 200 lbs.; the one purchased weighed 200 lbs. The Phuine was purchased at the works of the manufacturer in Camden. It is put up in bags marked 200 lbs.; the one purchased weighed 196 lbs. The mechanical condition of both the Superphosphate and the Phuine was very good, and we should judge that they could be easily applied with a drill. We give the following quotations from the circular of the manufacturer, showing what he *modestly* claims for his "Genuine Improved Superphosphate of Lime." Of the Phuine, he says nothing. Our analyses of the latter will fully show its *claims*.

"☞Calling the attention of buyers to this highly concentrated genuine SUPERPHOSPHATE, I guarantee it to be as represented."

"I CLAIM,

"First.—That it contains less moisture than any other in the market. The ingredients of this Superphosphate are Bone Phosphate, Sulphuric Acid and Ammonia."

"Second.—It is more uniform in quality, one bag being a fair sample of 10,000 tons."

"Third.—It contains more agricultural value than any other Superphosphate of Lime in the market."

"Fourth.—The desire of the manufacturer to maintain his high reputation as a manufacturer of acids and other chemicals, as well as the manufacturer of the best Superphosphate, is a safe ground of assurance that it will always be uniformly excellent; and a further guarantee of uniformity is, that it is always made in the same way from one source, and that its source is unlimited in extent, and under his entire control."

"Fifth.—The consumer can depend upon always receiving a uniform article."

"I recommend this article with confidence, because I know what it is, and have experience as to its effects. The value of a real Suphcrphosphate of Lime as a fertilizer is well known, both in this country and Europe. In England alone, more than ONE HUNDRED THOUSAND tons are annually sold. I introduce this article to farmers in general as a staple and standard article, intending to make it a permanent trade."

"Examine carefully the brand on each barrel and bag; by paying attention to this you will never be deceived into buying a worthless article."

"The proprietor had to overcome at first the great predjudice existing to Superphosphates in general, as there had been so many spurious articles in the market of late years; but he is happy to say, he has succeeded in doing so, and the only way now to retain the returning confidence of agriculturists, is to keep true to his promise and keep his Superphosphate to its standard."

"CAUTION TO BUYERS.

"Observe that my name and place of manufacture are on each and every package, none other being genuine. I will guarantee the quality of every package sold by me, and if any manufacturer or dealer should be induced, by the reputation of my article, to palm a spurious imitation of it on the public, it will be my business to detect and punish him. Should this book reach any parties who have sold or used, or who may hereafter use my Superphosphate, and should it not fulfil all it professes to do, they have full liberty to contradict my assertions, and I will cheerfully bear all the expenses of the same."

"MORO PHILLIPS,

"*Sole Proprietor and Manufacturer.*"

This manufacturer makes great pretensions of the quality and standard of his Superphosphate; but unfortunately he has not stated in his circulars what this quality and standard is, or given an analysis; consequently, we are compelled to take *our* analyses of his Superphosphate as our guide in deciding this matter, from which showing we feel compelled to state that the standard is low and the quality bad, and at the price at which it is sold, is a shameful imposition on the farmer; and also that the manufacturer should look at home, instead of censuring rival manufacturers, or, in other words, "He should take the beam out of his own eye, to enable him to see clearly to take the mote out of his brother's eye." And we think the agricultural community will consider it the duty of the manufacturer to elevate the standard and improve the quality of his Superphosphate, if that be *possible,* rather than keep it at its present grade. When he does this, he will discover that it is not necessary to blow his own trumpet as long and as loud as he has done.

Little need be said of the Phuine; it is sold at the same price as the Superphosphate, and hence, the reader can see by the analyses, that it is even a greater swindle than the latter.

## ANALYSES OF "THE EXCELLENZA AMMONIATED SOLUBLE PHOSPHATE."

*Percentage, or amount contained in* 100.

| | 1st Sample. | 2d Sample. | Mean. | |
|---|---|---|---|---|
| Water (expelled at 212° Fahrenheit) | 13·86 | 13·79 | 13·83 | |
| Nitrogen.......... | 0·55 | 0·57 | 0·56 = 0·68 | Actual Ammonia. |
| Nitrogen in organic matter.. | 2·41 | 2·31 | 2·36 | |
| Potash, soluble in acidulated water. | trace | trace | trace | |
| Phosphoric Acid (anhydrous), soluble in water at 60° to 70° F... | 9·71 | 9·84 | 9·78=16·12 | Superphosphate of Lime. |
| Insoluble Phosphoric Acid (anhydrous)...... | 1·68 | 1·57 | 1·63 = 3·56 | Bone Phosphate of Lime. |

From the mean of the above analyses, we deduce the following amounts contained in a ton, or 2000 lbs., together with the value of a ton to the farmer:

| | | | | |
|---|---|---|---|---|
| 276·60 lbs. | Water.................... | @ $0.00 | per lb. | $ 0.00 |
| 13·60 " | Actual Ammonia......... | @ 0.25 | " | 3.40 |
| 47·20 " | Nitrogen in organic matter. | @ 0.15 | " | 7.08 |
| | Trace Potash............. | @ 0.08 | " | 0.00 |
| 195·60 " | Soluble Phosphoric Acid.. | @ 0.12½ | " | 24.45 |
| 32·60 " | Insoluble " " | @ 0.00 | " | 0.00 |

Total value as fertilizer.............................. $34.93
Value of bags (say)........................... 2.00

Total value to farmer.............................. $36.93

The above fertilizer is sold at $56 per ton, involving a loss of $19.07, or 52 per cent. to the farmer on every ton he purchases; or, in other words, he pays for it more than 1½ times as much as it is worth.

## THE EXCELLENZA AMMONIATED SOLUBLE PHOSPHATE.

The above phosphate, from which samples for analyses were selected, was purchased from Messrs. Dugdale & Girvin, Baltimore. It is put up in bags marked 200 lbs.; the one purchased weighed 198 lbs. Its mechanical condition was good. Messrs. Dugdale & Girvin state in their circular that:

"We have been at special pains in the manufacture of the 'Excellenza,' to produce a greater amount of soluble material for the price, than any other fertilizer with which we are acquainted."

They also give an endorsement and analysis of Professor Chandler, as follows:

"SCHOOL OF MINES, COLUMBIA COLLEGE.
"NEW YORK, *September* 26, 1870.

"I have examined the 'Excellenza' ammoniated superphosphate of lime, and find it to be an excellent article, containing from 14 to 15 per cent. of soluble phosphoric acid, which is a *very unusual percentage*. It also contains a very good percentage of ammonia, or ammonia-producing materials. *It is one of the best fertilizers in the market, and is superior to most of the other superphosphates.*

"C. F. CHANDLER, Ph. D.,
"*Prof. Analytical and Applied Chemistry.*"

### CERTIFICATE OF ANALYSIS.

NEW YORK, *August* 11, 1870.

The sample of "Excellenza Ammoniated Soluble Phosphate," submitted to me for examination, contains,

| | | |
|---|---|---|
| Ammonia (N.H. 4·0)................ | | 4·16 |
| Soluble Phosphoric Acid............ | 14·45 | |
| Equal to *Soluble Bone Phosphate*..... | | 31·50 |
| Insoluble Phosphoric Acid.......... | 0·26 | |
| Equal to *Insoluble Bone Phosphate*... | | 0·62 |

Respectfully, your obedient servant,
(Signed), C. F. CHANDLER, Ph. D.,
*Prof. Analytical and Applied Chemistry.*

We are at a loss to know whether the Professor, in rendering the soluble phosphoric acid, has reference to the *hydrated* or the *anhydrous* acid. If we regard it as *hydrated* phosphoric acid, and compare the Professor's analysis with our analyses, the similarity is quite striking, for 14·45 per cent. of hydrated phosphoric acid correspond to 10·47 of the *anhydrous* acid, and 10·47 of *anhydrous* phosphoric acid, or 14·45 of the *hydrated*, are equal to 22·86 of bone phosphate of lime *rendered soluble*, not "31·50" (31·54). If the 14·45 per cent. represent *anhydrous* phosphoric acid, then 31·54, representing the amount of bone phosphate of lime *rendered soluble*, is correct, and the three analyses show conclusively how the "Excellenza" during the few months of its existence has depreciated in value as regards its phosphoric acid.

Messrs. Dugdale & Girvin are deserving of all credit in manufacturing and introducing this fertilizer; and there should be no necessity of any subterfuge in recommending it to the public. Truthful, candid statements are all that is needed; and if Messrs. Dugdale & Girvin will conform to these, and discard the *trickeries* of the fertilizing business as it now is, we doubt not that their efforts will be crowned with success, and they themselves will be convinced that "honesty" in this business, as well as in all others, "is the best policy."

## ANALYSES OF BOWER'S COMPLETE MANURE.

*Percentage, or amount contained in* 100.

| | 1st Sample. | 2d Sample. | Mean. | |
|---|---|---|---|---|
| Water (expelled at 212° Fahrenheit) | 7·22 | 7·30 | 7·26 | |
| Nitrogen.......... | 0·21 | 0·18 | 0·20 = 0·24 | Actual Ammonia. |
| Nitrogen in organic matter.. | 0·60 | 0·70 | 0·65 | |
| Potash, soluble in acidulated water | 0·95 | 0·90 | 0·93 | |
| Phosphoric Acid (anhydrous), soluble in water at 60° to 70° F... | 2·07 | 1·91 | 1·99 = 3·28 | Superphosphate of Lime. |
| Insoluble Phosphoric Acid (anhydrous)...... | 20·42 | 20·28 | 20·35 = 44·43 | Bone Phosphate of Lime. |

From the mean of the above analyses, we deduce the following amounts contained in a ton, or 2000 lbs., together with the value of a ton to the farmer :

| | | | | | |
|---|---|---|---|---|---|
| 145·20 lbs. | Water.................... | @ | $0.00 | per lb. | $0.00 |
| 4·80 " | Actual Ammonia.......... | @ | 0.25 | " | 1.20 |
| 13·00 " | Nitrogen in organic matter. | @ | 0.15 | " | 1.95 |
| 18·60 " | Potash.................... | @ | 0.08 | " | 1.49 |
| 39·80 " | Soluble Phosphoric Acid .. | @ | 0.12½ | " | 4.98 |
| 407·00 " | Insoluble " " .. | @ | 0.00 | " | 0.00 |

| | |
|---|---|
| Total value as fertilizer.......................... | $ 9.62 |
| Value of bags (say)................................ | 2.00 |
| Total value to farmer .............................. | $11.62 |

The above manure is sold at $52 per ton, involving a loss of $40.38, or 348 per cent. to the farmer on every ton he purchases ; or, for manure alone, he pays 5⅛ times as much as it is worth.

## BOWER'S COMPLETE MANURE.

The above manure, from which samples for analyses were selected, was purchased from Messrs. Dixon, Sharpless & Co., Philadelphia. It is put up in bags marked 200 lbs. ; the one purchased weighed 190 lbs., being 10 lbs. less than it should have weighed, or a deficiency of 100 lbs. to the ton. The mechanical condition of the manure was good. The following quotations from the manufacturer's circular will be valuable to the reader, from which he can make his own deductions

No. 1. "All will of course agree that farm-yard or stable manure is a good fertilizer, yet unless it is properly rotted or prepared, and kept from the washing rains, its good qualities may be much impaired, and within my own experience but few farmers pay enough attention to the important point of having the manure in such a place as to prevent being leached out by rains. Take the best stable manure, however, and make a comparison by analysis of its virtues with that of an artificial fertilizer, as the 'Complete Manure,' it is found, estimating the cost (delivered) of farm-yard manure at $5.00 per ton, and the 'Complete Manure' at $60.00, (delivered,) that the actual value of the 'Complete Manure' to the farmer is more than double its cost, when compared with the very best farm-yard manure."

No. 2. "It must be borne in mind, that in order to achieve the results obtained by the 'Complete Manure,' a considerable proportion of the constituents must be in a form to make them be taken up at once by the rootlets of the plant ; that is to say, they must be easily dissolved in the water contained in the soil. It is true, that Nature, among all her other wonders, has provided means to render soluble these constituents, but the process has wisely been made a slow one ; the chemist can provide the means to make sufficient for the growing crop dissolvable, the balance remaining in the soil to be acted upon by the air and water of the soil to provide food for future crops.'

No. 3. "A benefit derived from the use of a powerful manure, such as the 'Complete Manure,' is that it forces the young plant forward by reason of the large amount of *soluble* matter it contains. The importance of this cannot well be overestimated, as the plant soon reaches that degree of strength and toughness which will prevent an early frost from injuring, or some insect from devouring it; hence it may be said to be particularly applicable to cotton, tobacco, wheat, corn, potatoes, and other root vegetables, as all the young plants of these are subject to the ravages of the insect, or the blight of the frost.'

No. 4. "In manufactured manures, much of their agricultural value depends upon the mechanical condition in which they are supplied, the extent to which the component parts have been pulverized and intermixed; the richest manure, chemically speaking, will be of little use unless it is moderately dry, reduced to fine powder, and its constituents thoroughly incorporated. This must be borne in mind in judging of the value of a manure, and a proportionate price ought to be allowed for the degree of completeness with which these matters have been attended to. Although in theory the production of an artificial fertilizer is a very simple matter, in practice it is found somewhat troublesome, from the difficulty of producing a manageable article, and a great deal of experience and skill are required to prepare a manure of the requisite chemical strength, and mechanical condition."

No. 5. "In speaking with farmers during the past season, many complaints have been met with of the inefficiency of some superphosphates, prepared guanos, poudrettes, and other so-called manures, some of them with high-sounding titles, having failed to produce the results their manufacturers claimed they would give. This has, no doubt, in some instances been the result of a bad season, or bad farming, or some untoward cause which is unaccountable; but there is good reason to fear that it has been the result of *adulteration*."

No. 6. "The adulteration of manures, as indeed of all other articles of commerce, is a practice that cannot be too strongly condemned; and it is much to be regretted that the laws of this country afford too many chances for successfully carrying on this species of fraud."

No. 7. "In the case of manures their adulteration is attended with several evils besides the more direct one of robbing those who purchase the adulterated article. The fact of manures being known to be extensively adulterated tends to restrict their use, and to withhold the good that a more extended use of these materials is calculated to confer both on the farmer and on the community. For the same reason the trade of honest manufacturers is injured and confined. Under the name of manures all kinds of mixtures are sold, often worth but a fraction of the price paid for them, and in too many instances altogether worthless. The frauds practised by dishonest manure dealers consist of diluting or weakening of standard manures—by the admixture of less valuable or worthless material, as tanner's bark, road or street scrapings, old mortar, spent wood-ashes, coal ashes, or other material; and in order to give them apparent value, animal matter with a horrid stench is mixed with these in some instances (many persons are induced to think that a manure, in order to be good, must have a vile smell, than which there can be no greater mistake). Such mixtures are brought into the market as new compounds under all sorts of high-flown names, which often indicate properties in every way the reverse of those possessed by the so-called manures they represent."

No. 8. "By a rudimentary knowledge of Chemistry, manures can be tested with sufficient accuracy to assure their genuineness; various operations upon the farm can be wonderfully improved by studying Nature's processes, for in these we see the working of the Divine hand, at once so wonderful, so simple, and so well adapted to the wants of mankind. In Mechanics, we have a help which is daily being increased, by the genius of our people, and the farmer can, by devising various simple changes in machines, no doubt increase their usefulness, or the uses of them."

No. 9. "I do not forget that science is in its infancy; there are numerous secrets which Nature refuses to give up, and which, with all the chemical and mechanical aids available, the most arduous researches have not been able to get from her, except by degrees; as fresh discoveries come to light, I will make every effort to take advantage of them in improving the 'Complete Manure,' while farmers can at all times rely upon receiving 'THE WORTH OF THEIR MONEY' when purchasing it."

. . . . . . . . .

After the above, a brief breathing pause should be allowed to our readers. Such an extensive knowledge of Chemistry, as applied to Agriculture, should enable Mr. Bower to produce a "Complete Manure." But if our readers will compare these remarks of Mr. Bower with our analyses of his "Complete Manure," the application of the Fable of the mountain in labor, when "*nascitur ridiculus mus*" (a miserable mouse was brought forth), will be appreciated.

## TESTIMONIALS.

No. 1. "MESSRS. BOOTH & GARRETT, of Philadelphia, Chemists of high respectability, say, in speaking of the 'Complete Manure,' in a note to Messrs. Dixon, Sharpless & Co., dealers in fertilizers:

"The constitution of the above indicates a decided advance in the composition of a fertilizer, by the introduction of a considerable percentage of Potassa, and countenances the claim involved in the name 'Complete Manure.'"

No. 2. "The report upon the 'Complete Manure,' made by Messrs. Williams & Moss, of Philadelphia, Chemists of large experience in the analysis of fertilizers, says:

"We find from an analysis of your 'Complete Manure,' that the name you have given it is certainly warranted by its chemical composition; in addition to thus cordially recommending your fertilizer from a chemical stand point, we should state that its mechanical condition is most excellent, being such as to admit of its use in the drill without further preparation."

No. 3. "MINING AND ASSAY OFFICE AND CHEMICAL LABORATORY, NO. 57 BROADWAY, OPPOSITE EXCHANGE PLACE, NEW YORK, *October* 10th, 1867.

"HENRY BOWER, ESQ., PHILADELPHIA.

"*Dear Sir:*—Enclosed please find results of an analysis of a sample of your 'Complete Manure,' taken from Dixon & Sharpless' warehouse, September 25th.

"These results show at a glance the great merit your article possesses as a fertilizer, and warrant the opinion that it will take a leading rank among manures. The liberal proportions of *soluble* phosphoric acid, ammonia and potash, afford to soil a large amount of nutriment immediately available to growing crops, while the remainder of the phosphoric acid, becoming gradually soluble through atmospheric influences, assures a lasting supply of plant food.

"The introduction of potash, and the nice adjustment of the proportions of the above ingredients, render the name you have given your fertilizer particularly appropriate, as it contains all the elements necessary to insure success, and I am confident that wherever it is used its reputation will rapidly extend. "Respectfully yours,

"C. ELTON BUCK."

No. 4. "OFFICE STATE GEOLOGICAL SURVEY, NEW BRUNSWICK, N. J.; *July* 15th, 1869.

"*Dear Sir:*—Your letter of May 20th was duly received. The five bags of your 'Complete Manure' so generously sent to the College Farm were also duly received. For this donation I desire to tender the thanks of the Trustees of the College, and to say that it was immediately used in trials upon corn, beets, and carrots, and on potatoes; and also it has been subjected to chemical analysis. The results of these will be given in the annual report upon the farm, which is made to the Legislature, and is printed and circulated extensively throughout the State. An earlier acknowledgment ought to have been made, but it has been delayed so as to send the chemical analysis, and that, though long expected, has but recently been completed. The crops upon which the 'Manure' was tried are looking well. The results of the analysis show it to be a valuable fertilizer, and all that I have heard of it is in its favor. I hope to send you further reports of it in the course of the season.

"Respectfully yours,

"GEORGE H. COOK,
*State Geologist.*"

"To Henry Bower, Esq.

No. 5. "LABORATORY OF THE MEDICAL COLLEGE, QUEEN STREET, CHARLESTON, S. C., *December* 9th, 1869.

"This article certainly deserves the name it bears, *i. e.*, of a Complete Manure—furnishing to the plant all the important elements of its food.

"CHARLES U. SHEPARD, M. D.
*Inspector of Fertilizers for South Carolina.*"

No. 6. 'SAVANNAH, GA., *February* 1st, 1870.

"I take pleasure in saying that the accompanying analysis of Bower's Complete Manure, made for Messrs. Hacker & Molony, Savannah, Ga., warrants our confidence in its fertilizing properties. Its amount of Ammonia, and its excellent supply of *Phosphoric Acid*, in a *soluble* state, will ensure the early growth and development of the plant, together with a fine fruitage, to which the Phosphoric Acid mainly contributes, and these results may be expected for the first year, while the amount of insoluble Phosphate remaining in the soil will, by slow chemical reaction going on during the suceeding Fall and Winter, prepare the land for a better crop during the year.

"A MEANS, *Inspector.*"

The farmer after reading the above testimonials and comparing them with the analyses of the "Complete Manure" furnished by *us*, would naturally be induced to ask the following questions: Where are the analyses of the "Complete Manure" furnished by these gentlemen? Is it excessive modesty, or some other motive, that prevents Mr. Bower from publishing them? Was the "Complete Manure" made of a *better quality*, at the time these testimonials were given, than it is at present? If it was not, what are we to characterize these chemists, who knowingly allow their names to be used to encourage the perpetration of such a great fraud? If these chemists gave candid and honest statements at the time, and its present deterioration is due to Mr. Bower, we think it is due to those of them that are honest and capable, and most of whose opinions should have weight with the community, and also to Mr. Bower himself, *if he desires to be considered an honest man*, at once to withdraw these testimonials, and modify his circular so as to bring its statements within the bounds of truth; or, if this be distasteful to him, let him make reparation to his customers, and in the future manufacture a better article than was sold to us

## ANALYSES OF THE PATAPSCO GUANO COMPANY'S AMMONIATED SOLUBLE PHOSPHATE!

*Percentage, or amount contained in* 100.

| | 1st Sample. | 2nd Sample. | Mean. | |
|---|---|---|---|---|
| Water (expelled at 212° Fahrenheit). | 14·97 | 15·06 | 15·02 | |
| Nitrogen. | 0·73 | 0·82 | 0·78 = 0·95 | Actual Ammonia. |
| Nitrogen in organic matter. | 1·54 | 1·58 | 1·56 | |
| Potash, soluble in acidulated water. | 0·62 | 0·65 | 0·64 | |
| Phosphoric Acid (anhydrous), soluble in water at 60° to 70° F. | 8·43 | 8·21 | 8·32 = 13·71 | Superphosphate of Lime. |
| Insoluble Phosphoric Acid (anhydrous). | 6·56 | 6·69 | 6·63 = 14·47 | BonePhosphate of Lime. |

From the mean of the above analyses, we deduce the following amounts, contained in a ton, or 2000 lbs., together with the value of a ton to the farmer:

| | | | | | |
|---|---|---|---|---|---|
| 300·40 lbs. | Water | @ | $ 0.00 | per lb. | $ 0.00 |
| 19·00 " | Actual Ammonia | @ | 0.25 | " | 4.75 |
| 31·20 " | Nitrogen in organic matter | @ | 0.15 | " | 4.68 |
| 12·80 " | Potash | @ | 0.08 | " | 1.02 |
| 166·40 " | Soluble Phosphoric Acid | @ | 0.12½ | " | 20.80 |
| 132·60 " | Insoluble " " | @ | 0.00 | " | 0.00 |

Total value as fertilizer .......... $31.25
Value of bags (say) .......... 2.00

Total value to farmer .......... $33.25

The above phosphate is sold at $55 per ton, involving a loss of $21.75, or nearly 66 per cent. to the farmer on every ton he purchases; or, in other words, he pays for it nearly 1⅔ times as much as it is worth.

## PATAPSCO GUANO COMPANY'S AMMONIATED SOLUBLE PHOSPHATE!

The above fertilizer, from which samples for analyses were selected, was purchased at the company's office, Baltimore. It is put up in bags marked 167 lbs.; the bag purchased weighed 170 lbs. Its mechanical condition was very bad. We found hard lumps in it, as large as a 50-lb. cannon ball; as the manufacturers recommend this article to be drilled, we are in doubt whether they meant the *drill* of the farmer, or the *drill* of the quarryman. From our experience in pulverizing the article, we incline to think it was the latter. This is a very objectionable feature of this fertilizer, and must necessarily give the farmer considerable trouble. In an attempt to conform with the laws of the State of Maryland, there were some lettering and figures on the bag, which we are charitable enough to concede were intended for an analysis. After considerable trouble, we set down the following, which if not correct, we shall feel under obligation to the company if they will notify us:

| | |
|---|---|
| Soluble Phosphates | 24·00 |
| Insoluble Phosphates | 18·00 |
| Ammonia | 4·00 |
| Salts of Potash | 7·00 |

This, to say the least, is a garbled analysis. It states that this superphosphate contains 24 per cent. of "Soluble Phosphates," but as to the amount of phosphoric acid in the "Soluble Phosphates" we are left entirely in the dark. Again, we are informed that the superphosphate contains 7 per cent. of "Salts of Potash," but as to the *amount* of *potash* we remain uninformed. By referring to our analyses, the reader will notice less than *one* per cent. of potash, and by converting this potash into the sulphate or muriate, he will obtain less than two per cent., which shows a great discrepancy in the analyses. We quote the following from the circular of these manufacturers:

"With their increased facilities, improved machinery, and skilled workmen, under the superintendence of

DR. G. A. LIEBIG,

who personally selects and tests every article used in its manufacture, and is constantly present at the works and directs every department, is a sufficient guarantee that its manufacture can be relied upon as being equal to anything which can be produced.

"The company continues to use the celebrated

NAVASSA PHOSPHATE,

(the richest phosphatic guano now known) which, together with the other ingredients, and its careful preparation, produce those prompt and permanent effects which have uniformly been shown upon all crops upon which it has been applied."

## ANALYSES OF NEEDLES' IMPROVED SUPERPHOSPHATE OF LIME.

*Percentage, or amount contained in* 100.

| | 1st Sample. | 2d Sample. | Mean. | |
|---|---|---|---|---|
| Water (expelled at 212° Fahrenheit) | 5·63 | 5·59 | 5·61 | |
| Nitrogen .......... | 0·17 | 0·19 | 0·18 = 0·22 | Actual Ammonia. |
| Nitrogen in org. matter......... | 0·60 | 0·63 | 0·62 | |
| Potash, soluble in acidulated water | trace | trace | trace | |
| Phosphoric Acid (anhydrous), soluble in water at 60° to 70° F... | trace | trace | trace | |
| Insoluble Phosphoric Acid (anhydrous) ...... | 22·43 | 22·55 | 22·49=49·10 | Bone Phosphate of Lime. |

From the mean of the above analyses, we deduce the following amounts, contained in a ton, or 2000 lbs., together with the value of a ton to the farmer:

| | | | | | |
|---|---|---|---|---|---|
| 112·20 lbs. | Water........................ | @ | $ 0.00 | per lb. | $ 0.00 |
| 4·40 " | Actual Ammonia ........ | @ | 0.25 | " | 1.10 |
| 12·40 " | Nitrogen in org. matter.... | @ | 0.15 | " | 1.86 |
| | Trace Potash.............. | @ | 0.08 | " | 0.00 |
| | Trace Soluble Phos. Acid.. | @ | 0.12½ | " | 0.00 |
| 449·80 " | Insoluble Phos. Acid...... | @ | 0.00 | " | 0.00 |

| | |
|---|---|
| Total value as fertilizer................................ | $ 2.96 |
| Value of bags (say)....................................... | 2.00 |
| Total value to farmer.................................... | 4.96 |

The above Phosphate is sold at $47 per ton, involving a loss to the farmer of $42.04, or 847 per cent. on every ton he purchases; or, taking the manure *alone*, he pays for it nearly 16 times as much as it is worth.

## NEEDLES' IMPROVED SUPERPHOSPHATE OF LIME.

The above fertilizer, from which samples for analyses were selected, was purchased at the manufacturer's office, Philadelphia. It is put up in 200 lb. bags; the one purchased weighed 187 lbs., being 13 lbs. less than it should be with the bag included, or 130 lbs. on a ton. The mechanical condition of this fertilizer was good, and could be easily applied by a drill. When we have said that, we have said all that is possible for us to say in its favor. Therefore we make the following selections from Mr. Needles' circular, which show conclusively that even *truth*, which costs nothing but an honest intention, is too valuable to waste on his worthless product:

1. "It is always of the same pure quality."
2. "It is a permanent enricher of the soil."
3. "It loses none of its strength by exposure to the air."
4. "It is the cheapest Phosphate in the country."
5. "We were the originators of the preparation of this well known manure in Philadelphia, our house having been engaged for over twenty-one years in the manufacture and sale of CONCENTRATED FERTILIZERS."

In commenting on this fertilizer, and the above remarks, only a few words are necessary, as the fertilizer can only be characterized as a scandalous cheat and an unmitigated swindle on the community.

The reader will notice from the analyses that it contains only a *trace* of Soluble Phosphoric Acid; consequently, it has not the least pretension to be called a "Superphosphate." It is a fraud in weight as well as in quality, and if Mr. Needles has been manufacturing a similar article, and giving such deficient weight for the past twenty-one years, common justice, and common law, should have sufficient power to restrain him from continuing his criminal practices, and punish him according to his deservings. And if twenty-one years have been devoted to such practices, the remainder of his life should be devoted to making a partial atonement for the wrongs perpetrated on his customers.

The article is simply ground mineral phosphate, with a possible scattering of bones, and if there was any Sulphuric Acid used in its preparation, there was not a sufficient quantity to liberate but a trace of Soluble Phosphoric Acid, so that it may only be considered a raw material for the manufacture of a Superphosphate. Such outrageous frauds as these are calculated to excite the indignation of all the community.

The fact that such frauds can be successfully practised for twenty-one years, proves conclusively the necessity of just such information as is given in this book

## ANALYSES OF THE BROMOPHYTE FERTILIZER.

*Percentage, or amount contained in* 100.

| | 1st Sample. | 2d Sample. | Mean. |
|---|---|---|---|
| Water (expelled at 212° Fahrenheit). | 13·02 | 13·20 | 13·11 |
| Nitrogen. | 0·18 | 0·17 | 0·18 = 0·22 { Actual Ammonia. |
| Nitrogen in organic matter. | 0·75 | 0·83 | 0·79 |
| Potash, soluble in acidulated water. | 0·23 | .... | .... |
| Phosphoric Acid (anhydrous), soluble in water at 60° to 70° F. | trace | trace | trace |
| Insoluble Phosphoric Acid (anhydrous). | 1·51 | .... | .... |

From the analyses, we deduce the following amounts, contained in a ton, or 2000 lbs., together with the value of a ton to the farmer:

| | | | | | |
|---|---|---|---|---|---|
| 262·20 lbs. | Water ................ | @ | $0.00 | per lb. | $ 0.00 |
| 4·40 " | Actual Ammonia...... | @ | 0.25 | " | 1.10 |
| 15·80 " | Nitrogen in organic mat. | @ | 0.15 | " | 2.37 |
| 4·60 " | Potash................ | @ | 0.08 | " | 0.37 |
| | Trace Soluble Phos. Acid | @ | 0.12½ | " | 0.00 |
| 30·20 " | Insoluble " " . | @ | 0.00 | " | 0.00 |
| | Total value as fertilizer...................... | | | | $ 3.84 |
| | Value of bags (say)........................ | | | | 2.00 |
| | Total value to farmer ...................... | | | | $ 5.84 |

The above fertilizer is sold at $40 per ton, involving a loss of $34.16, or 585 per cent. to the farmer on every ton he purchases; or, for the manure alone, he pays $36.16, which is more than 9 times as much as it is worth.

## THE BROMOPHYTE FERTILIZER.

The above fertilizer, from which samples for analyses were selected, was purchased at the company's office, Philadelphia. Its mechanical condition was good, which is almost the only good thing it can conscientiously boast of. We make the following selections from the circular of this company, with the analyses of the Bromophyte by Prof. Blaney:

"In the manufacture of Bromophyte, the most scrupulous regard is paid to the laws of chemistry; and to distinguish this fertilizer from all others—which we neither endorse nor condemn—we have called it Bromophyte. This term is taken from two Greek words, which signify *food* for *plants*."

"The farmer and planter will see at once that his interest is our interest. We cannot hope to succeed unless we make good our promises. Nothing is surer than our failure if we do not give the farmer the worth of his money. We can, therefore, have no motive in deceiving any one."

"We offer this fertilizer at about one-half the cost of guano, while its value, we are led to believe, is equal to if not better than the best Peruvian."

"The attention of the Fruit Growers' Association of Washington was lately called to this Bromophyte, and a member of the Association, Professor Thomas Taylor, a well-known chemist, at a meeting held August 3, 1869, read a paper upon the subject, from which we make several extracts:"

"Mr. President and Gentlemen:—I have here a sample of a valuable fertilizer, which is attracting much attention at this time. It is known by the name of Bromophyte, which signifies *plant food.* Its base is human excreta, including urine, and is submitted to a process of deodorization by which it is deprived of its smell.

"The efficacy of peat, which is used, is due to the soluble salts which it contains, and to its property of absorbing ammonia from the atmosphere—having an absorbing power of seventy-two times its own bulk.

"Marl, one of the constituents of Bromophyte, is valuable for various reasons—it is a composition of clay and shells, the clay being the more important substance of the two. Its very valuable properties were first pointed out by Professor Way, Chemist of the English Royal Agricultural Society. He says that clay will decompose the salts of ammonia, potash and soda, and retain their bases."

"At the close of Mr. Taylor's remarks, Mr. William Saunders, of the Agricultural Department, proposed a vote of thanks to Mr. Taylor for his valuable remarks, which was unanimously carried.

"The following statement has been received from Professor Blaney, of Chicago, relative to the merits of Bromophyte:

"CHICAGO, *October* 26, 1870.

"This is to certify that I have examined the specimens of Bromophyte submitted to me, and have found the same to be composed as follows:

| | |
|---|---|
| Volatile matter, organic matter, water and a trace of free ammonia | 59·05 |
| Inorganic matter | 40·95 |

The Bromophyte contains of salts 40·95 per cent., namely:

| | |
|---|---|
| Sulphate of Lime | 17·6765 |
| Phosphate of Lime | 1·4922 |
| Phosphate of Magnesia | 1·1335 |
| Carbonate of Magnesia | 2·2613 |
| Chloride of sodium | 2·0540 |
| Sesquioxide of Iron and Alumina | 5·0790 |
| Insoluble Silicates | 11·2690 |
| Chloride of Potassium, a trace. | |
| Total | 40·9655 |
| Gain | ·0155 |
| | 40·9500 |

"The Bromophyte was found by organic analysis to contain nitrogen, 3·92 per cent., equivalent to ammonia, 4·76 per cent.

"JAMES V. T. BLANEY,

"*Analytical and Consulting Chemist.*"

"P. S.—It will be seen, by comparing with analysis of guano, that Bromophyte is two per cent. the stronger."

After making an analysis of this "BROMOPHYTE," and knowing its composition and value, we doubt whether the writer of the circular, or even Professors Taylor and Blaney were in earnest in their encomiums of this article. We rather think these gentlemen have endeavored to perpetrate a practical joke on the farmers. That any chemist (and Prof. Taylor is represented to be one), should seriously recommend the use of peat and marl, *clay and shells* in a high-priced fertilizer that sells for two cents per lb., is almost incredible; or that Prof. Blaney should seriously say that it is two per cent. stronger than guano, is certainly beyond belief.

The farmers who have used the article seem to have been in the same vein of humor, so palpably exhibited by the facetious Professors Taylor and Blaney, as the following specimens of their certificates will show:

GREAT ON TURNIP TOPS.

"WASHINGTON, D. C., *April* 1, 1869.

"RANDALL FISH, Esq.

"*Sir:*—In reply to your note, inquiring about your fertilizer, I am happy to say that it will work wonders.

"I tried it last season on some turnips as late as the 1st of October, and I never saw such a crop of tops in my life. Of course, it was too late to fetch a full crop, yet some were as large as hens' eggs.

"I do not hesitate to say that I think it superior to any fertilizer in the market, as it will benefit the ground while it stimulates the present crop. I have used it with the greatest success, and have found it to be better than any other, having used it side by side with the Patapsco and other fertilizers, and it far exceeds them. It has proven satisfactory to Dr. Nichols, the Superintendent of the Insane Asylum, as he has this spring purchased five tons of it. "SAMUEL A. SMITH,

"*Gardener at the Insane Asylum.*"

We should expect just such a certificate from an Insane Asylum.

## GREAT ON CUCUMBERS.

"WASHINGTON, D. C., *August* 18, 1870.

"RANDALL FISH, Esq.

"*Dear Sir* :—I have used your fertilizer, called Bromophyte, on three acres of cucumbers, on my farm at Mt. Vernon, and can say that I believe it to be a first-rate article. A few rows I left without any fertilizer, on some I put Peruvian Guano, and on some Patapsco Guano. Those without any fertilizers are very poor, but where your fertilizer was used they are very fine, and much better than the vines that were fertilized with the Peruvian or Patapsco Guano. "DR. E. P. HOWLAND,

"*No.* 27 *Four-and-a-Half Street.*"

## DODGE ON BROMOPHYTE.

"WASHINGTON, D. C.

"I have seen the effects and examined the character of the fertilizer manufactured by Randall Fish, and am satisfied it is among the best now offered to the public. I have used it on my strawberries and other plants, and find the effect upon their growth superior to that of any other fertilizer I have ever used. I shall want more.

"It effects wonders on every kind of vegetable to which I have applied it, making vegetation grow on barren soil.

"Very respectfully,

"A. T. C. DODGE."

This, we think, is a very good specimen of "dodge." As it makes vegetation grow on *barren soil*, Bromophyte must contain the essence of strawberries. Who will eat strawberries after this?

## GASS ON BROMOPHYTE.

"Gelen, Washington Co., *August* 26, 1869.

"Mr. Randall Fish :

"I have used your Bromophyte on tomatoes, squashes, cucumbers and on corn, and must say that it exceeds my expectations. I believe that it is better than any fertilizer now in use. I have tried most all kinds in the market, and this is the best I have ever found. I have examined the corn to-day, and find, where your fertilizer was used, it was a deep green, and where other fertilizers were used beside it, the great drought had turned the leaves yellow, and the stocks were much smaller.

"Very respectfully,

"John Gass."

We fear the corn was not so green as the buyer of the Bromophyte. Taken altogether it is a very *gassy* certificate.

## A 20,000 POUNDER CERTIFICATE.

(*The biggest gun known.*)

"Alexandria, Va., *March* 15, 1870.

"Randall Fish, Esq.

"*Dear Sir* :—Please send me ten tons of your Bromophyte, the most economical manure, which insures the quickest and best returns of any I have ever used. Rely on me as a customer while I have any land to cultivate.

"Yours, very respectfully,

"J. Millard."

If the Bromophyte Mr. Millard purchased was no better than that sold to us, and he continues to go it so strong on Bromophyte, he will soon have no land to cultivate—it will be in the hands of the sheriff.

## A CERTIFICATE FROM THE "LAND OF DREAMS."

"Norfolk, Va., *May* 13, 1870.

"C. C. Brown, Esq.

"*Dear Sir* :—I have been experimenting last fall and this spring with your Bromophyte. It beats any fertilizer I know of. For early truck of all kinds it is all that can be desired. It is destined to take the place of nearly all the so-called fertilizers, now so numerous. For radishes, it beats all I ever dreamed of. I do not dare to tell how short a time it took to produce for me the finest radishes I ever saw.

"Yours, etc.,

"GEORGE S. OLDFIELD,

"*Formerly Judge of County Court.*"

*Query.*—Does the Judge often dream of radishes—it must be an interesting subject for a Judge. We shall next expect to hear of the Judge dreaming of "turnip tops."

FISHING FOR DODGE.

"WASHINGTON, D. C., *June* 29, 1870.

"RANDALL FISH, Esq.

"*Dear Sir*:—In reply to your favor of to-day, I would say that I have used the Bromophyte—Fish's—in my garden in this city for two years, and do not desire anything better for strawberries. In fact, it seems to impart a remarkably strong and healthy growth to any and every vegetable to which I have applied it, and I believe it is superior to any fertilizer in the market, not excepting the Peruvian.

"Respectfully, yours, etc.,

"A. T. C. DODGE."

Another specimen of "dodge;" being better than Peruvian Guano, we think it slightly "fishy."

The reader will notice that these certificates are given by farmers in the vicinity of Washington. The Bromophyte to which they have reference being prepared there. We do not say that excreta at Washington are richer than at Philadelphia; but it is possible that the Washington manufacturers may be more honest, and make a better article than their Philadelphia brethren—it is almost impossible that they could make a worse. The use of these certificates by the Philadelphia Company is literally stealing the thunder of the excreta of Washington.

## METHODS OF ANALYSIS.

The methods of analysis employed to determine the amount of nitrogen, actual ammonia, and potash, and of phosphoric acid in the several manures, of which analyses are given in this chapter, are of too intricate a nature to be understood by the general reader. Hence we state the methods only in general terms, with such remarks and particulars as will enable professional chemists, into whose hands our work may fall, to estimate the carefulness with which they have been made.

### METHOD FOR TOTAL NITROGEN.

From about 30 grammes of the finely pulverized and intimately mixed substance 1 to 2 grammes were taken for analysis, which was made according to Varrentrapp and Wills' method. We remark, that the actual amount of Nitrogen was calculated from the actual amount of metallic platinum obtained, and not from the weight of the precipitate, as is sometimes done: the former being considered the most reliable.

### METHOD FOR ACTUAL AMMONIA AND POTASH.

| | | |
|---|---|---|
| Substance | = | 50 grammes. |
| Fluid | = | 250 c.c. |
| Fluid taken | = | 25 c.c. = 5 grammes substance. |

The substance in an evaporating dish was treated: first, with small quantities of water at 60° to 70°; then boiled successively in water acidulated with hydrochloric acid; and finally, washed on a filter with boiling water, till the filtrate measured nearly 250 c.c.

The ammonia was determined according to

### SCHLOESING'S PROCESS.

Strength of Soda Solution, 3.06 c.c. = 1 c.c. Normal Sulphuric Acid.

The potash was determined as potassio-bichloride of platinum.

### METHOD FOR TOTAL PHOSPHORIC ACID.

| | | |
|---|---|---|
| Substance | = | 20 grammes. |
| Fluid | = | 1000 c.c. |
| Fluid taken | = | 50 c.c. = 1 gramme substance. |

The hydrochloric acid solution, with the addition of several drops of concentrated nitric acid, was evaporated *completely to dryness*, and the residue treated with dilute hydrochloric acid. To the solution thus obtained, there was added; first, citric acid, in quantity sufficient; then ammonia; then, acetic acid, each slightly in excess; and finally, to the nearly boiling solution, oxalate of ammonia was added. The precipitate obtained was collected *at once* on a double filter, and to the cool and strongly ammoniacal filtrate, were added, 6 to 10 c.c. of an ammoniacal ammonio-sulphate of magnesia solution—each c.c. of which corresponds to 0.0358 gramme anhydrous phosphoric acid. The filtrate and wash water measured 250 to 300 c.c., and for every 54c.c. of the same, 0.000637 gramme phosphoric acid was allowed.

METHOD FOR SOLUBLE PHOSPHORIC ACID.

| | | |
|---|---|---|
| Substance | = | 20 grammes. |
| Fluid | = | 1000 c. c. |
| Fluid taken | = | 100 c. c. = 2 grammes substance. |

The substance was triturated in a mortar with distilled water, at 60° or 70°, the powder allowed to settle, and the fluid decanted. This operation was repeated till ¾ litre of fluid was obtained, when the powder was collected on a filter and washed with distilled water till the filtrate measured one litre. The phosphoric acid, as in the previous instance, was determined gravimetrically.

NOTE.—In one or two instances, instead of 1 to 2 grammes, 10 grammes of the substance were taken for the phosphoric acid determination.

## CONCLUDING REMARKS.

Manufacturers of fertilizers attach great importance to the certificates of farmers, and it is considered a strong point as an evidence of the superior quality of their products; hence they procure as many of them as possible. Two advantages are thus gained: First. It effectually closes the farmer's mouth for subsequent unfavorable criticism. Second. Every farmer's opinion has weight in the circle in which he moves, and his favorable report of a fertilizer induces others *to give it a trial.* Thus the business of these manufacturers is increased, and the farmer unwittingly becomes a party to their frauds, and when his neighbors find that they are cheated, he receives his share of blame. Hence farmers should be very careful in giving these loosely worded recommendations, which benefit no one but the manufacturers. Those who have given these certificates know how they have been procured; personal friendship for the manufacturer or dealer, has led many to give favorable reports, we doubt not against their better judgment, while with others, perhaps, the desire of seeing their name in print has its influence.

Certificates are a part of the stock in trade of *quackery*, and no honestly conducted business needs them. Besides the certificates given to different manufacturers when taken collectively do not amount to anything, because each manure sold is represented by the certificates to be the best. Such conflicting statements are without value as evidence; consequently, the farmer is as much puzzled in the selection of a good manure, as he would be without seeing the certificates.

If this business had been legitimately conducted, and the price regulated by the quality and condition of the valuable constituents of the fertilizer, manufacturers would have no occasion to resort to customers' certificates.

There is another class of certificates that, unfortunately, do not meet the public eye, namely: The *complaints* of those who have realized that they have been swindled in the purchase of these manures. These certificates would present an interesting sequel to the others, and in *number* as well as in *force*, would completely overshadow them. If time and space permitted, we could give a long list of these negative certificates that would be anything but interesting reading for the manufacturers. An illustration of the unreliability of certificates is seen in the samples we have given from the users of the Bromophyte, a manure that is almost worthless. Some of its users certify that it is better than Peruvian Guano, or the Patapsco Ammoniated Phosphate, the latter, according to our analyses, being one of the best superphosphates now made in this country. Many certificates are given before the crop is harvested; such premature statements must be very unreliable. Farmers should realize the importance of knowing the *source of the benefits realized* before giving certificates. It may be due to a favorable season, to substances already in the soil, or to the manure, or to all three combined. If the farmer sees a favorable appearance in his crop, he is too apt at once to attribute it exclusively to the bought fertilizer, forgetting what he must have frequently seen, when using stable manure alone, that one year a good crop may be raised, and the next time, though equally well cultivated and manured, a poor one. It has been shown that the amounts required of the valuable constituents of crops are very small. Hence, if the *so-called* concentrated fertilizers contain but a little of what is really needed, its effect on the crop *would be apparent.* But our farmers should bear in mind that they pay *exorbitant prices* for the benefits received. If they apply 400 lbs. of a fertilizer costing $50 per ton, it would be $10 to the acre, and they should have clear views of the amount of any crop that should be expected from such an outlay. As an illustration, 25 bushels of wheat with the straw requires:

| | | | | |
|---|---|---|---|---|
| 27·95 lbs. | of Phosphoric Acid | @ $0.12½ | per lb. | $3.49 |
| 39·65 " | " Potash | @ 0.08 | " | 3.17 |
| 46·60 " | " Nitrogen | @ 0.15 | " | 6.99 |
| | | | Total | $13.65 |

Hence, if an outlay of $13.65 on an acre should produce 25 bushels of wheat with the straw, an outlay of $10 to an acre should produce over 18 bushels of wheat with the straw, in addition to what could be produced without the application of fertilizers, or if we allow half of the nitrogen to be represented by actual ammonia at 25 cents per lb., an outlay of $10 to the acre should produce 14½ bushels. This calculation can be readily applied to other crops from the same data, and from it the farmer can see how small the amount of benefit, in increased crops, he has derived from the use of these fraudulent manures in proportion to the money invested. We are quite sure if the farmer had correct views on the subject, he would no more think of giving certificates to these manufacturers, than he would of giving a certificate of good character to the burglar who had broken into his house and stolen his money, but spared his life, or to the thief who had stolen his horse and failed to set fire to his barn.

The reader should now be fully convinced from the facts stated and analyses given, of the absolute necessity of National and State legislation to protect the farmers and the public from the rapacity of manufacturers of fertilizers. There are Grain, Flour, Liquor, Tobacco, Leather, Oil, Drug and other Inspectors, appointed to protect purchasers and *honest* manufacturers and dealers. Fertilizers are equal in importance to any of those commercial articles mentioned, while there are greater facilities for fraud. In England and other European countries, the prices of these fertilizers are fixed by the amount and value of the fertilizing elements contained in them, according to the manner indicated in this book; and in this matter, we are far behind those countries we are accustomed to style *slow*. In those countries, concentrated fertilizers are inspected by government officials. As the result of the rigid inspection laws of Germany, purchasers are protected. We quote from the circular of George Charles Zimmer, at Manheim, one of the largest manufacturers of fertilizers in Germany, and give three analyses of the superphosphates manufactured by him, to show the operation of the law:

These fertilizers are always sold and delivered of an approved, uniform, superior quality, and their ingredients *warranted;* samples of the same are deposited with the Central Agricultural Department of the Grand Duchy of Baden, at Carlsruhe, under whose control the products of the factory are placed by law. The monthly official analyses of supplies on hand in the manufactory, are published from time to time in the Weekly Journal of the Agricultural Society of the Grand Duchy of Baden, and every purchaser of at least half a ton at one time of one of these superphosphates, has the privilege to transmit (free of charge) with enclosure of the original invoice, a sample of the same to Doctor J. Nessler, the President of the Experimental Station, at Carlsruhe, in order to be analyzed, free of expense, to the purchaser. Furthermore, these fertilizers are subject to the control of the Agricultural Societies of Hessen on the Rhine, Rhenish Prussia, etc., and the results of their investigations are communicated to the public from time to time, in their respective agricultural papers.

No. 1—Analysis of Coprolite Superphosphate.

| | *Percentage.* | | *Equal to* | |
|---|---|---|---|---|
| Soluble Phosphoric Acid, | 10 to 11 | = | 16 to 18 | Superphosphate of Lime. |
| Insoluble Phosphoric Acid, | 3 to 4 | = | 6 to 8 | Bone Phosphate of Lime. |

No. 2—Analysis of Bone Meal Superphosphate.

| | *Percentage.* | | *Equal to* | |
|---|---|---|---|---|
| Soluble Phosphoric Acid, | 13 to 14 | = | 22 to 24 | Superphosphate of Lime. |
| Insoluble Phosphoric Acid, | 3 to 4 | = | 6 to 8 | Bone Phosphate of Lime. |
| Nitrogen........ | 0·5 to 1 | | .... .... | |

No. 3.—Analysis of Baker Guano Superphosphate.

| | *Percentage.* | | *Equal to* | |
|---|---|---|---|---|
| Soluble Phosphoric Acid, | 18 to 20 | = | 30 to 32 | Superphosphate of Lime. |
| Insoluble Phosphoric Acid, | 2 to 3 | = | 4 to 6 | Bone Phosphate of Lime. |

On comparing the above analyses of superphosphates made in Germany, with those made by our *boastful* manufacturers, the reader will notice that their *lowest grade* superphosphates contain more *soluble* phosphoric acid than our *best*, and that the *insoluble* phosphoric acid (3 to 4 per cent.) contained in those made at Manheim, is about equal to the average amount of *soluble* phosphoric acid, in American commercial manures.

THE END.