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BY THE HOUSE OF DELEGATES,

January 22nd, 1850.

Read, and three thousand copies ordered to be printed. February 19th, five thousand extra copies ordered to be printed—five hundred of which to be placed at the disposal of Dr. Higgins.

REPORT

OF

JAMES HIGGINS, M. D.

STATE AGRICULTURAL CHEMIST,

TO THE

HOUSE OF DELEGATES OF MARYLAND.

ANNAPOLIS:
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1850.

REPORT

The Legislature of Maryland at the session of 1847, 48, created, the office of Agricultural Chemist by the following act:

CHAPTER 249.

An act entitled, an act to provide for the appointment of an Agricultural Chemist for the State.

SECTION. 1. Be it enacted by the General Assembly of Maryland, That the Governor by and with the advice and consent of the Senate, shall hereafter annually appoint and commission a person of ability, integrity and suitable practical and scientific attainments, as Agricultural Chemist for the State, and if the Senate shall have adjourned before the Governor shall make the appointment for the present year, or if a vacancy shall hereafter occur during the recess of the Senate, then the Governor alone shall make such appointment, which shall be good and valid until the tenth day after the meeting of the Senate.

SEC. 2. Be it enacted, That the State shall be divided into three districts; the first shall comprise that part of the State now comprised in the first Gubernatorial district; the second that of the third Gubernatorial district; and the third that of the second Gubernatorial district.

SEC. 3. Be it enacted, That the said Agricultural Chemist, shall spend one year, the firs tbeginning on the date of his appointment, in each of said districts in the order named, it shall alse be his duty to spend one month in each county and Howard District, and visit each election district.

SEC. 4. Be it enacted, That it shall be the duty of said Agricultural Chemist, to analyze specimens of each variety of soil of the county in which he shall be, that may be brought to him or that he may find to exist, and also to examine and if necessary analyze specimens of each kind of marl or other vegetable or mineral deposit that may come to his knowledge, in order that his instructions may be of more practical utility.

SEC. 5. Be it enacted, That it shall also be his further duty to deliver one public lecture, after having given timely notice thereof, in each election district in each county, and then to deliver a course of public lectures at each county town, and at some central place in Baltimore county, after having given also sufficient notice thereof in each election district, and he shall also permit the clerk of the levy court or the commissioners of tax as the case may be, to take a copy of such course of lectures, to be retained and kept for the use and benefit of the county, and published by said levy court or commissioners of the tax if to them it shall seem expedient.

Sec. 6. Be it enacted, That the said chemist shall make an annual report to the House of Delegates if in session, and if not then to the Governor, whose duty it shall be to cause the same to be published, of his proceedings, and such other matters touching the agricultural interest of the State, as may be consdered necessary.

Sec. 7. And be it enacted, That for the faithful discharge of his duties, the said chemist shall receive the annual salary of fifteen hundred dollars, to be paid as the salaries of other officers are or may be paid, and for the purchase of chemical implements and materials, the said chemist shall be allowed for the first year, the sum of two hundred dollars in advance, and on each succeeding year a sum not exceeding fifty dollars, out of such monies as may be in the Treasury not otherwise appropriated.

I had the honor to receive the appointment under the above law, and as soon as the necessary apparatus, tests and re-agents could be procured, commenced the discharge of its duties.

A part of those duties was to analyze the varieties of soil to order to determine the presence or absence of the necessary constituents of crops;—to see whether they existed in sufficient quantities,—to recommend the application of such particular substances as would most economically supply whatever defects might exist; to render barren soils fertile, and retain the fertility of those which might be productive at the present.

To determine the *necessary* constituents of crops, we have only to examine them by the aids which analytical chemistry affords, and when we find particular substances always present in them, when we find that although in different plants they exist in variable proportions, yet that they *are always* present, we must conclude that they are the substances *necessary* to the existence of vegetable life. There are certain substances to be described hereafter, which are always found in plants; in no clime, in no country, under no circumstances do we ever find the one without the other. The conclusion then is, that these substances are necessary to the existence of plants. But there is another and a stronger proof. The object and aim of all cultivation is to sustain by the food which it produces, the human body. This food then, *must* contain all of the elements which enter into the composition of the body, if it did not, it could not subserve the purposes of nutriment. The human body is always losing something by exercise, something by disease, nay, something by breathing—(the very act of life,) which is again supplied to it by the food which it takes under the instinct of the appetite. If this food did not contain *all* of the elements thus lost, some part of the body would not be renewed and life would end. Food must contain not only the elements of blood and bone, but of all the tissues of the body; and as all food, is either directly or indirectly supplied by plants, the plants must contain them. These substances then are the necessary constituents of plants. It is out of place here to speak of the manner in which the elements of vegetable structure are converted into the different substances which enter into the composition of animal bodies, and I shall say nothing on that subject.

The necessary constituents of soils are determined by a knowledge of what plants require. The food of plants is derived from the air which surrounds them, and from the soil in which they grow. We shall not in this place say of the atmosphere any more than that if the soil cannot obtain the proper food from it, then that food must be supplied artificially, or sterility will be the inevitable consequence. A certain portion of the elements of plants cannot from their nature exist in the atmosphere; they must then be present in the soil or vegetation cannot be produced, because without them plants cannot be formed. We can in this manner perfectly ascertain what substances are necessary to the plants that are used for food, from our knowledge of the matter in a human body which is furnished by that food, and also perfectly ascertain what are the necessary constituents of soils from a knowledge of the materials which those plants require for their complete development. The best *proportions necessary to constitute a fertile soil* can only be determined by the chemical analysis of a large number of fertile soils. With each examination one certain step is gained in the solution of this great question.

As examinations become more numerous the *minimum* quantity, that will produce the largest yield will be ascertained, and then the perfection of Agriculture will be attained. Of the substances to be described hereafter *all must be present to constitute a fertile soil* and they not only be *present*, but they must be in *sufficient quantities*, and in a form to supply the wants of the crop. What the *best quantity* is has not yet been exactly ascertained. We must not reject the aid of science, because it cannot at once give us a perfect system, we must compare what it affords with what exists without its aid. The one system is possessed of a degree of certainty continually approaching to perfection, the other is altogether empirical, and never takes one certain forward step.

I have said that all of the necessary substances must be present, and I moreover add that *an excess of any one* cannot compensate for the absence or deficiency of another. So that we have this general rule, that the fertility of a soil depends not on the *quantity* of several of the necessary constituents, but *upon the proper proportion of them all.*

To show this, I submit the following table, the facts of which are taken from numerous analyses made in England and Germany, by men whose reputation vouch for their truth, and from some made by myself in this State.

It is only by facts of this kind, well established and indisputable facts, that principles in agriculture or in any art or science can be demonstrated. The creations of fancy however beautiful cannot now satisfy the human mind in its yearnings for truth. It seeks for and is only contented with what is proven by exact demonstration. Now no mere hypothesis however brilliant, can be received with blind confidence. No theory now, however fascinating, can be tolerated, that is not founded on legitimate deductions from indubitable facts. Experimental inquiry and scientific investigations must be appealed to, to satisfy all doubts; for the human mind is not satisfied with explanations of that which it does not understand by assumptions more incomprehensible than that which is sought to be explained.

A soil may contain any or even all save *one* of the constituents of a *good* soil, in the large proportion indicated below and yet be unproductive.

Lime,	1.65	*1.80		*6.25		
Humus,	3.98	*4.10		*3.60	*3.88	
Magnesia,	.16	.28	.73	.80	*1.25	
Potash,	.05	.15	.30	*1.20		
Soda,	*.10	*.30		*.85	*1.65	*2.13
Phosphoric acid,	.19	.198		.36	.40	.20
Animal and vegetable or Organic matter,	*10.12	*25.00		*32.16	*52.17	
Chlorine,	.06	.08		*.11	*6.21	*.42
Sulphuric acid,	.051	*.082		*.255	*.267	
Alumina or pure Clay,	5.25	7.97		*13.21	*18.50	
Silica or Sand,	*92.	*95.61		*97.84	*98.00	
Iron as per Oxide,	*8.14	*10.30		*17.75	*29.00	

All these soils were unproductive so that it is proven by the above facts, that a soil may contain five hundred and forty, or even eighteen hundred and seventy-five bushels of lime, distributed to the depth of twelve inches, that it may contain three hundred and seventy-five bushels of magnesia, that it may contain sixty bushels of phosphoric acid, equal to about two hundred and forty bushels of bone dust, or that it may contain three hundred and sixty bushels of potash and yet be barren, sterile and unproductive and not repay the cost of cultivation. The same is equally true of any number, save all of the constituents of a good soil.

On the other hand it is proven that soils very productive particularly for wheat, may contain the small proportions of any one

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Those marked thus* are soils of our own State.

N. B. .1 or .10 is the one tenth of one per cent., and is equal to about thirty bushels to the acre of the substance it represents, the specimen being taken to the depth of twelve inches. It is equal to the one-thousandth part of the specimen.

of the necessary constituents, the rest being present in proper proportions. This is shown below.

Lime,	.29	*.32	*.40		
Magnesia,	*.21	*.18	*.16	*.12	
Potash,	.12	.10	.08	.06	.02
Soda,	.09	.03	.018		
Phosphoric acid,	.02	.01			
Organic matter,	.67				
Chlorine,	·003	·002			
Sulphuric acid,	·005	·008			
Silicia (sand,)	64.5	59.21			
Alumina,	1.	1.70	2.60		
Iron as per Oxide,	1.25	1.06	·69		

It is shown from the above that a very fertile soil may contain only eight-seven bushels of lime to the acre, to the depth of twelve inches, or only two one-thousandth of a bushel of chlorine, or as little as six bushels of potash, or three of phosphoric acid, to equal to about twelve of bone dust.

Hence on the examination of a soil, if we find the above proportion of any one of the necessary constitutents, in a form capable of being used by plants, we must conclude that enough of that particular constituent is present. If the soil be unproductive we have to look for and counteract some other chemical or mechanical deficiency.

To retain the fertility of a soil already productive, it is necessary to add to it a quantity of fertilizing matter equal to that which is taken off by the crop, allowance being made for the portion which may be lost by percolation through the soil. By doing this we can in a very cheap manner always retain soils at whatever point of production, they may have, and even have their productiveness increased, a soil which from its texture, is particularly good for wheat, may thus be kept in a condition to produce a crop every year *without any rotation.* The same is true with regard to corn or any other crop.

SOIL.

By this term is understood in an agricultural sense that portion of the earth's surface which serves or may serve for the production of crops.

Under all circumstances where a blade of grass and the smallest seed are produced, there are *present all* of the necessary constituents of fertility.

The quantity of these things present, when taken in connection with its physical character determine the fertility of a soil.

In all soils which are not *absolutely* barren we have the following constituents they being in fact *the soil,* the things out of which the soil is made.

Those marked thus * are soils of our own State.

ORGANIC MATTER.

This is animal and vegetable matter considered, without reference to its inorganic constituents, and is composed of the remains of plants or animals which existed on the soil. It is called *organic*, because it has at one time entered into a form capable of performing the functions of life and has become a part of those things which are called organs, whose duty it is to perform processes, without which there cannot exist that system of vital functions which we call Life.

At one time very great importance was attached to vegetable matter in soils, many teaching that it was the indispensable thing to fertility, and that lands were productive in proportion as they contained a greater or less quantity of it. This has been shown by numerous examinations not to be the case, for the productiveness of soils bears no relation to the quantity of organic matter which they contain.

Its use is now restricted to giving the necessary degree of porosity to stiff compact soils, and by its decomposition to render rain water or dew better solvents of the mineral constitutents of a soil. Every grain of sand contains some, sometimes all of the necessary constituents of crops, which are however of no use until they become dissolved into a state capable of being taken up by plants. Whatever will effect this is of service in a soil. Vegetable matter contains a large proportion of carbon, (charcoal,) which an exposure to the air is changed into carbonic acid. Water impregnated with this substance, has the property of powerfully dissolving all the minerals found in a soil, and by this means rendering it more productive. Its quantity varies greatly in different soils. In some I have found less than one per cent. and in others, "the Black Gum Swamp Soils" of Worcester and Somerset as much as sixty-two per cent. Secondly,

SILICA, OF SILICOUS EARTH OR SAND,

Exists abundantly in all soils. Though having none of the sensible properties of an acid, it nevertheless belongs to this class of bodies, and combines with bases to form salts. It very rarely exists in a pure form in the earth, being almost always in union with some other substance, and forming a class of bodies called *silicates*. With alumina and the per oxide of iron, it forms our red and yellow clays, it most generally is associated with lime, magnesia, potash or soda. The "grains of sand" in soils are composed of pure sand, (silicic acid) in combination with some of the above substances. In pure water these combinations are quite insoluble, but water charged with carbonic acid, dissolves them in a sensible degree. When in the *nascent* state, that is, when first set free from its combinations, water dissolves pure silicic acid very readily.

Besides its determining the mechanical properties of soils and when in a very fine state of division acting as a substitute for iron and clay in their absorbent capacity, it has a more particular use, that of forming the stalk and stem of plants and the husk or outward envelope of the grain. In combination with potash, soda, lime and magnesia, but more particularly with potash, it gives hardness and firmness to the stalk of grasses, indian corn, wheat, rye, oats, &c. It gives strength to the stalk to support the weight of the blades and ear, forms channels for the circulation of the sap, and for the transmission from the root of whatever nutriment other parts of the plant may require. Without the presence of this substance, and that too in a suitable state to be taken up by the roots, whatever quantity of the other constituents of plants might be present in a soil, vegetation could not arrive at any perfection. If the materials for the grain or ear existed, still there would be no stalk to support them. The quantity in different soils varies from thirty-five per cent in the "Black Gum Swamp Soils" of Somerset and Worcester, to ninety-two and seventy-four hundreths in some of the soils of Cecil, Kent, Queen Anne's, Talbot, Caroline and Dorchester counties.

The soils which in common parlance are called "Sandy Soils" frequently contain no more sand than those which are called "White Oak Soils, or Pipe Clay Soil."

The difference in their texture is due to the size of the individual grains of sand and not to the quantity which actually exists. Other things being equal, the finer the grains of sand the better the soil. As the growing crop can only use such materials as are already in or can be reduced to a soluble state; whatever can conduce to the state of solution will benefit them. The finer the grains of sand the more easily they are acted on by atmospheric agency, and the more speedily will they yield whatever substances they may *contain*. But there is another and a very great difference in the value of coarse and fine sand. A large part of the food of plants is derived from the atmosphere. This food must be absorbed wholly by the soil in the early growth of the plant, and if the soil has not the power of absorption, the plant will pine, languish and die, unless it be supported by applied manures. Sand in a very fine state of division has powerful absorbent qualities, it absorbs and retains atmospheric food for plants and to a very great extent supplies that place of alumina (clay) and the per oxide of iron, which are famous for this property.

IRON.

Another constituent substance of soils is *iron*.

It always is present though not in the form of metallic iron, but in the state or condition of an oxide of iron. When metallic iron is exposed to air and moisture, it becomes rough and covered with reddish or brown scales. This is what is called in common language *rust of iron*, the process is called *rusting*. In chemical language it is called the *oxidation* of iron and the product an *oxide of iron*. In soils it is generally in the condition of per oxide or its highest degree of oxidation and gives a reddish or brown color to them. It is this which gives our red and yellow clay soils their peculiar color and frequently also tinges sand —which thus colored is called Ferruginous sand. It has several important uses in the soil.

1st. It is one of the necessary constituents of the human body being always found in the blood of healthy persons. From the impossibility of its existence in the air, we know that the body must be supplied with it from the food which it consumes; but the plants used for food can no more obtain it from the *air*, than animals can, hence they must obtain it from the soil, and it is therefore a necessary constituent of soils.

Not only is it itself food for plants, but it is a gatherer of food for them from the atmosphere.

Baron Liebig, one of the ablest writers on agricultural chemistry, of this or any other day, though overlooking the first use of iron in a soil, so clearly and satisfactorily explains the second, that I cannot do better than use his own words:

* "Per oxide of iron and alumina" says this able and eloquent writer, "are distinguished from all other metallic oxides," (i. e. rusts of metals,) "by their power of forming solid compounds with ammonia. The precipitates obtained by the addition of ammonia to salts of alumina or iron are true salts in which the ammonia is contained as a base. Minerals containing alumina or oxides of iron, also possess in an eminent degree the remarkable property of attracting ammonia from the atmosphere and retaining it. * * * * Soils therefore containing the oxides of iron and burned clay, must absorb ammonia, an action which is favored by their porous condition; they further prevent by their chemical properties the escape of the ammonia once absorbed. Such soils act indeed precisely as a mineral acid would do if extensively spread over their surface."

"The ammonia absorbed by the clay of ferruginous oxides is separated by every shower of rain and conveyed in solution to the soil."

Our red and yellow clays need not burning, the iron in them being already in the state of per oxide, heat would not benefit them. It is only in the white or dark clays where the iron is in the state of protoxide, that heat would be of any use if applied.

The per oxide of iron in a soil, also absorbs and retains moisture, and whatever else of the food of plants which exists in the air.

3rd. It gives firmness and compactness to the soil, and better fits it for those plants which flourish best in those soils.

4th. It gives color to soils which makes them absorb heat better, and in this way it gives crops a quick, early growth.

The quantity of the peroxide of iron, which exists in soils is very variable. In the red clay lands of Cecil, I have found as much as (4.80,) four and eight tenths of one per cent. In some of

*Chemistry in its Applications to Agriculture and Physiology. (Edited by Lyon Playfair and Dr. Gregory, 4th London Edition.)

the white oak lands as little as sixty-eight hundredths of one per cent. In some of the light sandy soils in Caroline, Dorchester, Somerset, Worcester, and in those lying on both sides of the Chester river, occasionally a fraction less, .64. As a general rule, the quantity of it in the soil decreases, as we go down the Shore.

ALUMINA.

Pure clay or alumina is another of the constituents of all soils. It, like iron, is the oxide or rust of a metal call aluminum which never exists naturally in its pure state. "The different kinds of clay of which pipes, procelain and earthenware are made, consists of hydrate of alumina, in a greater or less degree of purity." It has not the same important action as iron in the human economy, but its uses in the soil are very nearly the same, giving it tenacity and firmness, absorbing, like it, moisture and food from the atmosphere, forming "true salts" with ammonia, and having, like it, the properties of an acid or an alkali; of an acid, by uniting with alkaline bases such as potassa, lime and baryta; and of an alkali, by forming salts, with acids. Our red and yellow clays are by no means pure alumina, but silicates of alumina and the per oxide of iron, united with lime, magnesia, and sometimes with potash, and very rarely with soda—that is, pure sand chemically united to these substances. It varies in soils from (.72) seventy-two hundieths of one per cent. in light sand soils, to as much 5.25 in others. In those soils which are commonly called "pipe clay or white oak soils," it is not in such proportions as persons usually imagine, being very rarely over 3.75 per cent. and sometimes as little as 1.02 per cent. in them. Where it exists in the proportion of from nine to ten per cent. good building bricks may be made. In the clay from which the *best* Baltimore bricks are produced, I have never found more than 19.50 per cent. of alumina. Sand in a very fine state of division, as is the case in the "pipe clay or white oak soils" may be a substitute to a certain extent, for both iron and clay.

LIME.

The great use of this substance as a manure, and the frequent benefits that result from its application, make almost superfluous the bringing forward of any proofs of its necessity in a soil. Lime, like alumina, is the oxide or rust of a metal, never existing naturally in its pure state. The metal of lime is called calcium. Lime exists in a soil sometimes as carbonate, that is air slaked lime, but most generally as silicate, that is chemically united to silicic acid, or sand. In the human body in union with phosphoric acid, it forms a very large part of the bones. It exists in combination with different acids in the root, stalk, blade, and grain of all plants.

Besides the necessity of its presence to form the structure of plants, it performs many other important functions in a soil. It promotes the decomposition of vegetable matter, and thus causes to yield the different mineral substances which it contains, as means for the production of another growth. It improves the mechanical texture of land; this is but one of its smallest uses. It powerfully aids the disintegration of the minerals (grains of sand,) in a soil, which contain many of the necessary elements of plants, and which, without the *fluxing* or *fusing* power of lime, would still retain them. This is one of its greatest and most important uses, and we cannot yet say, whether or not, lime, when applied to a soil, does not act more beneficially in this way than in any other. More investigations by chemical analysis, assisted by practical experiments, must be made than have yet been, to settle this question, and to determine in what manner, under what circumstances, and in what quantities lime acts best. In none of the soils which I have examined, has it been found in sufficient quantities, except where, at some time or other, it has been applied artificially. For other information—*see* the arricle on it, under the head of Manures.

MAGNESIA.

Magnesia is the oxide of rust of a metal called magnesium, which never exist naturally in a pure state. It is one of the necessary constituents of soil, being found in the bones of animals, and in the roots, stalks, leaves, and grain of plants. It has, in many respects the same action as lime, and to a certain extent can be substituted for it. The quantity of it varies in different soils. In some I have found as much as one per cent equal to about three hundred bushels to the acre, to the depth of twelve inches, and in others but a mere trace. The facts to show what the best quantity is in a soil, are very meagre. As far as my knowledge extends, I believe that where it exists in a less quantity than one-tenth of one per cent in a soil, magnesian lime is the best application for that soil. There have, as yet, been no experiments on the subject, and no means taken any where as far as I know, save in Maryland, to lay down any foundation for experiment that will be worth any thing when made. My own knowledge, as to the action of it, is derived from gentlemen who have used both magnesian and oyster shell lime on their lands, and from analyses of the soils which I subsequently made, have led me to the above opinion, and are the only data yet given to the agricultural community on this subject.

POTASH.

Potash, the oxide or rust of a metal called potassium, is another of the necessary constituents of soils. In union with silicic acid it gives strength and firmness to the stalk, and to the husks or envelop of the grain.

The proportions in which I have found it to exist in soils are very variable, from a mere trace in some, to as much as (1.20) one and two-tenths of one per cent in others. But a very small quantity is absolutely necessary. I have known a very productive soil to contain as little as (.05) five one hundreths of one per cent, and fifteen bushels of wheat to be produced where only (.008,) or the eighth one thousandth part of one per cent existed.

SODA.

Soda, the oxide or rust of a metal called sodium, is another of the necessary constituents of a fertile soil. It has nearly the same uses as potash, and may be substituted for it to a certain extent. It exists in various proportions in soil, but a very small quantity seems to be all that is necessary. I have not been able to make very satisfactory examinations in relation to this substance, as the section of the State where I conducted them was supplied, to some extent, by air from the salt water which surrounded it on every side. The quantity in the soil, therefore, could not be taken as proof of the quantity necessary to supply the crop.

On salt water, land produces wheat with bright strong straw, whilst land remote from it with an equal quantity of inorganic matter, will not do this, because it is not supplied with soda from the atmosphere.

PHOSPHORIC ACID.

Is also one of the necessary constituents of a fertile soil. With lime and magnesia it forms about fifty per cent of the bones of animals. Its elements are also found in the blood and brain, and in combination with different bases, it forms a very large proportion of all grains that are used for food. It exists in the soil, in combination with lime, magnesia, potash, soda, iron and alumina. With those substances, and others of this class, it form salts, which are called phosphates. Unless there be this substance present in a soil in sufficient abundance, and in proper *form* for use, no matter how rank or strong the crop of straw may be, there will be no corresponding yield of grain. Hence, in soils famous for large crops of straw, with a small quantity of grain, the farmer may increase it by the application of manures containing this substance, which are principally bone dust and guano.

SULPHURIC ACID.

Sulphuric, acid, (commonly called oil of vitriol,) is also a necessary constituent of fertile soils. It most generally exists in combination with lime, forming, with two equivalents of water, what is generally known as gypsum. Its elements exist in all plants, and in the blood of all animals.

The quantity necessary to constitute a fertile soil, is very small. This has been shown by numerous practical experiments, as well as by many analyses. Sulphates, as such, will not act on a soil which contains as little as (.005) the five one thousandth part of one per cent of sulphuric acid.

Besides the soil, the air undoubtedly supplies the plants some portion of the two substances named above, or rather supplies the elements by which they may be formed. All animal and vegetable bodies, by their putrefaction, give rise to volatile compounds, containing sulphur and phosphorus, and under conditions which we know to exist, these compounds are changed into phosphoric and sulphuric acid, which, with bases, will form phosphates and sulphates. Although these two substances have not, as yet, been *detected* in atmospheric air, yet we know that they must exist there, and will be brought down by dew, rain, and snow, to the surface of the earth.

CHLORINE.

Chlorine is another of the necessary constituents of a fertile soil. In its pure state it "is a yellowish green colored gas, which has an astringent taste, and a disagreeable odor." When breathed, it excites violent spasm of some of the upper parts of the windpipe, and has a very irritant effect on the organs of respiration, even when very much diluted with air. In the soil it is almost always united to soda, and *very* rarely to lime, magnesia, or potash. United to any of the bases, it loses its poisonous properties. With soda, it forms the different kinds of common table salt. It is believed to add to the weight of the grain. The quantity necessary to constitute a fertile soil, all other things being present, is very small. I have not been able to determine, with any degree of certainty, the smallest quantity necessary in a soil, as the atmosphere from the contiguity of salt water in the localities which I have examined, always contained a varying proportion of this substance.

The above compose all of the substances necessary to constitute a fertile soil. In some soils manganese is found, which is the oxide or rust of a metal called manganesium. This, though occasionally found in fertile soils, and in the ashes of plants growing on them, yet is not essential, since its presence does not increase, nor its absence decrease, the productiveness of a soil.

The air, in common with the vegetable matter in a soil, furnishes to plants carbonic acid, out of which they form woody fibre, and all substances in them which contain charcoal.

Besides this, it in common with many manures, affords ammonia, a substance which supplies a great share of the nutritious parts of plants, and constitutes by its elements a large part of the mass of the bodies of the vegetable and animal creation.

Water is supplied, in this country at least, wholly from the atmosphere, in the form of dew or rain.

To recapitulate, then, we have as food for plants furnished by the soil alone:—

Silica or sand,
Alumina or clay,
Iron,
Lime,
Magnesia,
Potash,

Soda,
Chlorine,

We have furnished in a great measure by the soil, but partly also by the air: —

The elements of phosphoric acid containing phosphorus:

The elements of sulphuric acid containing sulphur.

In localities adjacent to the ocean, bay, or indeed any salt water, there is always present in the air both soda and chlorine in the form of common salt.

We have furnished in a great measure by the air, but partly also by the soil: —

Carbonic acid containing charcoal:

Ammonia containing nitrogen.

We have furnished exclusively by the air: —

Water.

These contain all of the elements necessary to the perfection of vegetable and animal life. Those of them which are not present in the soil in sufficient quantities, and which cannot be derived from the atmosphere, must be supplied artificially by what are called

MANURES.

Manures may be defined to be whatever will contribute to increase the productiveness of the soil, either by furnishing directly food to plants, which may be absent, or by causing that food, which already may be present, to assume a *form* capable of being used by them.

However valuable any substance may be in itself, yet it is no manure to a soil that already contains it in sufficient abundance, or has not some other thing present in a form which plants cannot use, and which by the application of the substance used for manure, may be so changed as to yield food for plants.

Thus lime may act as a manure, when it is deficient in a soil, by being directly used for the structure of plants, or it may act as a manure in a soil when it exists in sufficient abundance, but not in a *condition* to set free other things which may there exist, but not in a form capable of being used.

Vegetable matter may be a manure by yielding its carbon and its salts to plants, or it may act by impregnating water with carbonic acid, which thus acquires the property of dissolving the mineral constituents of a soil, and of placing them in a fit condition for use.

All manures should be in the finest possible state of division, and mixed either directly, or indirectly most thoroughly with the soil. Every particle of manure should be placed, if possible, in immediate contact with a grain of sand.

STABLE AND BARN YARD MANURE.

This being, to a great number of agriculturists, the only form in which manures are applied to lands, any suggestions to increase its value cannot be overrated.

Stable and barn yard manure is composed of the excrements of cattle, mixed with that part of the produce of land which is unconsumed by them. It is nothing more than the former produce of the land, modified by its passage through the bodies of animals, or modified by the presence of those things which have, at one time served the purposes of food. It, therefore, contains *all* of the substances necessary to plants, as well those furnished by the air, as those which are obtaind from the soil. I shall not go into any elaborate description of its several constituents, nor of their properties, but only give directions for preserving it in its greatest possible state of usefulness. In the decomposition or rottening of stable manure, a substance is formed, called ammonia, which is very volatile, that is, it will readily escape into the air at all times, but more especially when the weather is warm. There would seem to an uninstructed mind, no possible way of preventing the loss of this substance, but by making the receptacles of stable manure air-tight; but chemistry shows, by teaching the nature and properties of bodies, that this substance, one of especial value in stable manure, can be so changed by the addition of another substance of little cost, and of easy application, as not to escape at any degree of heat to which stable manure is ever subject; this change does not in the least affect the value of the manure. To effect this, nothing more is necessary than a small quantity of gypsum, (plaster of paris,) say from a half gallon to a peck, scattered over the yards or stables twice a week.

When manure is to be applied to sandy soils, in which the sand is white, sulphate of iron (copperas,) should be prefered. A few pounds beat very finely, are enough for each week.

In this way the value of the manure will be increased one-half, or at least one-third, and all disagreeable stench removed from the yards or stables. This stench is produced by innumerable fine particles of ammonia escaping into the air, and affects, sometimes seriously the health of animals subject to it. In the application thus recommended above, not only is the health of a farmer's stock, but the value of his manure greatly increased, either consideration being sufficient to pay one hundred times over, the cost of the application of gypsum or of copperas. Either of those substances when applied to privies or any place where animal and vegetable matter is undergoing decomposition, will at once arrest all offensive odors arising from them. So much for saving that part of the manure which escapes through the air.

As commonly taken care of, this kind of manure is subject to another great loss, which should likewise be zealously guarded against.

When any body becomes saturated with water, all of the soluble substances in it are at once dissolved, and if, when in this condition, any additional quantity of water be added, it takes the place of that which previously existed, and forces out, not only the water, but likewise all of the substances which the water held in solution. That pait of stable manure which the water dissolves, is most valuable, and when exposed, as it usually is by farmers, nearly all of its valuable matter will be carried away, by water falling on the heaps and then running off. So effectually does this deprive all substances of their soluble matter, that druggists use a process identical in principle with it, to obtain the active matter of many drugs and medicines. A quantity of rhubarb, ginger, &c., being first saturated with water is allowed to remain for a short time, an additional quantity of water then being added, the water first present, passes through, taking with it all the *strength* of the substances acted on, and leaves behind nothing but a worthless inert mass.

A little reflection will show, that the same thing must constantly occur in stable and barn yard manure.

The yards, then, for the accumulation of this kind of manure, should be so arranged as to permit no water to run off from them. If provender be scarce, then scrapings from the woods or ditches should be used to absorb all of the water which falls on them.

Should the bottom of the yards be sandy, clay should be used on it to prevent the water filtering through the manure. To sum up all in a few words:—*Sow gypsum, or copperas finely powdered, over the stable and barn yard manure, and let no water run off from it.*

Any farmer can easily, if he chooses, carry out all of these important directions.

Lime, neither quick, water slaked, nor air slaked, should ever be mixed with this kind of manure. The last can do no good, the other two will do very great injury to it.

The above directions are short, but they have at least the merit of being easily understood and carried out. When this is done, they are perfectly efficient to preserve this valuable substance from the slightest loss.

It is a much mooted question at present, as to whether this manure should be ploughed in with the crop or applied to the surface.

There is, and can be no general rule on this subject. To some crops it cannot be applied in the latter manner. The mode of application also depends on the degree of rottenness which the manure has undeigone. When it is much decomposed and where its action is desired immediately, as on tobacco or corn, it is best to mix it thoroughly with the soil. Even when not thoroughly rotted, it is best to plough it under for tobacco. Tobacco land may be so manured, as always to retain its capacity for raising "bright tobacco:" such as is now produced on virgin soils or "new ground" alone.

One of the most respectable and intelligent planters in this State, by following out directions based on scientific principles, has assured me of the decided advantage experienced, both in regard to the quantity and quality of his crop. This advantage was proven by the growth of the article on land adjoining, and prepared with great care, in conformity with long established usage. When it is not well rotted, it is best to apply it to clover preceding the wheat crop which is to be sown.

I shall be able to publish some very valuable comparative facts on this subject during the present year, which will give much valuable practical information. I can now state, however, with full confidence, that unless this manure be *very thoroughly* decomposed it should never be ploughed in for wheat, as it will alter the *texture* of the soil and make it less productive for this crop. Wheat delights in a close compact soil:—stable and barn yard manure not well rotted, will make the soil porous, and thus injure it. For indian corn this objection does not hold good, and where the land intended for corn is stiff, it will derive benefit from this manure being ploughed in with the soil.

Besides affording all of the necessary food for plants, the straw, litter, &c., in this manure, during their decay, impregnate rain water with carbonic acid, which renders it a much more powerful solvent of all the minerals in a soil.

A great part of the good effects of green crops when used for manure, such as clover, peas, &c., is also due to this cause. Every substance capable of being rotted, when covering land, not only keeps the land moist by preventing the evaporation of water which falls, but it also furnishes to the water carbonic acid—and enables it to disintegrate and dissolve the particles of soil.

Besides this, clover, or anything else, when it rots, returns to the soil all of the constituents necessary to its own growth, which it had extracted. Upon these three causes, and none other, depend the action of this class of manures, and the efficacy of top-dressing.

To the barn yard, or compost *heap*, should be added scrapings from the woods, the contents of privies, (one of the most powerful of all manures,) and whatever the experience of farmers may have shown them to be valuable. A small quantity added daily, will, in the course of a season, make a very large heap, and more than ten times repay all the cost and labor of collecting it. *Dead animals should never be suffered to lie exposed in the air.* If a common sized horse or ox, when dead, be covered over with earth made moist with oil of vitriol, diluted with ten or twelve times its bulk of water, it will make enough manure to produce at least thirty bushels of wheat. The oil of vitriol will not only arrest the volatile compounds formed from the animal undergoing putrefaction, *but also cause them to be formed more quickly.* When the decomposition of the flesh of the animal is complete, the whole heap covering it should be dug down and applied to the land. If the bones be not dissolved, or decomposed, they should be put in some convenient place, to be dealt with as is directed under the head of bone dust.

MARSH MUD

Is also a valuable manure. That at the heads of creeks and ravines has been used with a general benefit, second only to stable manure. The large marshes on many of the rivers on the Eastern Shore are invaluable, and at the same time exhaustless sources of fertility. I have examined the "mud" from many of them, and have always found it competent to furnish in large quantities, many of the necessary constituents. Many specimens are easily burnt, which affords great facility and saving of labor in its application.

This mud should be dug up and put in heaps, and at any suitable time should be burnt, and the ashes immediately applied to the land. When it will not burn it should be made into a compost with quick, or water slaked lime, and applied to the soil.

This mud is very rich in all of the necessary constituents of soils, as may be seen from the following analysis:

Marsh mud from Chickamacomico river in Dorchester county. Specimens being dried was composed of :—

Vegetable matter,	90.80
Sand,	7.40
Clay and iron as per oxide,	.60
Lime (ox. calc.,)	.65
Phosphoric acid,	·15
Magnesia,	.13
Potash and soda,	.12
Sulphuric acid and Chlorine, (a trace.)	

Specimens examined from the marshes of the Transqueken and Blackwater, in Dorchester, from the Nanticoke and Pocomoke, from the Wicomico and Monie, in Somerset, and from the Choptank, in Caroline county, all proved to be valuable as manures. It exists in very great abundance, particularly in Caroline, Dorchester, Somerset and Worcester counties. On the borders of the rivers, the *marsh* sometimes presents an unbroken level surface as far as the eye can reach, affording a rich pasture for large herds of cattle. It is composed mainly of vegetable matter, in every stage of decay. Its texture is so very soft and yielding, that in many places a pole may be thrust down to the depth of ten or twelve feet, without meeting with any obstruction, and can be shaken by the weight of a man for many yards around. This is peculiar to the marshes on the fresh water streams. On the heads of the salt water creeks, it is much more firm, having a much less proportion of organic matter, and always a large per centage of soda. This marsh should never be hauled in its wet state, as a large amount of labor is incurred, without any profit. It should always be burnt when it is susceptible of combustion, and when this is not the case, it should be mixed in compost with water slaked or quick lime. But the farmer, if he cannot burn, nor cannot mix it with lime, should not fail to use it by itself. When applied alone, it will be found a valuable application to all the soils to which it is contiguous. The only objection to its use in its native state is, that it is, liable from the large quantity of organic matter which it contains, to produce *sorrel.* This will not happen when the vegetable or organic matter is destroyed by fire, or decomposed by quick or water slaked lime.

The next substance which we shall mention as a manure, is one used from the earliest ages to the present day, with various degrees of success.

Its cost to the farmer, the immense quantity, and the generality of its application, its great value when properly, the loss of labor, time and money, when improperly used, are all strong reasons why its nature, the difference of its different varieties, and the best mode of its application, should be well known.

LIME.

Lime, as used in agriculture, is obtained either from limestones, oyster shells, Indian shell banks, or marl. In all of these different substances it exists naturally in the state of carbonate. The limestone subjected in kilns properly prepared, to a degree of heat sufficient to expel the carbonic acid, becomes quick lime, (oxide of calcium,) and is changed in its mechanical condition from a hard compact mass into a very fine powder. On exposure to the atmosphere, it absorbs from it carbonic acid, and returns into the same chemical condition as it existed in the limestone, its physical character remaining the same as when first burnt, that is, it still exists in a finely, divided state, fit to be equally distributed over the land. On the addition of water to quick lime, heat is evolved, and not a mere mixture, but a chemical union takes place between the water and the lime, and a hydrate of lime is formed—or in common language, it becomes *water slaked.* This compound contains of lime above 76 per cent, while air slaked lime contains but 56 and nearly one-third per cent. The lime obtained from oyster shells is reduced to powder in the same manner as stone lime, and is, in every respect, identical with it, as far as the lime is concerned. It contains, however, another substance—phosphate of lime—i. e., lime associated with phosphoric acid, the same thing which gives bones their peculiar value. This forms from one and a half to two and three quarters per cent in oyster shells. So that in them, we have all the properties of lime, with those of bone dust in that quantity superadded. Oyster shells also, contain a small quantity of magnesia, but not enough to influence their agricultural value. We obtain lime from oyster shells, purer than from common limestone.

The analyses of the following specimens of lime that had been sold for agricultural purposes, and comprising all of those used on the Eastern Shore, will show their composition :

Lime from North River, commonly called "New York Lime," is composed of

Water,*	17.70 per cent.

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* Unslaked.

Lime as quick lime,	37.30	per cent.
Magnesia,	21.20	"
Sand, clay and iron,	23.80	"

The specimens of the lime were taken from the load in the condition in which it is sold; and I may here remark, that all of the specimens were taken from lots which had been sold. The proportions given are by weight, and not by measurement.

Reading Lime—Pennsylvania.

Water,*	1.40	per cent.
Sand,	5.80	"
Clay and iron,	10.10	"
Lime, (quick lime,)	52.29	"
Magnesia,	30.30	"

Schuylkill Lime, No. 1.

Water,*	12.80	per cent.
Sand,	4.00	"
Lime, (quick lime,)	35.00	"
Magnesia,	40.54	"
Clay and iron,	7.60	"

Schuylkill Lime, No. 2.

Sand,	6.50	per cent.
Clay and iron,	5.00	"
Lime,	62.00	"
Magnesia,	26.00	"

Schuylkill Lime, No. 3.

Water,*	3.26	per cent.
Sand,	6.50	"
Clay and iron,	5.00	"
Lime,	60.24	"
Magnesia,	25.00	"

Susquehanna Lime—near Wrightsville.

All of the specimens unslaked, contained of

Sand,	4.85	per cent.
Iron and clay,	7.16	"
Lime,	73.00	"
Magnesia,	15.00	"

No. 2.

Sand,	7.21	per cent.
Iron and clay,	3.32	"
Lime,	68.06	"
Magnesia,	21.40	"

No. 3.

Sand,	11.02	per cent.
Iron and clay,	6.14	"
Lime,	71.63	"
Magnesia,	11.20	"

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*Unslaked.

Baltimore County Lime.

The average of eight different analyses of the air slaked lime, gave of lime as carbonate, i. e., air slaked lime, 81.4 per cent.

Lime from Indian Shell Banks. No. 1.—A.

Specimen fully slaked.

Sand,	3.00	per cent.
Clay and iron	.30	"
Lime as corbonate,	94.10	"
Lime as phosphate, i. e., bone dust	2.20	"

Lime from Indian Shell Banks, No. 2.

Sand,	2.00	per cent.
Lime as carbonate,	95.15	"
Lime as phosphate,	2.20	"
Clay and iron,	.60	"

Lime from Indian Shell Banks, No. 3.

Sand,	6.25	per cent.
Clay and iron,	.15	"
Line as carbonate, i. e., air slaked,	91.20	"
Lime as phosphate, i. e., bone dust,	2.30	"

N. B.—The Nos. 1, 2, 3, affixed to the "Lime from Indian Shell Banks," "Schuylkill Lime," and "Susquehanna Lime," only denote the order in which they were examined.

North River Lime.—R.

Specimens obtained from Worcester county.

Water,	7.00	per cent.
Sand, clay and iron,	11.90	"
Lime,	56.00	"
Magnesia,	25.00	"

Pecqua Lime.

Used extensively in the upper part of Cecil county.

Sand clay and iron,	3.75	per cent.
Lime,	58.00	"
Magnesia,	36.00	"
Water,	1.50	"

Gas House Lime, No. 1.—Y.

Water and free sulphur,	9.20	per cent.
Sand,	4.00	"
Clay and iron,	1.00	"
Lime as carbonate,	80.00	"
Lime as sulphate, i. e., gypsum,	3.00	"
Lime as phosphate,	2.00	"

Gas House Lime No. 2.—M.

This specimen had been exposed to rain.

Sand,	6.00	per cent.
Sulphur, (free,)	.90	"

Water,	13.00	per cent.
Lime as carbonate,	68.75	"
Lime as sulphate, (gypsum,)	9.30	"
Lime as phosphate,	1.90	"

Gas house lime is obtained from oyster shells, and is used to cleanse the carburetted hydrogen, (the gas used for light,) from sulphuretted hydrogen, (that which is easily recognised by its smell, in the neighborhood of the gas house.) This lime always contains a portion of sulphuretted hydrogen, depending on the quantity of sulphur in the coal from which the gas is made.

When exposed to the atmosphere, the sulphuretted hydrogen, (hydro-sulphuric acid,) loses one of its elements, and becomes converted into sulphur. The sulphur thus formed, by further exposure to the air becomes changed into sulphurous acid, and whilst in this state, would rapidly evaporate, but lime being at hand, it unites with it, forming a salt of lime, called sulphite of lime. On more prolonged exposure, the sulphurous acid becomes changed into sulphuric acid, (oil of vitriol,) which unites to the lime, and forms sulphate of lime, (gypsum.)

There not being a sufficient quantity of sulphur present to make enough of sulphuric acid to unite with all of the lime, a part remains as carbonate of lime.

It will be seen from the above short description of the changes going on in gas house lime, that at certain periods we have in it:—1st. Sulphuretted hydrogen;—2nd. Free sulphur;—3rd. Sulphite of lime; and 4th. Sulphate of lime;—at one and the same time. Phosphate of lime is always present, and undergoes no change.

When it has been exposed for some time, we then have in it only gypsum, air slaked lime, and the phosphate of lime. Should this lime be applied when first taken from the gas house, after being used to purify gas made from coal, containing a large proportion of sulphur, its action will be as follows:—whilst the sulphur remains unchanged, the usual effects of lime will be produced; when it becomes converted into sulphurous acid, it will not only counteract the good effects of the lime, but destroy all vegetation; when the sulphurous acid becomes changed into sulphuric acid, gypsum is formed, and we have its effect superadded to air slaked lime. Gypsum as has been *demonstrated* by Liebig, is decomposed by contact with the ammonia of the atmosphere, one of its elements uniting itself to it, thereby *fixing* it:—in other words, destroying its volatility. But its use does not stop here:—*it also affords sulphur, which is absolutely necessary to the formation of the nutritious part of all substances used as food by men or animals.*

That the above will be the effect of gas house lime, under certain conditions, there can be no doubt. It contains sulphuretted hydrogen:—This sulphuretted hydrogen *must* become converted into sulphur;—this must, and does become converted into sulphuric acid:—but sulphuric acid, and its salts, we have the highest authority for saying, will, "even in very minute quantities, destroy all vegetation."—*Christison on Poisons, p.* 750. And I am assured by a gentleman of the highest authority, that the application of from thirty to fifty bushels per acre, destroyed one crop;—and that, after that it acted well.

I have also known plants in a green house destroyed by fumigations of sulphur, sulphurous acid being formed. When sulphuric acid is formed in the gas house lime, as formed it must be, gypsum at the same time comes into existence: and we will have its action and that of air slaked lime manifest, provided the soil to which it is applied be deficient in sulphates and lime.

What quantity of sulphuretted hydrogen, or free sulphur, must exist in the gas house lime at the time of its application, sufficient to produce deleterious effects, has not been as yet determined. There is the same poverty of *exact* knowledge in relation to this, as unfortunately there is in regard to other substances used as manures. The specimens marked No. 2, containing nearly one per cent. of free sulphur, on growing wheat, was applied at the rate of about one hundred bushels to the acre, last winter, by a gentleman whose statement can be implicitly relied on, with very good results: not the slightest injury was experienced. We thus have *one fact*, and that is, that gas house lime containing (.90,) equal to nine-tenths of one per cent. of sulphur, when used as a top-dressing to wheat in the winter, is beneficial.

The injurious effects which have resulted from its application, and its known properties, admonish us however, when ignorant of its exact composition, *not to apply it to a growing crop*, nor *to a soil that is to be immediately cultivated;* when containing a large proportion of sulphur, to apply it to a soil abounding in *weeds*,—which are pests to cultivation,—and to meadows, sometime before seeding them, to destroy all grasses likely to injure the hay crop. We can also safely say, that when applied to a soil deficient in sulphates and lime, the combined effects of gypsum and common oyster shell lime will be experienced. When its composition is unknown, it should be applied to the surface one season before the crop is planted.

The numerous enquiries made of me lately, by letter and otherwise, in relation to gas house lime, must be my apology for dwelling on it so much at length.

From the above analyses, the great difference in the various lime used *indiscriminately* for agricultural purposes, can be seen at a glance:—some containing forty per cent. of magnesia, and some none;—some containing near ten per cent. of gypsum, and some none;—some having twice as much lime as others, and no magnesia. If every soil was exactly alike, could it be possible that each of these limes would be equally beneficial? If the oyster shell lime should be the best application, see what a loss would be incurred by the application of Schuylkill lime, No. 1, containing not half as much lime. If on the other hand this lime, (the Schuylkill,) should be the best—as it is for some soils—consider the loss in applying oyster shell lime, and thus withholding from them forty per cent. of magnesia.

But when we remember that many soils contain an abundance of magnesia, and some scarcely any, the loss in applying to the first a lime containing more than fifty per cent. of what is already present in sufficient abundance, is greatly increased. The same remark is equally true in relation to the soil containing a mere trace of magnesia, when we apply to it lime also containing none. In each case our expense receives no remuneration—our efforts at improvement are useless—we labor in vain. That many soils have an abundance of magnesia, and some a mere trace, is an unquestionable fact. That the limes used for agricultural purposes, have the same difference in composition, is a truth beyond cavil. Now, how can these limes be economically applied, by one ignorant of their composition, and ignorant of the composition of the soil? How can wearrive at the constituents of each? How can this knowledge, necessary, *absolutely* necessary, be obtained, but by an analysis, both of the lime which we apply, and of the soil to which it is applied?

When if is remembered that magnesia is as necessary to constitute a good soil, as any other one substance whatever, and that being absent or deficient, it must be supplied, how can its absence or deficiency be known, without a chemical analysis of the soil? And, even when this is ascertained, how can the right lime be applied, without an analysis of it, to see whether or not it contains magnesia? Let a soil, containing an abundance of magnesia, but deficient in lime, be treated with the Schuykill, Reading, or New York lime. The quantity of lime in these varieties will doubtless increase the crop, and permanently improve the land; but how immeasurably greater would have been the benefit from oyster shell, or Baltimore lime? Many sensible practical men purchase Schuylkill lime, when they would not have our common lime given to them, because they, by experiment, know the value of the one, and the worthlessness of the other, to *their* soil. Many again, in the same way, have found out the superiority of oyster shell lime to all others. Should not the expense incurred by experiment have been saved to them? This knowledge could have been afforded, and should. *The whole aim of the application of manures being the greatest yield in crops, from the smallest outlay* of money, it is not enough for a farmer to know that the application of a particular substance does *well;* he should not be satisfied unless he *knows* that it is the *best* for his particular soil which can be used. That different substances when applied indiscriminately to all soils, must be productive of disappointment and loss, is so apparent that I shall not pursue the subject any further. In the application of millions of bushels of lime, decidedly differing in their composition, upon soils equally different from each other, with no rule to guide, no law to direct, an hundred times more money is annually lost to the agricultural interest of the State, then the amount of all the appropriations ever made for its benefit.

If the office of Agricultural Chemist had shown nothing but the proper adaption of particular varieties of lime to particular soils, the State would derive an hundred times more benefit from it, than the cost has been for its maintenance. I will not now say more on this subject. Axioms admit of no demonstration—self-evident truths need no proof.

I have found, and I believe I am the first to notice the fact, that the proportion of phosphate of lime varies with the localities in which oyster shells are found. As we approach the ocean, the phosphate of lime in them increases. I have made many analyses of them for the estimation of phosphoric acid, and find this law to be universal. So that other things being equal, the shells increase in value as they approach the ocean.

Shell banks are another source from which lime is supplied to soils. These shell banks are deposits by the aborigines of the country, and frequently cover an extent of from 1 to 40 acres, to the depth of from 6 inches, to as many feet. As those who have never seen these social relicks of the "Poor Indian," have questioned the mode of their deposition, I will state the reasons for the belief of their Indian origin: Ist. They are always found near the Waters's edge, on the slope of a hill, with a southern exposure, sheltered from the north and nort-west winds. This is a position which the Indians would naturally select to enjoy their repast on the delicious article of food which the shells contained. 2nd. The bones of many animals, such as deer, bears, and numerous small game, are found intermixed with the shells, not in a state of integrity, but *broken*, showing that they came there not by the death of the animals in a natural manner, but were brought for the purpose of being consumed as food. 3rd. There are found, also, with those shells, numerous small pebbles, evidently used to break off the edge of the oyster, in order to open them with greater facility. 4th. There are also found with the shells, Indian arrow heads, battle axes, pipes, and various domestic implements, that had been left by the tribes after feasting. Another and most conclusive reason against the opinion that these shell banks are mere oyster beds left exposed by the retreating of the waters is, that the shells are all separated, and no two lying together will fit each other, a large shell overlays one which is very small, and no one seems to be the fellow of its neighbor. These shells, moreover, lie frequently in heaps surrounding a cavity, showing as if a particular family sat together, consumed their food, and threw the shells around them. The use to which the remains of the food of the Aborigines are applied, is a striking proof of the benefits conferred on the human race by civilization. The refuse matter of their feasts is applied to the growth of food by another and a strange nation, who have extinguished their council fires, exterminated their race, and only remember their names amongst the traditions of the past.

From long exposure to atmospheric influence, and other causes, the shells become disintegrated, and readily crumble on free exposure to the air. Again, after the lapse of a considerable period, they become very much disorganised by another process. At first a little moss forms on the surface of the shells, this takes up enough lime that has been dissolved by the carbonic acid of the atmosphere, to give support to a higher order of vegetation; this vegetation, by its decay, furnishes food for a succeeding generation of plants, and by an increased supply of carbonic acid, dissolves more lime to supply another generation. This, in its turn, dying, furnishes increased means for the solution of the shell, until, in many cases, these banks are covered with the most luxuriant vegetation, and support large trees. The layer of matter covering the shells is called "shell mould," and consists of shells in a very comminuted state, and the organic and inorganic remains of the plants to which it owes its formation. A little reflection will at once show that this mould must prove a most valuable manure, being nothing but the remains, the ashes, so to speak, of plants mixed with a large quantity of oyster shells, in a very minute state of division.

This mould contains of air slaked lime, by the average of fifteen different analysis, 45.6 per cent, being more than half as good as common agricultural lime, and when we also consider the other matters in this mould, the ratio to limestone is much increased. It is almost needless to say, that the lime in this *mould* is identical with that in limestones, fresh shells, &c., and will act equally as well. A custom has prevailed, to a very injurious extent, of applying the mould together with quantities of large coarse fragments of shells. I cannot too strongly reprobate this mode of using the banks. These large fragments take up much space in the soil that should be filled by other matter, injure its texture, and render the crops grown on it very liable to *burn* or *fire*. Though these shells be composed of lime, it is not available but in a very slight degree, to the use of crops. Lime, to be serviceable, must be in the state of very fine powder, and intimately incorporated with the soil. When it exists in shells of any size, it does almost no good by its presence, and, as I have before said, *injures* the texture of the soil. For all present practical purposes, pebble stones would be equally beneficial.

The best way to use these shell banks; is to have a seive fixed with a slight inclination. Against this the shells should be thrown, as when persons wish to free sand from gravel. The fine particles which pass through the seive, should be applied as they are, whilst the coarse shells which do not pass through, should be put into kilns and burnt. In this way no part of these valuable deposits would be lost, all would be saved for agricultural improvement, thereby increasing the quantity of crops, and augmenting the value of land, instead of retarding its improvement, as is the case when coarse shells are applied. The lime from these old shells is equally valuable as that derived from those which are recent. Some of the best crops, and the finest land, have been produced *solely* by the application of shell mould, and lime burnt from shell banks.

MARL.

The term *Marl,* in the sense in which it is used in the district of country where my labors have been, is assigned to two substances distinct in their physical properties, and essentially different in their chemical composition. This difference is denoted in its name by the addition of *shell* in the one instance, and Jersey or green sand in the other. The one is called shell marl, being derived from shells; the other is called Jersey marl, from having been first used for manuring in New Jersey, and also green sand from its color and appearance. I shall now only speak of shell marl, or that derived from decayed shells, reserving a section for the exclusive consideration of the green sand or Jersey marl.

The shell marl, as may readily be supposed from its origin owes its valuable properties to lime, which exists in it in the state of carbonate; also contains about one seventy-fifth of magnesia. In some rare instances, however, the quantity of magnesia is as much as five per cent. Phosphate of lime is present also in some deposits, in others there is a mere trace, and frequently it is entirely absent. In some marls a small quantity of lime is present as sulphate.

The quantity of magnesia is not estimated separately from the lime in any of the marls, unless it forms at least two per cent. A particuliar description of the physical characters of each marl is not given with its analysis in the report on the marls of the different counties, as it would lead to no better knowledge of their constituents. It is enough to say in this place, that they differ very much in different localities, both as regards appearance, the state of division of the shells, and the quantity of lime which they contain. Sometimes the shells are almost as perfect when first exposed as those in the recent state; some crumble into fine powder on exposure to the atmosphere, whilst others remain sound for a long period of time; some have the appearance of dirty lime, scarcely a vestige of shell being visible; others are consolidated like mortar, and have to be dug with pickaxes, often coming up in large hard lumps, which gradually fall to pieces on exposure to the air. Other specimens, again, have a brick red color and are very hard, obtaining both their color and consistency from agglutination, caused by the per oxide of iron. They vary as much in their agricultural value as in their appearance, some containing as little as ten per cent of carbonate of lime, with only a trace of magnesia, and none of the phosphates, others having as much as seventy-six per cent of the carbonate of lime, and others two and one-fifty per cent of the phosphates. The *appearance* of the marl is a very *imperfect* indication of its value. Some in which there is but a mere visible appearance of shells, yields as much as fifty per cent of air slaked lime, whilst others, which *appear* to be made up entirely of shells, have not more than twenty or twenty-five per cent. In the one case the shells have become disintegrated by heat and moisture, no current of water passing through them during the process; in the other, water charged with carbonic acid, has circulated through the shell beds, dissolving and carrying away the lime, the *essence* of the shell, and has left only its form unbroken. As a general rule, those shells imbedded in clay, or which have a large admixture of it, contain more lime than those which a have a sandy foundation, as water percolates easily through sand, carrying with it some of the lime by mere force of attrition, and dissolving more when charged with carbonic acid. Water charged with this gas, very readily dissolves lime in the state in which it exists in shells. In many beds of marl the *form* of the shell only is left, all of the lime having been dissolved by the above process. The lime in marl is as good, pound for pound, as that which exists in limestones, has the advantage from its admixture of sand and of clay, being more easily incorporated with the soil. It is identical with it in every respect, serves the same purposes, answers the same end in the production of vegetation, and should be used to fulfil the same indications, viz: to supply lime to a soil deficient in it. Its application then resolves itself into a mere question of cost. The per centage of lime in a marl being known, its owner can determine for himself, whether he can, by using marl, apply to his soil any given number of bushels of lime cheaper than he can by buying lime. An allowance must be made in the marl for the application of a larger quantity of lime than is represented by its analysis, as all of the lime in it cannot at once be made available, in consequence of some of the shells not being entirely reduced to powder. In making this comparison, however, it must be understood, that the agricultural lime, seldom contains more than eighty-five per cent of lime. Another item in this comparison is, the greater facility with which lime in marl admits of thorough incorporation with the soil. The inert lime for the present in marl varies in every specimen, and depends on the quantity of large shells which are found in it, and the facility with which they fall to pieces when exposed to the atmosphere. These are then the four sources from which lime is derived for agricultural purposes, viz: limestone, Indian shell banks, burnt oyster shells, and shell marl. The indications for its use, is, its absence or deficiency in the soil.

MODE OF APPLICATION.

This is a subject upon which there is much difference of opinion among practical men.

The greatest good is obtained from lime when thoroughly mixed and incorporated with the soil. This is proven by the fact, that when lime exists naturally in a soil, other things being equal, a larger crop is produced then when the same quantity is applied artificially. This superior produce is obviously due to the more intimate mixture in the former, than in the latter case. In the application of lime, then, the first consideration should be so to use it as to mix it ultimately with the soil. This is sought to be done in three ways:—1st. By applying it to the surface, and suffering it to remain undisturbed for a year or two;—2nd. By applying it to the surface, ploughing it under immediately, and working the land in some crop;—3rd. By mixing it in compost beds, and applying it in the same manner. Each of these methods has its peculiar advantages, and is also liable to objections. The *texture* of the soil is to be taken into consideration. By the first method, the lime becomes very thoroughly mixed with the soil, particularly if it be a loose sandy soil, as the rain water washes down its particles, and fixes them between the grains of sand. But when lime, or any other manure, is purchased, an immediate return is desired, which cannot be had if this plan be followed. Many of our farmers, too, having but little ready money, cannot afford to spend it without getting speedy remuneration for its use. By the second method, the lime is thrown to the bottom of the furrow, and cannot be afterwards well incorporated with the soil, which is a great objection, as the benefit from its use, to the fullest extent, is not speedily obtained. The third method has the advantage of diffusing the lime very equally over the surface, and insuring its mixture afterwards; but it involves great labor in hauling and applying it, and but a small quantity can be applied at a time in this manner. The best mode of combining the advantages of these several methods, is first to fallow up the ground, which leaves it uneven, with numerous fissures produced by the ploughing, apply the lime, then follow it with a heavy iron tooth harrow, and cultivate it in some crop that requires frequent working,—corn for example. In this manner we mix the lime well with the soil, receive its benefits immediately in a crop, which can be more completely realised, as the corn can be followed by wheat, with which clover may be sown. The chief indications are then fulfilled. 1st. The lime is more thoroughly mixed with the soil. 2nd. Return for its cost in a crop of corn. 3rd. Increased return by a crop of wheat immediately succeeding the corn, and then the benefit of a good crop of clover, so useful, not only as food for stock but as an improvement to the crop which it precedes.

For the reasons above stated, this mode of applying lime is preferable to all others. By it we mix the lime thoroughly with the soil, and obtain immediate return for its cost, a consideration of the highest importance with farmers, who have not the ability to lay out of their money for several successive years, but need an immediate return. Again this mode gives not only the speediest reward, but gives a much greater profit than any other mode in the same number of years, which is the ultimate end of the application of all manures.

It has been a much mooted question, whether lime should be applied in its *caustic* or slaked state. The only condition to decide this is the quantity of organic (vegetable,) matter in the soil. Where this is large, as in the upper districts of Caroline county, in the Black Gum swamp soils of Dorchester, Somerset, and Worcester, and, indeed, in all newly cleared or drained lands, caustic and even hydrate of lime (water slaked,) should be preferred, it promotes, in a very strong degree, the decomposition of vegetable matter, which is of no use in a soil until it is decomposed.

Until it becomes so, all of its inorganic matter, its compounds of lime, potash, soda and magnesia, are entirely useless to the crop, being, in reference to it, so much inert matter. Whatever can so act as to bring these inert materials into actual use must benefit the soil even independent of its own direct use.

All vegetable matter contains these constituents, which are essential to its very existence, and when set free, they serve as food for cultivated plants. This is the only material advantage that caustic lime has over that which is slaked, as it all becomes slakened after exposure to the atmosphere. Lime should always be applied to the soil in as dry a condition as possible, for when it is wet it becomes cemented into lumps which becomes very hard, and a long time elapses before they are broken down and mixed with the soil. While it remains in lumps it is of no use to the crops, and those who apply it in this condition not only loose actually the lime, but also its effect on their crops; each a matter of great consideration. Magnesian limes should not be spread on the land until the lime in them becomes slakened. If put on in the caustic state, water will cause the magnesia and lime to form a cement and small balls will be formed which require a long time to fall to pieces. There is a custom prevalent in some sections of the State, of mixing caustic lime with stable and barn yard manure. This cannot be too strongly reprobated. If those who use it in this way were to try to injure there manure as much as possible, they could not adopt a better plan. Ammonia, one of the most valuable constituents of stable and barn yard manure, is expelled from the heap by caustic lime, and escapes into the air.

This plan should therefore *never* be followed. It is no proof in its favor, that the manure, after being treated in this manner, still does good, a part of its valuable constituents, fire will not destroy; but one of the things which give it its peculiar distinctive value, is entirely dissipated when mixed with either caustic lime, (oxide of calcium,) or water slaked lime, (hydrate of lime.) It is indeed one of the means by which chemists determine the quantity of ammonia in a compound, so thoroughly and entirely does it drive it all away.

Upon grass lands, when they fail to produce well, and that failure is owing to deficiency of lime in them, it may with great advantage be spread on the surface and have a light harrow run over it.

This will not only insure to the crop the full benefit of the lime, but will materially improve the texture of soil by loosening the surface, and from the long absence of cultivation becomes *bound*, and frequently covered with moss, and unfitted to produce a good crop of hay. The full benefit of the lime can be obtained without the trouble and expense of breaking the land from its "setting" in grass, and no intermission need be had in the crop. When it is intended to supply the deficiency of lime in a soil by the medium of marl, it should always be applied *as long a time as possible* before the culture of the soil. Atmospheric influences, the alteration of heat and cold, and of dryness and moisture, are all powerful agents to disintegrate the marl, reduce the shells to powder, and bring it into a condition most favorable to the crop, whose production it is intended to assist. Situated as the great mass of our farmers are, precise and exact rules cannot be followed. Many are obliged to yield to circumstances, but they should keep the above principles steadily in view, and conform to them as nearly as possible.

They are the result of much and careful observation; are substantiated by the highest authorities; and are derived from a knowledge of the qualities of the cause, by whose application the desired effect is sought to be produced; in other words: from a knowledge of the action of the agent, and the object upon which it acts.

From a knowledge of the properties of lime as carbonate, and of those agents to which it is subject, the reasons for the above rules will appear manifest. I need not here repeat what was said in relation to the *different* modes of applying lime, except in relation to its use as a top dressing for grass. Keeping in view the great principle of incorporating it thoroughly with the soil, we see how this is done by top dressing of grass land. Though lime be but sparingly soluble in pure water, yet we have seen that it is quite freely so in water charged with carbonic acid; when marl lies with the decayed leaves and stalks of grass on the surface of the meadow, this gas surcharges rain water, as soon as it falls, *dissolves* the lime, and carries it in a state of solution in the soil.

This is not the only way however in which it is mixed with the soil. A large quantity of lime, though not dissolved, is yet carried down the interstices of the soil mechanically, by the water which falls on it. In this way a large quantity of it will disappear from the surface, having become diffused through the soil.

The rationale of the application of marl to the surface is equally sustained, when we consider its physical condition in connection with its chemical qualities.

The lime which exists in marl is always in the state of carbonate, and hence subject to the same influences as common lime that has been burnt from shells or lime stone, and become slakened.

There is however this difference, that the lime in marls is either in masses of comminuted shells, or in large fragments that have never been disintegrated. By atmospheric exposure on the surface they are subject to the action of water charged with carbonic acid.

The shells by alternate freezing and thawing crumble into finer particles, become more easily acted on by water impregnated with carbonic acid as this change progresses, and become entirely blended with the soil, fulfilling, perfectly, all the indications which first directed their use.

Modes of Action.—Sometimes it acts as direct food to the plant; sometimes by the decomposition of organic matter; and very frequently, by its power of setting free other valuable elements which may exist in soils, but not in a *form* capable of serving as food for plants.

Many theories have been published on the manner in which lime acts in producing fertility, and much has been spoken and written as to the peculiar manner in which it manifests its utility. A report like the present, designed to be merely practical in its nature, affords no opportunity to discuss these questions.

Let it be sufficient to say, that it should *always* be applied to a soil when it is not already present in sufficient quantities, and never applied when it is. This short remark comprises all of the rules for the necessity of its administration—further remarks would be unnecessary.

MAGNESIA.

Is the oxide or rust of a metal called magnesium, and its necessity to fertile soils is supported by facts as well established, evidence as conclusive, and testimony as convincing, as those which show the use of lime, potash, or any other constituent.

Like lime, it loses its carbonic acid when exposed to a high degree of heat in a current of air, and becomes caustic or *calcined* magnesia. It remains in this condition much longer than lime, as it imbibes carbonic acid with much more difficulty from the atmosphere. It also unites to water, but with much less intensity than lime, producing but a very slight degree of heat, whilst the union is being accomplished. Magnesia, for agricultural purposes, is obtained from a rock called dolomite, and is found associated with lime, both existing in the state of carbonate.

The proportion of lime and magnesia in this rock vary in the different localities, and even in different parts of the same rock; and the ratio of their ingredients is very variable, "since isomorphous substances crystallize together in all proportions." We can only estimate the quantity of each, and the particular adaptation of a limestone to the soil by a quantitative chemical analysis.

The belief is very generally diffused, that magnesia, instead of being a necessary constituent of a fertile soil, and an essential part of the composition of plants, injures the quality of the one, and proves detrimental to the growth of the other.

To correct this erroneous impression as far as I can, and show how far it is useful, and when it may be injurious, when it should be applied, and when withheld from a soil, I will briefly review the arguments against its use, and let the facts which I shall offer, urge its application.

Sprengle says, that soils containing much of the carbonate of magnesia are said to be highly absorbent of moisture, and to this cause is ascribed the coldness of such soils. This absorbent property of magnesia, so far from being an objection against, is a recommendation for its use, as we find many soils deficient in this property, being light, loose and porous,—deficient in the two great *absorbers* of food from the atmosphere, clay and the per oxide of iron, and not having a sufficiency of fine sand to effect the vicarious action of these substances. Here, then, for its mechanical agency alone, magnesia is indicated, and if it had no other use, should be applied.

Chaptal says, that "magnesia soils are by no means fertile," and that whenever lime, containing magnesia, is used for agricultural purposes, it no longer produces the same effect."

Against this sweeping declaration of the poverty of magnesian soils, no better argument can be used than that of showing the composition of some fertile soils.

Johnston, J. F. W., Lectures on the Application of Chemistry and Geology to Agriculture, p. 284, "gives a soil which had been cropped for 100 years successively, without manure or naked fallow," containing 1.16 per cent of magnesia, equal to about 350 bushels of magnesia to the acre, to the depth of twelve inches; another containing .312 per cent of magnesia, equal to about 94 bushels, "a virgin soil celebrated for its fertility;" another containing a carbonate of magnesia, 10.36 per cent, equal to about 3,100 bushels of carbonate of magnesia, which had been "unmanured for twelve years, and during the last nine, had been cropped with beans, barley, potatoes, winter barley and red clover—clover, winter barley, wheat oats, naked fallow."

Analyses of Spengle, too, shows very fertile soils containing—

.6	of one	per cent	of	carbonate	magnesia.
1.64	"	"	of	"	"
.52	"	"	of	"	"
2.22	"	"	of	"	"
.84	"	"	of	magnesia.	
1.04	"	"	of	"	

The following analyses of my own, also show, that magnesian soils, so far from being barren and unproductive, are exceedingly fertile. No. 1. Soil from Kent county, producing 20 bushels of wheat, and 10 barrels of corn per acre, contains of magnesia .35 of one per cent, equal to 100 bushels. No. 2. Also from Kent county, producing 22½ bushels of wheat, 8 barrels of corn, and fine crops of clover, contains .27, equal to eighty bushels to the acre. No. 3. A soil from Queen Anne's county, producing 30 or 35 bushels of wheat, 12 barrels of corn, and fine clover, contains of magnesia .4 per cent., equal to 120 bushels. No. 4. Soil from Queen Anne's county, producing 30 or 35 bushels of wheat, 12 or 15 barrels of corn, fine clover, contains of magnesia .38 per cent.

There is another soil from the same neighborhood, favorably situated, and in a fine state of cultivation (Dr. W. H. DeC.,) having very nearly the same constituents as the two last mentioned, which produces only 20 or 25 bushels of wheat, and contains only .01 per cent, equal to about 3 bushels of magnesia. These shows the necessity of magnesia, as strongly as facts can show anything.

Again in Talbot and Dorchester, we have fertile soils containing from 60 to 400 bushels of magnesia to the acre; and in Caroline and Worcester we have soils deficient in magnesia, all things else being present, and yet not so productive as where magnesia exists. But the evidence does not stop here, the ashes of the grain of wheat contain from 12.98 to 16.26 per cent of magnesia, according to the analyses of Bichon, Thou, Boussingault, Wills, and Fresenius, the inorganic part of the grain of barley contains of magnesia 10.5 per cent.

But why multiply proofs? The above are sufficient to show, that it is one of the necessary constituents of plants and of fertile soils, and if it does not exist in a soil, common sense tells us that it must be supplied, or that the soil cannot reach its maximum of productiveness. The application of caustic magnesia to a soil, may prove injurious from its caustic properties, since it does not readily imbibe carbonic acid from the atmosphere, and become *mild*, as lime does. From this quality, we should place it in as dense an atmosphere of carbonic acid as possible, by applying it to the surface, and turning it under with some green crops, or by mixing it in compost heaps, before applying it, or by letting it remain on the surface for as long a time as possible, before the land is cropped. On the Black Gum Swamp soils, and on those on the Beaver Dam in Queen Anne's, no injury need be feared from its use immediately before a crop.

On the soils not containing a large quantity of vegetable matter, from twenty to forty bushels of magnesia lime to the acre, is the best quantity. This quantity should be applied every three or four years, until about two hundred bushels shall have been used. The larger the per centage of magnesia in the lime, the smaller the quantity to be used.

POTASH

Is the oxide or rust of a metal called Potassium. This substance is supplied to soils from ashes, the unleached containing very much the larger quantity, from stable manure, from scrapings of the woods, and more especially from the green sand or Jersey marl. The quantity in ashes, as they are usually sold for manure, is very variable. I have found it to vary from five tenths of one per cent, to four and one half per cent. The quantity of Potash necessary to constitute a fertile soil, as I have elsewhere stated, is very small for reasons given elsewhere, I have not been able to give any very definite information in regard to it. It will be in my power, in my next annual report, to speak more particularly of this substance, as well as soda. With regard to both of these substances, I may here state, that upon land where the wheat crop is liable to rust, ashes, particularly the unleached, or common salt, which contains soda, will usually prevent its occurrence. Of common salt, from one to three bushels per acre, sown on the wheat is sufficient, and the proper time for doing this is the early part of April.

Chlorine exists in salt, and can only be econominally supplied by applying salt.

The next class of manures are those which especially supply phosphoric acid or phosphates of soils.

Phosphoric acid exists in the soil in combination with iron, clay, lime or magnesia.

In the stalk of plants, in combination with lime and magnesia, it is always found in small, and in the grain or seed, always in large quantities. In animals it is found in the bones in large proportions. With bases, it forms a class of salts called phosphates. What is the *exact* quantity which should exist in a soil to give it the greatest degree of fertility, has not been ascertained. Whenever the analysis of soils shows a less quantity than (.05) five one hundredths of one per cent of iron and alumina as phosphates, (for in this, for valid reasons, I have always estimated it,) phosphates may be advantageously supplied. The only indication for their use is their absence or deficiency.

SOURCES OF PHOSPHORIC ACID.

The chief sources of the supply of phosphoric acid are from bones and guano. Ashes, both leached and unleached, also contain them in large quantities, and to this much of their beneficial action may be frequently ascribed.

Bone dust contains about fifty per cent of phosphate of lime and magnesia. I mean, now, bone dust, such as is ground from bones, as they are used for manure without any especial washing. Besides this, they, by the decomposition of the animal matter in them, afford ammonia. In this manner, they have a two fold action on crops:—1st. By supplying them with ammonia;—2nd. By supplying phosphoric acid. They should be so prepared as to preserve both of these valuable constituents.

MODE OF PREPARATION OF BONES.

There have been many different ways of preparing bones. The most common is that of ground or crushed bones, in which they are broken to a greater or less degree of fineness, and then applied to the soil. Another mode recommended by Mr. Pusey, of England, is to first grind them, then moisten with water, cover them over with a stratum of earth, and suffer them thus to remain for a week or ten days. In this way the bones become converted into a soft pasty mass, which is to be thoroughly mixed with the earth which covers them and applied to the land. The outside of the heap should have a thick covering of gypsum, which will retain all of the ammonia generated during the decomposition of the animal matter in the bones.

Another mode has lately been advised and practised with success, viz: to dissolve the bones in sulphuric acid, diluted with water. In this way, the same quantity of bones will produce a much greater effect than when ground to the finest powder. To effect their solution, the bones should be first ground or broken with *rammers*, put into a wooden vessel, (a cider or hog trough will answer very well;) mixed with their weight of water, then with half their weight of the strong commercial oil of vitriol. The mass should be constantly stirred for two or three hours at first, then suffered to remain for a week or ten days, or until the fragments of bone are no longer visible—the whole, then, should be intimately mixed with ashes, saw dust, scrapings from the woods—*or what is much better, corn or wheat bran.* With this application, not only are the phosphates supplied to a soil, but also gypsum, the latter being formed by the action of oil of vitrol on the bones.

The use of the sulphuric acid requires some caution, as it will burn the skin and injure the clothes if suffered to come in contact with them.

The great superiority of bone prepared in this way, consists in their more complete division, they are reduced to an impalpable powder, which can be more evenly and equally distributed over the soil, more easily dissolved by the rain, and more readily taken up by the crop. The same amount expended in this way will produce a much greater return that when laid out for bone dust.

There is still another, and as I believe, a better mode of using bones, because cheaper and equally productive, viz: the applying of them in the *liquid* form. To do this the bones are first dissolved in oil of vitriol, and then diluted with a large quantity of water, and applied at the time of sowing wheat by a machine for that purpose.

The machines used in England for this purpose are very expensive, costing from two to five hundred dollars.

It may be applied by a very cheap and simple contrivance, as follows:

Take a hogshead of convenient size made of thick staves, and near the bottom insert a leaden pipe, connecting it with another hogshead, which may be of half the capacity of the first. The leaden pipe must have a stop-cock, by which the flow of water may be regulated from the larger into the smaller hogshead, so that in the smaller hogshead a regular head of water is kept up. This smaller hogshead is to have a leaden pipe also, with a stop-cock fixed into it near the bottom, which should be joined at right angles to a hollow cylinder of wood, perforated with numerous small gimblet holes.

This whole apparatus can be placed in a common horse cart, when the larger hogshead is to be filled with the dissolved bones. When in the field the stop-cock in the leaden pipe, leading from the larger to the smaller hogshead, is to be turned so as to keep up a regular head of water in the latter. As soon as the team starts, the stop-cock in the pipe, leading from the second hogshead to the perforated cylinder, is to be turned, and by means of the gimblet holes in the cylinder, the dissolved bones will be very equally distributed on the land. The perforated wooden cylinder should have a length equal to that of the axletree of the cart used. This simple contrivance will distribute the dissolved bones as effectually as the most expensive English machines, and the whole cost of it will not exceed twenty dollars. This application should follow immediately the sowing of the wheat. Bones used in this way will give the wheat a strong, quick growth, and thus, in a great measure, prevent injury from the fly. I am at present making some experiments to drive away or destroy the fly, and with strong prospects of success.

To apply bones in this manner is a great saving of them, and a much less quantity answers than when they are ground, dissolved in oil of vitriol in the way first mentioned, or decomposed by a covering of earth. They are scarce and expensive, and any mode therefore which can substitute for quantity, skill, or even expense in their preparation, should meet with the most favorable consideration. I am not aware they have been applied in this way in this country. In England the following experiments show the relative value of bones in the liquid form, when compared with other modes of application.

NO. 1.

Duke of Richmond's Experiment.

Lot 1.—Manured with 14 yards of farm yard dung, and 8 bushels of bone dust.
2. " " 315 lbs. of guano.
3. " " 16 bushels of bone-dust.
4. " " 2 bushels of bone dust dissolved in 83 lbs. of sulphuric acid, previously diluted with 12 gallons of water. 388 gallons of water were added to it. The mixture was then applied to the drills in a liquid state, by means of a water-cart.
5. " " 8 bushels of bone dust mixed with 83 pounds of sulphuric acid, previously diluted with 12 gallons of water. This mixture, nearly in a dry state, was then sown by hand along the drills.

Lots.	Cost of Manure.			Weight of Turnips.		Value of Turnips.			Produce of Barley.			Weight per Bushel.	Value of Barley.			Total Value of produce.			Value, after deducting cost of Manure.		
	£.	s.	d.	Tons.	Cwts.	£.	s.	d.	Qrs.	Bus.	Pk.	lbs.	£.	s.	d.	£.	s.	d.	£.	s.	d.
1	3	0	0	12	0	3	0	0	4	1	3	56	5	18	1½	8	18	1½	5	18	1½
2	1	17	4	11	4	2	16	0	3	5	1½	55	4	19	1½	7	15	1½	5	17	9½
3	1	16	0	11	0	2	15	0	3	7	1½	55	5	5	11	8	0	11	6	4	11
4	0	11	6	12	4	3	1	0	3	4	3	56	5	0	7½	8	1	7½	7	10	1½
5	1	5	0	11	0	2	15	0	3	6	2	56	5	6	9	8	1	9	6	16	9

NO. 1.—(Continued.)

Mr. William's Experiment.

	Manures and Quantity.		Application.	Produce per Acre.			Cost per Scotch Acre.		
				Tons.	Cwts.	lbs	£.	s.	d.
1842.	Bones . .	20 bushels .	Drilled	12	4	3	3	3	0
	Bones . . Sulphuric acid . Water . .	4 bushels 16 lbs. 224 lbs.	In 6,400 lbs. or 640 gallons of water in furrow, . . .	17	4	5	1	8	6
	Bones . . Sulphuric acid . Water . .	20 bushels 76 lbs. . 126 lbs.	From the remarks below, I conclude, that this lot was bones sprinkled with acid.—T. C. . .	13	0	52	3	12	6

Peculiarities :—The difference between the applications and the bone dust, applied in the usual way, "was most marked ;" the sulphuric solution brought the turnips to the hoe ten days earlier than the bones alone, and four days before the bones *sprinkled with acid.*

No. 1.—(Continued.)

MR. GEDDE'S EXPERIMENT.

	Manures and Quantity.		Application.	Produce per Acre. Tons,	Cwts.	Lbs.	Cost per Scotch Acre. £.	s.	d.
1842	Manure, - -	15 loads,							
	Bones, - -	15 bushels,		13	19	21	3	12	6
	Bone dust, - -	1 bushel,							
	Acid, - -	67½ pounds,	In 6,600 lbs, or 660 gallons of water,	13	10	21	0	17	6
	Water, - -	201½ "							
	Bones, - -	12 bushels,	Dibbled, - - - -	11	9	21	1	18	0

No. 2.

DUKE OF RICHMOND'S EXPERIMENT.

	Manures and Quantity.		Application.	Produce per Acre. Tons,	Cwts.	Lbs.	Cost per Acre. £.	s.	d.
1843	Bones, - - -	16 bushels,		11	0	0	1	16	0
	Bones, - - -	2 bushels,							
	Sulphuric Acid, - -	83 pounds,	With 400 gallons of water, -	12	4	0	0	11	6
	Bones, - - -	8 bushels,							
	Sulphuric Acid, - -	83 pounds.	Acid spread over bones and sown,	11	0	0	1	5	0

NO. 2.—(Continued.)

Mr. Hannan's Experiment.

	Manures and Quantity.	Application.	Produce per Acre. Tons.	Cwts.	lbs	Cost per Acre. £.	s.	d.
1843. Soil, very thin limestone, and poor in condition.	Bone Dust, - - 16 bushels,	Drilled with Seed, - -	15	3	4	1	13	0
	Bone Dust, - - 8 bushels, Sulphuric Acid, - 168 pounds, Water, - - 604 "	Drilled with water equal to 50 times the weight of the acid applied in the furrow-ridge plough up and then seed drilled,	17	7	1	1	15	0
	Bone Dust, - - 8 bushels, Sulphuric Acid, - 168 pounds, Water, - - 604 "	Diluted and applied as above, -	17	7	1	1	19	6
	Bone Dust, - - 8 bushels, burnt to half its original weight. Sulphuric Acid, - 84 pounds, Water, - - 252 "	Diluted and applied as above, -	13	7	6	1	6	0
	No manure, - - - -	- - - - - -	7	0	6			

If no experiments had been ever made, I can readily conceive how, not only bones, but any other manure, applied in this manner, will produce a much greater effect then when applied even in the finest powder. I will not recapitulate the reasons for this opinion here. Under the general head of manures they may be seen—common sense and experience confirm them.

GUANO

Is the next sourse of supply of phosphates. This substance has been, for the last few years, extensively used as a manure. Besides the phosphates which it contains, a large quantity of ammonia is generated during the decomposition of its azotised matter.

Guano, as is well known, is the dung or fecal matter of various tribes of sea birds deposited on the coast of Africa, South America, and on the Florida coast of the United States. The varieties most usually sold are the Chilian, Peruvian, Patigonian, and the African or Ichaboe Guano. Of these, the first two command much the highest price in the market, the African or Ichaboe being much less valued, and selling for a less price. The difference between the Chilian and Peruvian, and the two latter, depend on the difference of the climate in which they are found. The atmosphere in Peru and Chili is very dry, scarcely any rain falling, and hence the guano, after its deposition, suffers but little change, no water being present to aid the heat in its decomposition; both heat and water being essential to that process in organic substances.

On the coast of Africa and Patigonia, much rain falls, which not only dissolves some of the phosphates in guano, but readily washes out the ammonia as it is formed. These latter vareities, therefore, are never so rich in ammonia as the former, but they frequently contain a larger quantity of phosphates, inasmuch as the ammonia being formed and driven off, the proportion of phosphates in any given quantity will be comparatively greater. The indicatious for the use of guano, are the absence or deficiency of phosphates in a soil, and the inability of soils to supply themselves with ammonia, for want of power of absorption. The constituents for, and the conditions necessary to this, may be seen under the head of Alumina, Iron, and Sand, in the chapter on the constituents of soils and their properties.

I will, however, state here, that upon open, loose, light, porous soils, that species of guano, containing the largest quantity of ammonia, should be used; but on clayey land, or white oak soils, that kind containing the largest quantity of phosphates is preferable, because these soils can supply themselves with ammonia from the atmosphere. It is a matter, then, of the first importance for the purchaser to be able to know the constituents of guano. At present he cannot know them, unless he employs some chemist, which he had much better do, than to buy and apply guano in the dark. The different specimens of guano differ very much, and the purchaser should know, before buying, the value of each lot that he purchases.

There is much difference in opinion, as to the mode in which it should be applied, some advocating its application to the surface as a top dressing, others ploughing it under. Where the soil is porous, the former, I believe, is preferable; in stiff soils the latter is the better mode. In either case gypsum should be applied with it, in the proportion of about one-eighth by weight. The best quantity per acre, depends on the quantity of phosphates and ammonia in the specimen to be applied. A quantity of guano, capable of yielding phosphates, equal to about seventy-five pounds of bone dust, is the best, as far as my knowledge enables me to say; the facts in my possession in relation to this are very few, though I believe, more numerous than have been obtained by any one else. Indeed, though there has been so much written and published, as to the action of guano, no information has been elicited of general utility, because neither the composition of the guano, nor of the soil, has been given, and yet yet they are the two chief items which can afford us data, whereby to establish rules for the quantity to be used, or, indeed, for its use at all. I know of cases where it has acted well, that is, has more than paid for its cost, where, however, a much less sum expended in other manures, has paid more than twice as well.

Phosphates exist in night soil, in poudrette, in ashes, in stable and in barn yard manure, in some marls in oyster shell lime, and also in stone lime, but in the last, not in snfficient quantity to merit especial attention in reference to agriculture.

The next substances claiming attention, are those which furnish

SULPHUR OR SULPHURIC ACID

to the soil. They are called sulphates, because formed of sulphuric acid, (oil of vitriol,) in combination with some base. The sulphate, almost universally used, is gypsum, or plaister of paris, this is a sulphate of lime with two equivalents of water.

This substance has been most extravagantly lauded and condemned by different persons, as it chanced to act well or badly, when used by them.

The indication for its use, is its absence or deficiency in a soil. When all of the other necessary constituents of a soil are present, this being absent, its use in very small quantities, produces an almost magical effect, making all the difference between a soil almost absolutely barren, and one very fertile. Even though it be absent or deficient, by itself it will not do any good, unless *all* of the other necessary constituents of a soil be also present, so that when gypsum does not act well on land, it may be for two reasons; the first, because of its presence already in the soil,—or secondly, because of the *absence* or deficiency of some *other necessary constituent*—the analysis of the soil, or a *series* of experiments, being alone capable of deciding, to which of these causes its non-action should be attributed.

The very great difference in the gypsum which is sold in market, I shall advert to particularly when recommending some action in regard to its inspection. It is best applied by being sown broadcast on the growing crop, on clover early in the Spring, and on indian corn just before it begins to shoot. The proper quantity is from one-half to one bushel per acre. An advantage is also derived from rolling the corn in it before planting. To compost heaps, to barn yard and to stable manure, it should be applied every few days in quantities depending on the number of stock, one gallon at a time, being enough for the largest yards or stables in the country.

This should be done whether gypsum is applicable to the soil upon which the *manure* is to be used or not, as it preserves one of the valuable constituents of the manure which would be otherwise lost. *Sulphate of soda*, which is but common glauber salts, is another form in which the sulphuric acid, or one of the sulphates, can be applied. They are very cheap, being worth about three-fourths of a cent per pound, and when the soil is deficient in soda, should be preferred to gypsum, as by it both sulphuric acid and soda will be supplied at the same time.

Besides furnishing the elements to crops, which enter into its composition, gypsum is decomposed by the ammonia always present in the atmosphere, which, by uniting itself to the sulphuric acid of the gypsum, loses its volatility, that is, its tendency to escape into the air.

The application of gypsum, then, beside furnishing its own elements to crops, retains for them much valuable food from the air.

This mode of the action of gypsum has been denied by some very distinguished writers who allege against this theory, that the increase of the substances in crops which it absorbs from the air, is far beyond what the quantity applied is capable of retaining. Those who take this ground forget, that when sulphate of lime is decomposed by carbonate of ammonia, the growing crop takes up the ammonia without using the sulphuric acid, which is thus left to absorb and yield to the crop successive quantities of ammonia, as long as it remains in the soil. All chemists are familiar with similar action in the manufacture of certain chemical compounds.

Sulphate of magnesia, common Epsom salts, is another source from which the sulphuric acid may be applied to soils deficient in its two constituents, viz: sulphuric acid and magnesia. Though much dearer than the two above mentioned, it will be found superior to them on soils deficient in both sulphuric acid and magnesia. I have now some experiments to be performed in relation to the use of its substance, which, when complete, will be laid before the public.

Chlorine, which, in combination with bases, forms what are called in the language of chemistry chlorides, is another of the necessary constituents of soils, and consequently a manure. Common salts is the form in which it is most cheaply supplied. The indication for its use, is its presence or absence in the soil, or the position of the land in reference to salt water, as the vapor from it contains an appreciable amount of chlorine, which, by winds and storms, are carried to the neighboring land.

These comprise all of the necessary constituents of plants, all the necessary constituents of soils. The particular combination of each which will give the greatest yield, has not yet been determined. This can only be done by many careful analyses of fertile soils, in order to see what quantities are present in them, and, by the analysis of soils, which are unproductive, and then to determine, by the application of the necessary manure, the smallest quantity which will produce the greatest benefit. The *experiments* hitherto made determine nothing but the mere fact, that some particular manure has acted well on some particular soil. As long as we remain in ignorance of the composition of the soil, so long we can learn almost nothing. I deeply regret too, that men, from whose reputation and knowledge better things might have have been expected, have sanctioned the empirical course of endeavoring to obtain a knowledge of the best manure by its *mere* application to a soil, without any reference to the composition of the soil experimented upon.

The experiments made with so much care, and reported with such commendable exactness in the journal of the Royal Agricultural Society of England, are incomplete, and those recommended by Professor Johnston, as well as those reported by him, are valueless, except to the particular individuals who made them. All others would have to go over the same or other experiments, before they could tell whether the manures used successfully would be equally efficacious in their hands, for if they failed, being ignorant of the causes of failure, no plan would be suggested to ensure success on a second trial. There would be a constant groping in the dark, because the light afforded by an analysis of the soil was neither furnished nor recommended.

It may to some seem presumptuous, that I thus condemn the course followed by men of high reputation and acknowledged ability; but neither of these is a safeguard from error, and neither "the shadow of a great name," nor any authority, however imposing, should be blindly followed. The science of agriculture like all other sciences, has fixed laws; many of these laws are hidden at present from our view, and the veil which covers them will never be lifted, unless they be studied in a rational and philosophical manner. Each known fact in agriculture, to be useful, must have revealed with it *all* of *the* causes which led to its production. A successful or unsuccessful application of manure is a fact of no value, unless the composition of the soil upon which it was used be determined. Then all of the causes influencing its action will be manifest, and each experiment made will lead us onward to a perfect system; every trial of a manure will teach us how it should be used, and when rejected with profit.

In obedience to the law, I commenced the discharge of my duties in the first gubernatorial district, comprising eight counties, viz: Cecil, Kent, Queen Anne's, Caroline, Talbot, Dorchester, Somerset and Worcester, which constitute the

EASTERN SHORE OF MARYLAND.

It is bounded on the north by the far famed Mason and Dixon's line, (which separates it from Pennsylvania as it does the slave from the non-slaveholding part of our Union;) on the south by the eastern shore of Virginia; on the east by the Atlantic Ocean and Mason and Dixon's line, separating it from the State of Delaware; and on the west by the Chesapeake Bay. The mildness and salubrity of its climate, the natural fertility of its virgin soils, the numerous and various sources of improvement for those that have been worn out by improvident cultivation; the unequalled advantages of its geographical position; the high moral and social tone of its population;—all tend to make it an object of interest, as well to those who wish to cultivate the earth for a subsistence, as those who tired of a city life, or the drudgery of professional labor, desire to enjoy dignity with leisure in a retirement from noise and bustle, into the bosom of the country, where the pleasures of sense may be combined with the higher and purer social enjoyments, which all sigh for, and few obtain. A plain description of this section of our State, derived from personal observation during a residence there of nearly eighteen months, being the testimony of what I have seen, and of what I know, from careful observation, will fully confirm what I have said.

First, as to the advantages of its geographical position. Any one who will look at a large map of the United States, will not fail to perceive that in this respect it is *unequalled* by any other part of our Union.

On one side resting on the ocean, on the other reposing on the Chesapeake Bay,—the largest and most beautiful in the world,—intersected by rivers, or rather arms of the bay, every few miles, which afford at all seasons of the year a safe, cheap and speedy conveyance to market. Placed within a circle, as it were, surrounded by the great cities of New York, Philadelphia and Baltimore, all ready and willing consumers of its varied agricultural productions: the ingenuity of man could not improve its locality in this respect. All that railroads and canals, made with enormous labor and expense, can, in the opinions of the most sanguine, effect for other portions of the Union, is here accomplished by the hand of nature, in a manner blending the highest beauty with the greatest utility.

Almost every man has fine bold water, either at his door or only a few miles distant from it, navigable for the largest schooners and steamboats, which, with but little time and expense, can convey his productions to market, and bring in return whatever may be required for convenience, for comfort, for luxury. These waters are, moreover, abundantly supplied with the finest fish, terrapins, crabs and oysters, and some of them with wild fowl of flavor and excellence, unequalled elsewhere.

The character of its soil, and the means at hand for its improvement, are no less worthy of admiration. The variety of its soils affords an opportunity for the cultivation of every kind of grain, fruit or grass, which the climate of this latitude will admit of. Many of its soils are peculiarly adapted to the growth of wheat; others raise the finest crops of corn: its fruits, particularly peaches, are equal to the best in the country, and nothing is wanting but careful cultivation to make it the vineyard of the Union; and its capacity for growing grass will render it a fine grazing country. It has an abundance of the finest timber, particularly white oak, pine and cypress. In many places there are extensive deposites of bog iron ore, easily obtained, and several of the largest of chrome ore in the world. One great and valuable feature of this country, is the abundance and variety of its resources for agricultural improvement. On many of the rivers there are large deposites of Indian shell banks, capable of affording many millions of bushels of the purest lime. It has numerous deposites of very rich shell and green sand marl. In some of the counties the green sand marl contains a large per centage of gypsum. In many large districts of country shell marls, containing from forty to seventy-six per cent of air slaked lime, can be obtained with the greatest facility, being sometimes within a few feet of the surface, sometimes *croping out* upon it.

The shores of the bay, and its numerous creeks and rivers, afford large quantities of sea-weed, a most excellent and valuable manure. In other counties the marsh mud, easily obtained, is exceedingly rich in those constituents most generally needed by worn out soils. To those of its soils which require magnesia, the Chesapeake and Delaware canal, and Susquehanna river, afford every facility for a cheap supply. The whole country is well wooded, timbered and watered.

I find it to be an opinion generally held, that this is a very unhealthy section of our State. My opportunity for observation has been better, perhaps, than that of any other individual, whilst my professional studies, as they enable me to observe accurately, should give my opinions some consideration. So far as my knowledge extends, no part of our country is more healthy than this. There is no better mode of judging of the health of a country than by the physical appearance of its inhabitants. All writers on the science of health (Hygeine,) agree on this general rule, that the physical development of the inhabitants of a country is the best criterion to judge of the health of that country. The reasons of the truthfulness of this index are perfectly in accordance with sound physiology. Muscular development cannot take place, except when all the organs of nutrition are capable of performing their functions in a proper manner. This they cannot do, if exposed to the influences of causes which produce disease; if they do it not, then the appetite will not take food,—or if the appetite does, it will not be converted into aliment. Hence, instead of the full development of the osseous system, (the bones,) and muscular system, they will be sparingly nourished, and attain but little size. Travellers, and indeed all persons, speak invariably of the diminutive size of the inhabitants of unhealthy districts, and of the puny statute of the denizens of closely-built manufacturing towns, in comparison with the large size of the inhabitants of mountainous countries. Experience and the laws of physiology, then, alike declare, that the best test of the health of a country is, the physical developement of its inhabitants.

I have visited many sections of our country, and in no part of it have I seen the mass of population looking more healthy, or having more of all the signs of health manifested in their appearance, than on the Eastern Shore of Maryland. I have seen some of the largest gatherings of men that have ever taken place in our Union, and with any of them, the assemblages of farmers that I have met in my professional tour will favorably compare. Going through every part of each of the counties during all seasons of the year, I have had an opportunity of knowing whatever amount of sickness might exist, and I have in the same extent of population, found as much in those sections of our Union accounted the most healthy, as I have found on the Eastern Shore. The only diseases at all prevalent are intermittent and remittant fevers. These only prevail during a portion of the year, and seem to be the best preventatives against the numerous and fatal class of diseases of the chest which are so fearfully present in other parts of the country. Consumption so prevalent in many parts, is here almost unknown. My own observation, and the experience of its resident physicians, fully sustain this assertion. The people, then, of this part of our State suffer for a brief period of the year under a class of maladies, which, with proper treatment, are speedily and easily cured, and have almost a total exemption from a numerous class of always dangerous and frequently incurable diseases. It may be asked here, why then has this section of our State a reputation for unhealthiness, which it does not deserve? The only reason which I can give is this: in all of the counties on the Shore, there is a custom of having what are called "public days," in the county town, and frequently in other parts of the county. These days are set apart by common consent for the transaction of public and private business, and where very many meet who have no particular business to transact. In this way, several persons from each neighborhood always meet, and whatever cases of sickness occur in any particular section, are known and told with sympathy all over the county. So every case of sickness or death is known, and from the particular acquaintance and friendship engendered by frequent meetings of the people, is felt as a calamity to the whole community, although the number of cases do not exceed those in the healthiest parts of the Union.

More is known of the cases which do occur, but no more *actually* take place here, than in the most healthy parts of the country.

As this country progresses in its rapid march of agricultural improvement, the better and more perfect cultivation of its soils will remove many of the causes of sickness which now exist. This should and will be additional reason for inducing, by all means, the most thorough cultivation and improvement of its soils.

I have dwelt somewhat at length on this subject, to correct the erroneous impressions which exist, and to show to those in want of certain profitable employment, and of cheap and easily improved lands, that they need not feel any apprehensions on the score of health. Emigrants will find here land cheaper, taking every thing into consideration, than they can find in the West, and equally healthy; and if they are taken sick, or meet with misfortunes of any kind, instead of being subject to the privations of a newly settled country, they will experience every aid and assistance from a kind, generous and hospitable people.

The son of Erin will be received in a manner that will remind him of the warmth of his native land; the patient industry of the German will here meet with a speedy reward; and the Magyar will here find a home amidst a people capable of appreciating his noble patiotism and chivalric love of liberty.

The surface of the country is generally level. The upper part, in Cecil county, is very hilly; thence the face of the country gradually changes into a gently rolling surface in Kent and Queen Anne's, until it becomes very level and flat in the other counties.

Its scenery, though deprived of the grandeur of mountains, is more than compensated in beauty by its unrivalled water prospects. The rivers penetrate far up the country, winding gracefully from farm to farm, which seem to seek the embrace of the clear blue waters, in whose bosoms they lie. The fresh streams which are bordered by large marshes, in some seasons of the year, present scenes of the most ravishing beauty.

The waters of these streams are of a dark amber color, from the organic matter of the marshes which border on them, and are covered with the water-lily, a very large and most beautiful white flower; and the marshes on the sides next the river are filled with wild roses, whilst that part next to the highlands, are one unbroken forest of magnolia. As far as the eye can reach, it rests on one unbroken series of beautiful flowers, more beautiful from the dark sluggish waters which are in contrast with them. At night, the lilies on the water are covered with fire-flies, giving the scene an appearance of unequalled beauty and brilliancy. The whole forms a scene which art, with all its ability, can but faintly imitate, and which is without a parallel, even in the climates of the "gorgeous East." Its population has long been distinguished for the exercise of the highest degree of polished hospitality. Residing in the central part of the Union, immediately on Mason and Dixon's line, they have all of the virtues, with none of the vices, which belong to the two great sections of our Union. They possess the thrift, industry and economy of the North, without its parsimony,—the generosity and chivalry of the South, with none of its extravagance and recklessness. Living where the land and the waters meet, their minds have all the firmness of the former, their hearts all the freedom of the latter.

Though to some, the above short description may seem highly colored, all who have had the same opportunities for knowledge as I have had, will bear testimony to its correctness.

I do not conceive it necessary to go into a minute description of the topography of the several counties. The residents know it already, and to others it would possess no interest, and be of no benefit. I shall only speak of the particular deficiencies of each soil, show from what source these deficiencies are to be supplied, and give the compositions of *some* of the different marls. I shall only publish a few of the many analyses of soils made, as they would possess no particular interest beyond their immediate locality, and there I have already given all the requisite information. All of the analyses made by me would occupy a large space, and the great majority of farmers would derive but little benefit from reading them. I conceive my duty rather to lie in the application of the aids of science to agriculture, than in teaching that science; and to do the latter in a report of this kind, would be foreign to its object As the sick man needs not to know the exact mode in which the medicines administered for his relief act, but is satisfied with his recovery, so for those seeking to improve their lands, it is only necessary to know what will most certainly and cheaply accomplish their objects. This I shall show, without going into elaborate reasoning as to the theory of the action of their manures. The law seemed to indicate, that instruction on this point was to be given during my sojourn in the different counties, by means of lectures, by conversations, and, when required, by means of written communications. This is deemed, (and as far as my experience goes,) with great wisdom, the means best adapted to diffuse scientific agricultural information in the community. Notice was given in all the public papers of my presence in the respective counties, and of the time and place of delivering public lectures. Free opportunity was thus offered to all, of reaping whatever benefits could be derived from this office.

Having spoken of the components of soils in general, and of manures, I come now to describe several general varieties which exist in the section of the State where my duties have been performed. Although different parts of the same field present differences, yet on another and adjacent field, the same kind of soils will be found. The varieties of soil, which I shall particularly describe, are those which are met with in greater or less abundance, in all the counties on the Eastern Shore.

WHITE OAK OR PIPE CLAY SOIL,

Forming a large proportion of the soil of the Eastern Shore, must be of great interest, whether viewed as to its barrenness, when unimproved, or its fertility, when correctly manured. I have examined its properties, determined its constituents, and studied the best means of remedying the defects of each, with the most careful attention. To the knowledge of the first two, obtained by my own investigations, I am able to add, for the correction of the last, a knowledge derived from the accumulated experience of many of the best farmers on the Shore. This variety of soil is readily distinguished from all others by ITS WHITE COLOR, FIRM COMPACT TEXTURE, ITS LEVEL SURFACE, ITS GREAT RETENTIVENESS OF MOISTURE, by its softness and plasticity when wet, and by its firm and unyielding nature when dry. It is almost always in its original state, covered with white oak *timber*, from which it derives its name. Sometimes, however, pine grows abundantly on it, mixed with the white oak. The water which runs off from its surface is of a dirty white color, and even when it collects in pools, takes a long time to become clear; in other words, a long time must elapse before all the earthy matter, from its extreme fineness, subsides to the bottom. The *sub-soil* is most usually a *true* white clay, (silicate of alumina and protoxide of iron,) unless on the points of land running into the rivers and ocean where red clay predominates. Occasionally, we find the sub-soil of a "mottled, marbled" character, being a mixture of the red and white clay in various proportions. Its chemical constituents are no less constant and marked than its physical appearance. It is distinguished by the large proportion of sand, by the small proportion of iron and clay, by the presence of magnesia in sufficient quantities, by a great deficiency of lime, which *is constant*, and by a tolerable supply of the alkalies, phosphates and sulphates. The sand in these soils is always in a finely comminuted state, feeling but slightly gritty under the fingers, and receiving minute impressions when placed in contact with any uneven surface. It is from the extreme firmness of the sand, that this soil derives its compact texture and its power of retaining moisture. It is this which makes up for what would otherwise be a deficiency in the clay and iron. These two latter substances are particularly important in soils from their power of absorbing and retaining moisture. From the atmosphere they also absorb ammonia, a powerful fertilizing agent, and retain it with great force, forming combinations, "true salts," with it until the plant requires it for support. In a soil deficient in clay and iron, then, and whose sand is course, you will have to supply artificially, some manure containing this latter indispensable substance, or a good crop can never be obtained. There are examples of this kind in the loose, light, sandy soils in some parts of all of the counties. These soils owe their barrenness alike to their texture, and to their composition.

In the white oak soils, the fine sand is a substitute for iron and clay, absorbing, with great power, moisture, and whatever other fertilizing matter may be in the atmosphere, and retaining it until the wants of the plant require its use. The sand thus performs a vicarious action to iron and clay; it is a substitute for them in giving compactness to the soil; it is a substitute for them in absorbing moisture, and the food which plants obtain from the atmosphere.

The power of charcoal to absorb various gasses, is well known, a power derived exclusively from its mechanical texture, as shown by its great number of fine pores; and when we consider the fine state of division in which the sand exists in these soils, we readily see how a mass of it must present a very large surface for absorption, and how an almost infinite number of small spaces must exist between the grains of sand, giving it in a great degree the same properties as charcoal. For although this soil appears to form a solid mass, yet no grain of it is in perfect contact with any other grain. This is most satisfactorily demonstrated by placing a small lump of it under the field of a microscope, when the interstices, the spaces between each grain, are distinctly visible. Another advantage which this land possesses, is, that it more readily yields the mineral agents which it contains, to growing plants, all bodies (other things being equal,) being soluble in proportion to the fineness of their division. This is always acted on by those who wish to dissolve any substance of difficult solubility, by pulverizing it in a morter. Now, in a soil, every grain of sand contains something of use to the plant, which can be more readily dissolved from fine, than from coarse particles. These soils are uniformly deficient in lime, but have enough of magnesia: they have potash and soda, as well as sulphates and phosphates, in fair proportion.

How does an acquaintance with their texture and composition teach us to improve them? What are the indications, and how are they to be fulfilled?

First,—These soils are level and retentive of moisture. They should then be drained THOROUGHLY with *surface* drains. No water should ever be allowed to rest on them. The fields should be ditched at least on two sides, with a wide deep ditch, into which a number of small surface drains should run, and one or two large drains through a field are no substitute for a large number of smaller drains. These latter are more effectual and more easily made. A plough run once or twice in the same furrow, aided by the hoe, will in most cases, make a very effectual drain. The manure from the bottom of these ditches will, in a few years, pay for them, even if they had no other use.

These soils are compact, and, therefore, do not require a great depth of soil in order to give firmness and stability to the roots of plants growing on them. They, also, very effectively retain moisture, thus affording it to crops in a dry season; when overlaying a white sub-soil, they can gain nothing of use from it, for these sub soils contain almost nothing that is useful to vegetation, and some things in a condition that are injurious. How, then, should they be cultivated? Notwithstanding, it is so fashionable to advocate deep ploughing; notwithstanding, it is always insisted on by agricultural writers, speakers, and essayists, yet I must advise all to beware of it, on these lands, unless they have a red clay sub-soil. The only rational rules for ploughing, are short and plain. They are, to turn up a sufficient depth of soil to give a firm support to the plant, enough to retain moisture for its use, and never to go deeper, when those ends are obtained, unless the sub-soil be better than the surface soil. If it be worse, you injure, and cannot improve by deep ploughing.

If the sub-soil be better, then, and then only can you gain by deep ploughing. Reason and common sense alike tell us, that if you join a worse with a better soil, the compound will be inferior to that better soil. If, on the other hand, the sub-soil is better than that which overlays it, then should it be turned up with the plough, because the sum of the two will be better than the surface soil.

Such being the case, you should plough shallow in these white oak soils, and never turn up the *white* clay upon which they rest. The particular depth of ploughing, will vary slightly in different soils of this class, and I have never seen any that required more than five inches; most frequently three or four inches are sufficient. This depth is sufficient to support the roots of the plants, sufficient, to retain enough of moisture, and there is inferior soil underneath, which would deteriorate the quality of the surface soils.

Where there exists a sub-soil of mottled or marble clay, the same rules are to be observed as regards the depth of tillage. Upon the red or yellow clay sub-soils the practice should be different, as these may with advantage be turned up, never more, however, than one inch for each rotation, which may be repeated until the depth of tillage reaches to six or eight inches. These rules are founded on the nature of the sub-soil, and its influence on vegetation.

The iron in the red and yellow clays, is in the state of per oxide, that is, it is in its highest degree of rust, and can receive no more oxygen. Iron, in this condition, absorbs ammonia, (a very fertilizing constituent of the atmosphere,) and retains it until required by the growing plant. But the advantage does not stop here. The color of soils has an important influence on their productiveness. Those which are dark colored, absorb, and retain heat better than those of a lighter hue. Seed, in the former, sprout quicker, and grow more rapidly than in the latter. So by mixing a red or yellow clay with these white soils, you will cause the crop to take an earlier start, to grow more rapidly, and arrrive at maturity sooner, than if a contrary practice was adopted. These clays, too uniformly contain some lime, in which the surface soils are deficient.

We come now to speak of the best means of improving the soils under consideration, by manures, that is by the addition of those substances in which they are deficient: deficiency or absence being alaways the test of a manure. However valuable anything may be in itself, it is no manure when applied where it already exists in proper form, and in sufficient quantities. From what has been said of the composition of these soils, the rationale of their improvement is plain, cheap and certain. They are only deficient in lime: Then it should be applied to them in the purest form,—oyster shell lime is the lime for these soils, because, in reference to them, it contains less impurities than any other kind of lime. If Wrightsville, New York, or Schuylkill lime, be applied, much less of manure, for the same amount of money and labor, is given to the soil, than if oyster shell lime be used. Each of these limes contain a large pei centage of magnesia, and more sand, clay, and iron, than that from oyster shells. As these soils contain enough of magnesia, all the magnesia applied to them is so much lost in money and labor, to say nothing of the loss of the crop which a pure lime would have produced.

It matters not in what form the lime be applied, as it is a mere question of cost, whether pure oyster shell lime, shell marl, or the mould from Indian shell banks be used: all these act by supplying lime, the prime deficiency of the soil; they willact and bring it to a high degree of fertility, producing abundant crops of every kind, and the finest, heaviest crops of wheat; for these soils, from their texture, is peculiarly adapted to this grain.

The manner of applying lime to these lands now requires some notice. It it be applied to the surface a long time before the crop is to be planted, the rain, instead of carrying the particles of lime *down* into the soil, will carry them *off* from it, and in this way a large part will be lost. In loose, porous soils, this surface application will answer very, well, but hard compact soils should be first ploughed up, and then have the lime scattered immediately on the surface. In this way none will be lost.

The *quantity* of lime to be applied, is the next subject of consideration. Here again we have to consult fertile soils of this class. Science has given them a language, every sound of which is truth.

The most productive have not shown over two hundred bushels of air slaked lime to the acie, to the depth of twelve inches. There is no need then, of ever giving them more than this quantity. Six or seven-tenths of one per cent is always enough. Up to this point, the larger the quantity the better will be the crops. All who have this variety of soil should apply lime to them. If it be impossible to apply an hundred bushels, apply fifty; if not fifty, then twenty-five; if not twenty-five, then ten bushels; apply some, and do it at once, make a beginning, however small, and its good results will soon persuade all who make the effort, to surmount whatever trifling difficulties may intervene, and lead them to apply the necessary quantity.

Besides lime, a slight dressing of compost manure, made from the scrapings of the woods, will greatly aid in the improvement of these lands. It will materially quicken the action of the lime.

I need not give the reasons, the fact is certain and quite sufficient for our present purpose.

There are millions of acres of this land, now not worth in the market more than from five to eight dollars, which by the application of as much money in the proper manure, will pay for themselves and for the manure, by the very first, or, at most, the second crop. Lands, precisely similar to them, have produced from fifteen to twenty bushels of wheat to the acre, after proper draining and liming, which before would not produce more than four or five, frequently no more than two or three. I know some examples of this kind, upon which all may depend, which prove these two prime facts:—1st. That those lands, when improved, are the most productive and valuable in our State, taking every thing into consideration;—2nd. That lime is the cheapest agency to effect this improvement. I need not say, that in their unimproved condition they are the least profitable of all of our varieties of soil. If there be any one kind of manure which I can recommend for any particular soil with more confidence than any other, it is

OYSTER SHELL LIME TO WHITE OAK SOILS

If that cannot be obtained, then the Baltimore limes should be used. I have never known one single instance of failure from the use of oyster shell lime on these soils, where proper cultivation was also followed. The most productive lands in Talbot are of this kind, and made so by the use of this substance, and manure from the common resources of the farm. Land there, which twenty years ago was considered dear at ten, will now readily bring fifty and sixty dollars. The same degree of improvement has occurred in many other of the counties of this shore, but not so generally as in Talbot. I have now given the nature of the composition, and best means of improving, this variety of soil; shown what indications Analytical Chemistry declares were to be fulfiilled to render them fertile; and I have shown that where these indications had been carried out, they have never failed to produce the desired result; that art and science, theory and practice, all pointed to the same system of cultivation, and the same kind of manures. It remains then for the owners of this land to act their part, and their labor should be the less irksome from the certainty of its success.

The following are a few of the many analyses made of these soils:—

Specimen from Farley creek, Kent county,

Vegetable matter,	5.60
Silica, (sand,)	89.80
Iron and pure clay,	3.40
Iron and alumina, as phosphates,	.14
Lime, as air slaked lime,	.41
Magnesia,	.35
Potash and soda,	.12
Sulphuric acid,	.001
Chlorine,	.001

This soil produces from twenty to thirty bushels of wheat, and from six to ten barrels of corn to the acre, at present. It has been manured with two hundred bushels of Schuylkill lime to the acre. This soil in its original condition, contained an abundance of Magnesia. This was not the best lime for it. A specimen taken from an adjoining field gave two-tenths of one per cent. of magnesia. Before the application of the lime, the owner of this land informed me, that it would not have produced three bushels of wheat to the acre.

No. 2.

Specimen from the upper district of Queen Anne's county, taken to the depth of five inches, was composed as follows, of—

Vegetable matter,	3.50
Silica,	91.10
Alumina, (clay,)	2.50
Iron as per oxide,	2.00
Iron and alumina as phosphates,	.05
Lime as carbonate,	.04
Magnesia as carbonate,	.70
Potash and soda,	.03
Sulphuric acid,	.001
Chlorine,	.001

This soil had never been limed, it originally contained only twelve bushels of lime to the depth of 12 inches. It has a large abundance of magnesia, and is very poor. The manure is of course *lime*, and the common resources of the farm.

No. 3.

Specimen of unimproved white oak land from Kent Island, in Queen Anne's county. Specimen taken to the depth of five inches, and thoroughly dried gave as follows, of—

Vegetable matter,	3.78
Silica and sand,	92.30
Alumina,	2.00
Iron as per oxide,	1.25
Iron and alumina, or phosphates,	.08
Lime as carbonate,	.08
Magnesia,	.29
Potash and soda,	.16

Sulphuric acid and
Chlorine, not estimated quantitively, but evidently enough.

This land does not produce five buhsels of wheat to the acre, though it has all of the constituents of a fertile soil, except lime, in as good proportions as the other soils which produce twenty-five bushels of wheat.

No. 4.

Specimen from near Miles' River, Talbot county, was composed as follows, of—

Organic matter,	5.00
Silica, (sand,)	91.70

Alumina and iron as per oxide,	2.90
Iron and alumina as phosphates,	.11
Manganese, (a trace,)	
Lime as carbonate,	.32
Magnesia,	.18
Potash and soda,	.07
Sulphuric acid and chlorine in sufficient quantities.	

This is a very productive soil, made so by the application of marl.

No. 5.

Specimen from Tuckahoe Neck, Caroline county, was composed of—

Organic matter,	4.60
Silica or sand,	92.10
Alumina and iron as per oxide,	2.80
Iron and alumina as phosphates,	.03
Lime as carbonate,	.17
Magnesia,	.10
Potash and soda,	.04
Sulphuric acid, a trace,	
Chlorine, not deficient.	

This is rather more productive than most of the unimproved "white oak soils," the quantity of lime in it being above, and the quantity of phosphoric acid, under, the aveiage. Besides oyster shell lime, bone dust or guano, particularly the Patagonian or African, should be used on these soils.

Several examinations of soils in this Neck, show very nearly the same composition as the above.

No. 6.

Soil from near Cambridge, Dorchester county, Md. Specimen taken to the depth of six inches. This soil had never been improved; it was composed as follows, of—

Organic, i. e., vegetable matter,	7.20
Silica, i. e., sand,	90.50
Alumina, (clay,) and Iron as per oxide,	1.70
Alumina, and iron as phosphates,	.09
Lime as carbonate,	.10
Magnesia,	.21
Potash and soda,	.111
Sulphuric and acid,	.008
Chlorine,	.006

This soil was experimented on by J. Wallace, Esq., with the following result, which I cannot do better than give in his own words:—

"I accordingly purchased five hundred bushels of ashes in Baltimore, and had them landed at the cost of 12½ cents per bushel, and applied them upon lot No. 1, of field No. 1, at the rate of one hundred bushels per acre; immediately alongside, I applied one hundred bushels of shell lime, at a cost of 3 cents per bushel. The whole was sown in wheat in the fall of 1847, upon an oat stubble. At harvest I measured off and reaped separately, one acre of the ashed land, and one acre of the *unimproved* land. Upon the ashed land, I have raised seventeen bushels of grain, upon the unimproved only *seven* and one-half, an acre of nine and one half bushels. The product of the limed acre was not measured, but as the eye could observe, there was a slight difference in favor of the ashes, but very little. The difference in the cost of improvement, however, was material; the ashed land cost $12.50 per acre, and the limed only $3.00. On the young wheat, in the spring, clover seed was sown upon the whole field, but the plants all died in the summer, except where the lime and ashes had been applied. And I may here add, that in every instance I had failed to raise clover where either lime or ashes had not been applied."

For more particular details, the reader is referred to a letter from Mr. Wallace, in the January number of the American Farmer. It is by far the most valuable practical paper yet published on this subject.

These analyses and experiments place the matter beyond cavil, as to the successful manuring of poor lands of this description. I have examined numerous specimens of this variety of soil in other parts of Dorchester, in Somerset, and Worcester, in Queen Anne's, Kent, and Cecil, and they all have the same general composition, and would be benefitted by the same cultivation, the same kind and quantity of manures.

RED AND YELLOW CLAY SOILS.

By this term I include all of those soils, having for their bases, red or yellow clay. The surface soil depends very much for its color, on the quantity of vegetable matter in it. Sometimes it is filled with course gravel, sometimes it is a fine dark grey sand, frequently of a light reddish color, owing to the presence of per oxide of iron, and very often the surface soil has nothing by which it can be so described as to be recognized. The sub-soil is, however, always characteristic, being a red or yellow clay, similar to that from which bricks are made. The clay differs in color from a bright brick red, in Cecil, to a pale fawn color, in Worcester county. The transition in color is gradual, from Cecil to the southern parts of the shore, becoming less red by almost insensible degrees, a fact due to the dimunition in quantity of the iron. These clays, also, are less strong as we proceed downwards; that is they contain a less quantity of pure clay

The surface soils over these clays are deficient in alumina and per oxide of iron, in lime, magnesia, and the phosphates. The first two can be supplied by deep plowing.

The red and yellow clay sub-soils contain from eight and a half, to as much as twenty bushels of lime per acre, for every inch in depth. Hence, on those soils, with every inch of clay which is turned up, from eight and a half to twenty-five bushels of lime is brought into action. Besides this, they also contain magnesia, and sometimes potash. If there was no other reason but this, it should be sufficient to induce deep cultivation on the red and clay lands, which will also, partially supply the latter deficiencies. The composition of these soils points out the manures best adapted for them. These are the Schuylkill, Wrightsville, or New York lime and bone dust, or guano. Lime devoid of magnesia, will increase the growth of crops on these soils, yet it will never act as well as those which contain it, because, by the latter, both lime and magnesia, two deficiencies instead of one, are supplied.

They should be ploughed deep, but not more than two inches of the clay should be turned up in one rotation. This should be done in the fall, that it may be subject to the action of the winter's frost, and to the influence of the weather for a long time

For the reason that these soils differ very much as to the quantity of their necessary constituents, and of course in the quantity of manures which should be applied, I have not given any of their analyses in this report.

Those which I made have been given to the owners of the soil, and the necessary manures, both as to kind and quality, indicated at the same time.

I have, moreover, given all the information which I possess in regard to them, to their owners, through conversations and lectures. At present, gypsum would act well on these soils—when, however, they have a large admixture of the per oxide of iron and alumina, by means of deep ploughing, the benefits of this will be questionable.

The rules which I have laid down, aiding by observations of the effects of the specified manure, will aid greatly in their successful cultivation. These lands, from the facility with which they are improved, are very valuable. Though at present they may be cheaply purchased, yet, in a few years, when their worth become better known, they will command a very high price. Indeed, at present, they are rapidly increasing in value.

BLACK GUM SWAMP SOILS.

These are characterised by their black color, light porous texture, and the large quantity of vegetable matter which they contain. They are very productive in corn, but wheat does not flourish on them, owing to their porous texture. This class of soils is most generally found in bottom lands, and, when at all moist, should be drained.

The best application for them, is unslacked magnesian lime, for even when a fair proportion of lime is found on analysis, yet lime will act on them, as the substances necessary for plants are held by the vegetable matter, which cannot be yielded until it is decomposed: quick lime affects this very readily, and should be applied for every rotation as long as a large quantity of vegetable matter can be recognized. From twenty to forty bushels applied every year, will insure, for a number years, *very* large crops of corn, and, when the texture of the soil will allow, large crops of wheat will be produced. These soils are generally quite fertile, bearing from four to eight barrels of corn every year for a great number of years.

When quick lime cannot be procured, water-slaked lime should be used. Air-slaked lime will benefit them but very slightly, and common earth of any kind, by rendering them more compact, will also act beneficially on these soils.

Specimen from Fourth Election District, Worcester county, Md., thoroughly dried, was composed as follows, of—

Vegetable matter,	41.70
Silica, (sand,)	53.80
Iron, as per oxide,	.40
Alumina, (pure clay,)	3.50
Iron and alumina, as phosphates,	.08
Lime,	.20
Magnesia,	.21
Potash and soda,	.10
Sulphuric acid and chlorine, (a trace.)	

This soil produces from thirty to forty bushels of corn every year.

Specimens from the long marsh in Caroline, and the Beaver Dam in Queen Ann's county, showed a composition nearly similar to the above, except in having a larger quantity of iron and alumina as phosphates, from .2 (two-tenths) to .45 (four and a half tenths of one per cent.)

Specimen from near Newtown, Worcester county, Md.

Vegetable matter,	44.00
Silica, (sand,)	53.00
Iron,	.81
Alumina, (pure clay,)	1.00
Iron and alumina, as phosphates,	.15
Lime,	.30
Magnesia,	.25
Potash and soda,	.04
Sulphuric acid,	.002
Chlorine,	.006

This soil produces from thirty to forty bushels of corn every year—no wheat.

Specimen from Worcester county, Md., from near Derickson Cross Roads, being fully dried, was composed as follows, of—

Vegetable matter,	35.00
Silica, (sand,)	60.00
Iron as per oxide,	1.00
Alumina, (pure clay,)	2 60
Iron and alumina, as phosphates,	.16
Lime,	.35
Magnesia,	.24
Potash and soda,	.15
Sulphuric acid,	.009
Chlorine not estimated, but sufficient.	

This soil produces from fifty to sixty bushels of Indian corn every year—wheat does not thrive on it.

Specimen from Somerset county—

Vegetable matter,	42.60
Silica, (sand,)	53.20
Iron, as per oxide,	.61
Alumina, (pure clay,)	2.70
Iron and alumina, as phosphates,	.13
Lime,	.21
Magnesia,	.20
Potash and soda,	.15

Sulphuric acid and chlorine not estimated quantitatively, but sufficient.

This soil produces from thirty to forty bushels of corn every year—no wheat.

LIGHT SANDY SOILS.

These soils are characterized by their coarse, gritty texture, their porosity, their white color and their barrenness. Sometimes the sand in them is brownish from the presence of iron. Their greatest defect is mechanical. They are deficient in clay and iron, and their sand is too coarse to absorb much, if anything, from the atmosphere.

Their chemical defects are lime, magnesia, the phosphates; these substances, though present, are not in a condition to be used by plants.

They should be treated with compost, made of vegetable matter of any kind; such as scrapings from the woods, the *clearings* out of ditches, &c., with any of varieties of lime containing magnesia. Gypsum should always be sown on these lands when not in cultivation, and as large a crop of grass as possible suffered to grow on them, unmolested by cattle. When this decays, it will dissolve much of the mineral matter in the soil, that otherwise would not be taken up by plants. The compost manure, recommended above, supplying lime and magnesia, would act in the same manner. If the magnesian lime be applied by itself, not more than twenty bushels per acre should be applied at one time. This should be done in the fall or winter preceding the crop to be tilled.

It should be spread on the surface, for in these porous soils the rain will carry down the lime into the soil, distributing it very equally through it. As those soils cannot absorb ammonia well, that form of guano containing the largest amount of it should be preferred for them. When bone dust is applied, it should be done immediately before the crop is planted. Gypsum should always be used on these lands.

One of the best means for the improvement of this class of soils is by crops of *peas*, and the common *lady pea* is better for this purpose than all others. The ground intended for their use, should be ploughed up in April or May, and the peas harrowed in about the middle of the latter month, or first of June, by means of a light spike toothed harrow. In the fall the peas should be gathered from the vines, which will pay as well as any other crop on these lands. The succeeding year they will bring at least thirty per cent more of corn, than if they had not been cultivated in this way. There are soils of this kind near Worton Point, in Kent county, and also on the Chester river. They are found in the neighborhood of Sudlersville, in Queen Anne's, extending on the Chester river, for some distance below the Chestertown bridge, and reaching out into the country, until they become gradually blended with the red and yellow clay lands; they are found in Talbot, bordering on the Choptank, and they prevail very much in Caroline county; in the upper and middle districts in Dorchester county, on the Choptank, above Cambridge, to the Delaware line; and in the upper part of Somerset, and that part of Worcester called the Forrest. They also are found east of the Pocomoke, below Snow Hill, extending a few miles above it, until they meet with the yellow and red clay lands of Quepongo and Berlin.

The above compose the most marked varieties of soil found in the first gubernatorial district. To describe all which occur, would swell this report to an unreasonable length. The sub-varieties are very numerous, and as far as opportunity permitted, their characteristics were examined, their deficiencies determined, and the manures and cultivation best adapted to them, were made known by the means pointed out by the law.

The analyses of all kinds made of soil, exceed one hundred and fifty in number, but as their publication, would subserve no practical benefit, I have not included them in this report.

The owners of the soils will give me, in the course of a few years, the result of their experiments, which will form a collection of the most valuable facts yet given to the art or science of Agriculture.

I have adverted to the variety and richness of the marls of some parts of the Eastern Shore. These are comprised under two general classes, viz: the green sand marl and shell marl. These are the terms applied to the two varieties on the Shore, by which all there will readily understand my meaning.

THE GREEN SAND, OR JERSEY MARL,

Is found in large deposites on the head of Sassafras, in Kent county; on the Sassafras river, in Cecil; on the branches of the Great and Little Bohemia river; and in many other localities in the lower part of Cecil. A bed of it is found also below Chestertown, near the Chester river, but evidently not in its original position. Another bed, to the thicknes of about eighteen inches, is found overlaying shell marl of the very latest deposite in Talbot, at the head of Wye, on the land of Mr. Thomas Hopkins. This is also out of place, having been transported here by a current of water at some distant period. The green sand to which I refer, owes its value to the presence of potash. Sometimes, however, it contains carbonate of lime, and occasionally some sulphate of lime, (gypsum,) formed by the decomposition of the sulphuret of iron, and of carbonate of lime furnished by shells.

It is, by no means, to be taken as granted, that all sands which are colored green, possess fertilizing properties. Their color is due to the presence of iron, and not of potash or lime. They may, and sometimes do, have a bright green color, and yet have not enough of either of these substances to be of the smallest value as fertilizing agents. The test of value recommended by Professor Rogers, in his geological survey of New Jersey, that of a green stain being made by the sand on white paper, is not correct; though it was also mentioned in a report on the geology of Virginia as an unerring mark, and adopted by the lamented Professor Ducatel of this State. The green color of this marl is caused by the iron and not by potash. It is true, that when potash is present in the sand, the green stain will be made, but it is equally true, that it will be made if no potash is present; hence it is, by no means, an "unerring test" of the value of this kind of sand, and, indeed no test at all. The only means to determine the quantity of potash in green sand, is a chemical analysis made by an *experienced, practical chemist.* Its analysis is complicated and difficult, and liable to many sources of error. No confidence should be placed in any estimate of its worth, that is not based on a chemical analysis made by an experienced hand. This marl is sometimes found in large grains, sometimes the grains are very small, and the mass of it is very close and compact, the color is sometimes a bright green, which, on exposure to the air, becomes a dusky red, from the per oxidation of the iron. Frequently it is of a dull green, approaching to black. No indication of its value, however, is afforded by its external appearance.

The benefits of its action are due principally to the potash which it contains; besides this, its iron, when peroxodised, absorbs ammonia from the air, and improves, very materially, the texture of the soil, especially when the soil is light, loose, porous, sandy, or of a white color. The following are analyses of some of the different specimens examined by me.

MARLS OF KENT COUNTY.

Green sand from Ebenezer Welch, head of Sassafras, in Kent county, 100 parts, thoroughly dried, gave of—

Silica,	58.00
Iron as protoxide,	22.00
Alumina,	5.00
Lime,	6.00
Magnesia,	1.50
Potash,	6.50

A stratum in this bed, about four feet in thickness, intermixed with shell, gave as follows, of—

Silica,	31.00
Lime as carbonate,	57.00
Alumina and iron as phosphates,	1.00

Iron as protoxide,	4.50
Magnesia,	1.50
Potash,	2.50

Secimens from Mr. Briscoe, head of Sassafras river, the same locality as above, were composed of—

Silica, (sand,)	58.50
Iron as protoxide,	21.50
Alumina,	6·50
Lime,	5.00
Magnesia,	1.50
Potash,	6.70

The bed of green sand, on the head of Sassafras, is about twenty feet in depth to the level of the tide-water, and extends more than three-fourths of a mile down the river. This sand is found more or less intermixed with the sand on the streams, and with the under strata of some of the soils in different parts of the county. Analyses were made from many localities, but there was none of any practical value, except that below Chestertown, and a specimen furnished by Mr. George Spencer.

The former contained of potash, 4 per cent; the latter of potash, 3 per cent.

A specimen intermixed with many green particles of sand from near St. Paul's church yard, in the Lower District, gave of—

Silica,	90.00
Iron as protoxide, with per oxide,	4.25
Alumina,	2.00
Lime,	1.50
Potash,	1.25

Specimen of shell marl from Mrs. Julia Merritt, lower district of Kent.

Physical characters, hard compact texture, dusky red color, and intermixed with many small quartz pebbles. Specimens thoroughly dried, gave of—

Sand,	45.00
Iron as per oxide,	5.55
Lime ae carbonate,	49.22
Magnesia, (a trace,)	
Phosphates, (a trace,)	

Shell marls from the banks of Chester river, on the farm of Mr. Wm. Decourse, was composed as follows:—

Sand,	45.00
Iron as per oxide,	10.74
Alumina,	1.12
Lime as carbonate,	43.00

This marl was of very easy access, but had never been used, though the land on the farm, and all through the neighborhood, very much needed it.

Dark black marl, with small fragments of shells in it, from Mr. Malsberg, near Georgetown Cross Roads, contain of—

Silica,	13.75
Iron as per oxide,	12.00
Alumina,	1.00
Iron and alumina as phosphates,	.50
Lime as carbonate,	17.00
Lime as sulphate, (gypsum,)	4.00
Potash,	1.25

This is a very valuable marl, containing, as it does, almost all of the necessary constituents of soils in fair proportions.

Very many different specimens of the marl, and what was supposed to be fertilizing matter, were examined in all the counties during my stay in them, the analyses in every instance were furnished to the different individuals when the specimens were of any value, but when worthless, the result only was announced. It is unnecessary to give them in detail here. Many marls whose efficacy had been determined by long use, were not submitted for examination.

Many rich deposites of green sand marl occur in Cecil county, but as most of the specimens were brought to me only a few days before my duties there closed, I have not had an opportunity of thoroughly analyzing them. This shall be done in the course of a few months, and the results given to the owners in a proper manner.

ANALYSES OF SHELL MARLS FROM QUEEN ANNE'S COUNTY.

Specimens from W. A. Spencer. The bed situated at the edge of a running stream, and of very large size, covering an area of more than 50 acres, to the depth of 6 to 8 feet.

Specimen No. 1, was composed as follows, of—

Sand,	66.00
Iron as per oxide,	1.00
Alumina,	.25
Lime, as carbonate,	32.75

The above are the proportions in 100 parts, after being thoroughly dried.

Specimen No. 2, was composed as follows:—

Sand,	85.00
Iron,	1.50
Alumnia,	1.10
Lime as carbonate,	12.40

Specimen No. 3, was composed as follows:—

Sand,	90.00
Iron,	1.70
Alumina,	.50
Lime as carbonate,	7.80

This specimen was from a distinct stratum, immediately above the last.

Another specimen from the same bank, also, from a distinct stratum, was composed as follows, of—

Sand,	90.50
Iron,	1.50
Alumina,	.50
Lime, as carbonate,	7.50

The following shows the composition of two specimens of marl from Mr. Davidson, Wye Neck.

No. 1.

Contains of—

Sand,	68.20
Iron, as per oxide,	1.40
Alumina,	1.00
Lime as carbonate,	29.40

A stratum immediately overlaying the above, to *all appearance* equally good, was composed as follows, of—

Sand,	90.00
Iron,	2.50
Alumina,	1.00
Lime, as carbonate,	6.50

This is not worth hauling.

Specimen from Dr. Newman's, near Church Hill. This bed is of very large extent; covering about 150 acres, and being about twelve feet in thickness.

No. 1.

Contained of—

Silica,	57.00
Alumina and Iron,	2.00
Lime as carbonate,	41.00

No. 2.

Blue stratum from same beds, the shells being much more thoroughly decomposed was composed as follows, of—

Sand,	62.00
Iron,	1.40
Alumina,	2.00
Lime as carbonate,	34.50

Analyses of two specimens from Mr. William Carmichael, Wye river.

No. 1.

Was composed as follows, of—

Sand,	79.00
Iron, as per oxide and alumina,	3.50
Lime as carbonate,	17.50

No. 2.

Contained of—

Sand,	57.15
Alumina and iron,	5.05
Lime as carbonate,	37.80

Specimen from Mr. Walter D. Hardcastle's farm, near Reid's creek, was composed of—

Sand,	49.00
Iron, as per oxide,	3.00
Alumina,	2 25
Lime as carbonate,	45.75

A specimen from Mr. Greenberry Knott's farm, was composed as follows, of—

Sand,	71.85
Iron and alumina,	8.50
Lime as carbonate,	19.65

A specimen from Mr. Madison Brown, Centreville District, was composed as follows, of—

Sand,	55.00
Iron and alumina,	5.92
Lime as carbonate,	39.00

A specimen from Mr. R. E. Clayton, was composed as follows, of—

Sand,	60.80
Iron and alumina,	3.00
Lime as carbonate,	36.50

Specimen from Mr. William Hemsley, head of Wye was composed as follows, of—

Sand,	65.00
Alumina and iron,	8.00
Lime as carbonate,	26.50

Besides the above, many other valuable beds of marl are found in this county.

ANALYSES OF SHELL MARLS IN TALBOT COUNTY.

Specimen from Chas. Robinson, near Easton, was composed as follows, of—

Sand,	70.00
Iron and alumina,	.07
Lime as carbonate,	28.00
Lime as phosphate,	1.15

J. H. McNeill—Marl, No. 1.

Hard, compact, white shells, finely comminuted. Specimen having the appearance of mortar.

Sand,	17:00
Iron and alumina,	6.50
Lime as carbonate,	76.30

J. H. McNeill—Red, No. 2.

Sand,	19.00
Iron and alumina,	10.50
Lime as carbonate,	70.00
Loss and other components not material,	.50

No. 1.

Mr. Stiandberg,

Sand,	56.50
Iron and alumina,	3.50
Lime, as carbonate,	39.60

Mr. Strandberg, No. 2, contained of—

Sand,	58.25
Iron and alumina,	4.00
Lime as carbonate,	37.00

Specimen from Mr. Bartly Haskins, white color, showing but very little apperance of shells. It contained of—

Sand,	26.00
Clay and iron,	2.20
Lime as carbonate,	70.00
Lime as phosphate,	1.60

Specimen from Mr. William N. Mulliken, contained of—

Sand,	65.00
Iron and alumina,	4.60
Lime as carbonate,	30.00

Specimen from Mr. Sol. Merrick, contained of—

Sand,	56.25
Iron and clay,	5.15
Lime as carbonate,	38.60

The average of four specimens from Baker's Landing, the property of Thomas Hughlett, gave of—

Sand,	60 00
Iron and clay,	6.00
Lime as carbonate,	33.50

Specimen from T. R. Plater, near Tred Haven, compact, hard, and filled with finely comminuted shells, was composed of—

Sand,	21.00
Iron and alumina,	3.76
Lime as carbonate,	74.00
Lime as phosphate,	1.25

Specimens from Edmundson's Neck, was composed of—

Sand,	36.60
Iron and clay,	3.50
Lime as phosphate,	1.70
Lime as carbonate,	57.70

Ditch Bank Specimen,

From Rev. E. J. Way, was composed of—

Sand,	68.50
Iron and clay,	.90
Lime as carbonate,	30.60

Specimen from the Upper Pit, (E. J. Way,) was composed of—

Sand,	76.50
Iron and clay,	2.30
Lime as carbonate,	21.20

Specimen from Major John Dawson, Miles' river. One specimen contained of—

Lime as carbonate,	41.00

Specimen of blue marl from same, contained of—

Lime as carbonate,	21.00

Specimen from Mr. Edward Hambleton. The shell marl specimen was composed as follows, of—

Sand,	47.00
Iron and clay,	4.50
Lime as phosphate, (bone dust,)	1.75
Lime as carbonate,	46.60

The specimen of "greenish colored sand," overlaying the above, contained only a trace of sulphate of lime, (gypsum,) and is not worth the labor of its application. Many other analyses of marls were made and given to their owners.

These are but a part of the numerous and valuable marl beds in this county. At least one-third of it is underlayed by marl, whose average composition will give fifty per cent of air-slacked lime. These marls are very easily obtained, and produce, unaided, very great renovation in the adjoining land, frequently increasing the crop from three to twenty bushels of wheat in a single year, and giving a corresponding increase also of the corn crop. Notwithstanding the great and *now* universally admitted benefits of shell marl to the land of this county, it is only within the last few years that it has been generally used. Mr. Singleton applied it with great benefit near forty years ago.

The only specimens of marl brought to me for analyses in Caroline county, were two specimens from near Greensboro'.

Specimen No. 1.

Contained 28.50 per cent of air-slaked lime.

Specimen No. 2.

Contained 34.36 per cent of air-slaked lime.

There is a very valuable deposit also on the farm of Mr. T. H. Slaughter, near Denton, which as yet has never been used to any extent.

Its valuable matter is 68.60 of air-slaked lime, and 1.75 of phosphate of lime, (bone dust.) But very few marls on the shore are better than this.

I shall now call the attention of your honorable body to the inspection laws of the State, so far as they immediately affect the Agricultural interest. They are exceedingly defective, and need prompt and radical amendment.

To protect the weak against the oppression of the strong, and to secure to all safety in their persons and property, are duties which the State owes to all of its citizens.

In some instances these principles are fully carried out, they should be in all, but this is not the case.

If one, by reason of a superior physical ability, wrests from another his property, the State very wisely and justly interposes its power, causes restitution of the goods forcibly taken away, and punishes the offender, to prevent the commission of similar crimes. Equally binding is its obligation to protect all who may suffer in their property, from the superior knowledge of others, since losses as great may ensue from deficiency of knowledge, as from deficiency of strength, to resist imposition.

Every care is taken by the State to protect our citizens from injury of any kind from the latter cause, but whilst the duty to guard them against injury from the former is acknowledged, the means used are, in many instances, inadequate to the attainment of the end.

The State, to protect its citizens from loss, by the superior knowledge of others, has provided inspectors of various things in common use—men especially chosen, from their superior fitness, to discharge the duties assigned them; these duties being to determine the quality of different things inspected, and to affix to them some mark or brand, by which their value may be known by all. In this way it interposes its superior knowledge, with the same justice that it interposes its superior force, merely to save its citizens from imposition and loss. The duty is as strong in the one case as in the other, and equal necessity exists for its performance.

An inspection that does not show the true value of the article inspected, is worse for obvious reasons, than no inspection at all, and in inspections of things made up of different substances, the quantity of those which *give the article its value*, should be shown. I wish the above plain truths to be applied to the inspection of two articles of great cost to the Agricultural interest, which it is my duty to benefit by all the means in my power.

These two substances are guano and gypsum, (plaister of paris,) the cost of which, to the farmers of this State, is but little short of eight hundred thousand dollars. Too much care cannot be taken to determine their value, and I cannot urge upon your honorable body, too strongly, the necessity of having them subject to a form of inspection, which shall make known for, show to, the buyer the true value of the article which he purchases, and indicate to him the per centage of its valuable constituents.

I shall first speak of guano: Notwithstanding the many various compounds which enter its composition, yet its value almost entirely depends on two of them. On the ammonia already present in it as a salt, with that which is capable of being formed by the decomposition of its azotised matter, and on its phosphoric acid or phosphates, which are combinations of this acid with some base. The small quantity of the other substances in it possess no particular value, as they can, if needed, be supplied much cheaper from other sources.

Does the value of guano depend on its ammonia which it already may have, or which may be formed in it, and its phosphoric acid or phosphates? We have in support of this, a unity of sentiment among the ablest chemists. Liebig, Ure, Johnston, and indeed nearly all who have written on the subject, agree in the opinion, that guano owes its value to its ammonia and phosphates. These two substances *must* give guano its value, or nothing else does, for, take away these two, and only a moiety of other matters remain, which can be cheaply obtained from many sources.

Not only are these substances the cause of the value of guano, but as either may exist in greater or less proportion, in any particular specimen, it makes that specimen better or worse for particular soils. Ammonia is supplied to plants in large quantities from the atmosphere, being absorbed by soils, and, with iron and clay, form "true salts." But if any particular soil has not this absorbent capacity, and has a deficiency of iron and clay, it cannot obtain ammonia from the usual source of supply, and will be unproductive, unless it be supplied from some other source. If guano is used, then, the purchaser should know which of the different lots contains the most ammonia. But many soils have the capacity to supply themselves with ammonia, but are deficient in phosphates, and, therefore, barren, and if the owners of soils find it more convenient to buy guano, than any other manure, they should know what specimen contained the largest quantity of phosphates, what samples contained the most of what they want. If the purchaser does not know, would he not be constantly liable to loss, in buying the wrong specimen? If it even acts well, he is not assured that another specimen would not have acted better. If, on his land, in one year, he makes a luxuriant crop, by the use of guano, the next year, by the use of a different specimen, even at the *same price*, he may make a very inferior crop. Guano, therefore, has a relative value in relation to particular soils, as it can supply them with a greater or less proportion of their deficiencies; it has an absolute value depending on the quantity of ammonia which is already or can be formed in it, and on its phosphates. Most clearly and unquestionably, then, its inspection should show the proportion of each of these constituents, so as to show its absolute worth, and its relative value to different soils. When a farmer is buying guano, let him know how much of each valuable substance he may be purchasing, then he will not be spending his money without knowing what he is getting for it, and can better suit his guano to his particular soil. The proportion of the two valuable substances is very variable, and yet the guano, at present, has but two, or, at most, three grades of value.

Some specimens of No. 1, or No. 2, or No. 3, must be much more valuable than others, and yet each lot of the same number sells at the same price. The purchaser should not be obliged, in buying guano, to pay twice as much for some specimens as he does for others, of only equal, it may be of less value. I have made many analyses of guano, and submit the following to prove what I have above stated.

Analyses of different specimens of guano, to determine its agricultural value:

Specimen A, contained of—

Ammonia,	4.00 per cent.
Phosphates,	36.00 "

Sand,	7.00 per cent.
Water and organic matter,	50.00 "

Specimen N, which sold for, I believe, twenty dollars per ton, contained of—

Ammonia,	.3 tenths of one per cent.
Phosphates,	40.0 per cent.
Water and organic matter,	33.0 "
Silica, (sand,)	26.0 "

Specimen G contained of—

Ammonia,	7.00 per cent.

Phosphates and other constituents, not estimated.

Specimen O, contained of—

Ammonia,	15.25 per cent.
Phosphates,	46.12 "
Silica, (sand,)	.50 "
Organic matter, water, and other constituents,	38.13 "

Specimen J, sold in Kent county for twenty-nine dollars per ton, contained of—

Ammonia,	4.00
Phosphates,	40.00

I have not the notes of this analysis, but am quite certain that the above *very nearly* represents its value.

I have made many other analyses, but the above are sufficient to maintain the correctness of the position which I have assumed.

Specimen "O," and specimen "A," were No. 1, and sold at the same price. A glance at the difference in the quantity of their constituents, will show that their value must have been very different.

Specimen A sold for forty dollars per ton. Specimen J sold for twenty-nine. Yet specimen J is the better of the two. More numerous proofs can be adduced, but the above are sufficient to show the great difference in this article, and to prove also that the only safety which the buyer has, is in such an inspection as will show him the proportion of phosphates and ammonia in the article. The ammonia in the above, not only shows the quantity already present, but also all that which *can* be formed during the decomposition of the organic matter in the specimen. The mode of inspection which I have recommended above, is easily practicable, and any one who buys guano to even a small amount, would be a gainer by paying for its analysis before purchasing it. I do not pretend to give here the details of a proper law, but am ready when called on, to appear before the committee on Inspections, or that on Agriculture, and give them the benefit of all the knowledge which I may have on this subject. I have had numerous conversations with men of great ability, in relation to this matter, and am happy to have them all coinciding in opinion with me.

The form of inspection which I recommend, would save to the farmers of the State, every year, more than one hundred times the cost of what would be a fair remuneration for making it. There *must* be a chemical analysis of guano made, before we can ascertain its value, and its result should be shown. The merchant who sells, knows no more about its worth than the farmer who buys, and both may be deceived in regard to it. The smell gives no indication of its value, and we can no more judge from its appearance, what the quantity of its valuable constituents may be, than we can of the quality of the contents by looking at the outside of a barrel.

Since, then, neither the buyer nor seller can know, the State should ascertain and show the quantity of its valuable constituents.

In reference to the inspection of gypsum, the same argument holds good. This is a sulphate of lime, with two equivalents of water. The rock from which it is obtained, owes its value to the quantity of sulphate of lime in it, and in buying what is sold for gypsum, we wish the barrel as free from any other less valuable substance as it possibly can be, we should only pay for the barrel in proportion to the quantity of gypsum which it contains. Is that which is sold as gypsum, pure gypsum? or does the quantity of it vary very greatly in different barrels?

Let the following analyses answer:

Report of the analysis of ten different specimens of gypsum, to show its agricultural value.

No. 1,

Contained of—	
Sand,	5.77 pr ct.
Lime, as carbonate,	16.41
Alumina, with a trace of iron,	3.66
Lime, as sulphate, i. e., gypsum,	74.10

No. 2,

Contained of—	
Sand,	10.60
Lime, as carbonate,	17.25
Clay and iron,	1.36
Gypsum,	70.79

No. 3,

Contained of—	
Sand,	4.50
Clay and iron,	2.28
Lime, as corbonate,	4.00
Gypsum,	89.20
Specimen E, contained of—	
Sand,	13.68
Iron and clay,	5.29
Lime as corbonate,	21.59
Gypsum,	59.40
Specimen R, contained of—	
Sand,	4.65

Lime, as carbonate,	12.20
Clay and iron,	1.12
Gypsum,	82.00

Specimen T, contained of—

Sand,	10.00
Lime, as carbonate,	28.00
Iron and clay,	1.30
Gypsum,	60.70

No. 7,

Contained of—

Sand,	2.20
Iron and clay,	1.25
Lime, as carbonate,	10.00
Gypsum,	86.40

No. 8,

Contained of—

Sand,	2.04
Iron and clay,	2.10
Lime, as carbonate,	5.40
Gypsum,	89.90

No. 9,

Contained of—

Gypsum,	85.04

Other constituents not estimated.

No. 10,

Contained of—

Sand,	6.20
Iron and clay,	1.15
Lime, as carbonate,	7.35
Gypsum,	85.30

It is shown from the above analyses, that some specimens contain thirty per cent less of gypsum than others, yet he who buys, pays the same price for it, as if it contained the full amount of gypsum. The inspection should show in this, also, not only the *weight* of the barrel, but *what is in it*. When one gives $1.37 for a barrel of gypsum containing three bushels, about forty-six cents per bushel, he should know how much of gypsum he is buying,—not to be forced to pay $1.37 for a barrel of something, one third of which is only worth, at the highest rate, six cents per bushel ;—nor made to pay for common air slaked lime and sand, at the same rate as he pays for gypsum.

I must not be understood as charging the traders in this article with adulterating it. No such thing is necessary to my purpose. A great difference exists in the rock from which the gypsum is ground ; and if there was none, still it is *possible* for it to be adulterated, and the State should take the same precaution to guard its citizens from loss from this source, as it does in other articles of which the people at large are good judges, frequently as good as the inspector himself. As the gypsum, (sulphate of lime,) is that which every one seeks to buy when purchasing a thing under that name, the State should so order its inspection, that each barrel should show how much of this substance was in it, so that its price thereby might be regulated. No reasonable seller should object to such regulations; and every buyer ought to insist upon them. By them, the owner of a good article would get the value of his good commodity, and he who wished to buy, would not be deceived in the purchase of that which might be of little worth. While it would deprive the seller of no right, it would give great benefits to the buyer. The seller would get the value of his article,—the buyer the worth of his money. The fact is familiar to all who use plaister, that it acts much more favorably in some years than others. This has been attributed exclusively to the seasons, but very often the difference is owing to a difference in the article used.

The smallest per cent of gypsum in the specimens which I have examined, was 59.40; the highest was 89.60 per cent, a difference of more than thirty per cent. If only one half of that sold was of an average quality, a fair way of judging, then fifteen per cent of the money spent for gypsum is thrown away. The cost to the farmers of Maryland of this article, (freight and labor included,) as near as I can judge, is $700,000, so that considerably more than $100,000 is lost to the citizens of the State annually, in the attempt to buy what they do not get. They buy gypsum, and only obtain sand and common air-slaked lime.

I have thus called the attention of those interested to a subject to them of the deepest interest. I have shown the defects of the present laws. It remains for them to have those defects remedied. I can assure all interested, that these differences do exist in the manures spoken of above, which are not shown by the present form of inspection. In making your honorable body acquainted with this fact, I am only performing a part of my duty to the farmers of the State. Let them provide a law which, while it will do wrong to none, will do justice to themselves.

I do not know how the inspection of lime is performed, but its constituents should also be determined in the same manner.

This, however, is not practicable in every instance, as a large quantity of that used in the State comes from beyond its jurisdiction. I have obviated this difficulty as far as I could, by publishing analyses of the various limes used by the farmers of Maryland. It is, therefore, a useless office, serves no good purpose, and should be abolished. It is my further intention, during the present year, to procure a number of specimens from each of the quarries, both within and without the State, which supply lime to our farmers, and subject them to a more minute, rigid, and elaborate analysis than has been yet made of them. I have not done so during the present season, because of the impossibility of procuring the specimens.

There is another thing, perhaps, included under the broad term of "such other matters touching the Agricultural interest of the State, as may be considered necessary," which is the difficulty that sometimes happens, between the purchaser and the seller of wheat and other grain, as to its merchantable condition.

A load of grain is frequently contracted for by the merchant, and afterwards thrown upon the hands of the producer, or his agent, from the alledged difference in the condition of the sample and the load. When a merchant thus refuses to take the grain, there is no remedy left, but to sue for breach of contract, a course for obvious reasons, not always practicable. In the present state of things, wheat brought in the evening, is frequently returned in the morning, *especially when the market declines.* It thus happens that the producer sometimes looses by a decline in the price of grain between the contract for sale and delivery and never gains by any rise, for when any rise takes place, the *grain is never returned.*

That the load of grain sometimes does not correspond to the sample, I have no doubt; when it does, and a decline in price takes place, between the bargain for sale and its delivery, that it is sometimes thrown back upon the producer, is well known. There should be some fixed law, with a competent officer, to determine the merchantable quality of all grain offered for sale, and thus give fair play alike to the purchaser and grower.

This officer, moreover, could keep a strict account of all wheat, corn, &c., brought to the market, and give statistical information in regard to the amount of these crops, which would be of great value in an agricultural, as well as a commercial point of view.

I do not mean to accuse all of the dealers in grain of dishonesty, but to trust to the universal existence of its opposite virtue, is to have a greater amount of confidence than the experience of any would warrant. There is an obvious necessity for some legislation on this subject.

The office which the undersigned has the honor to fill, being a new one in this State, the bill creating it was, of course, liable to imperfections, which experience only could correct, and I would fail in my duty, were I not to make such recommendations to the Legislature, and people of this State, as would lead to the construction of a law better calculated to carry out their liberal views.

1st. I shall call your honorable body's attention to the purposes of the present law creating the office of State Agricultural Chemist. 2nd. Show in what particulars its errors consist, and recommend such changes as my experience convinces me are necessary. 3rd. *Show the utility of the office to the agricultural interest of our State.* The intent of the law of 1847, ch. 249, is best shown by its 4th section, which declares:

"That it shall be the duty of said Agricultural Chemist to analyze specimens of each variety of soil of the county in which he shall be, that may be brought to him, or that he may find to exist, and also to examine and, if necessary, analyze specimens of each kind of marl, or other vegatable or mineral deposit, that may come to his knowledge, in order that his instructions may be of more practical utility."

The law in this section was not sufficiently explicit. Its letter could have been carried out, and not one single fact of practical value elicited. The farmer would have been as ignorant of the composition of his soil, of its defects, and of the manure necessary to supply these defects, as if it never had existed. The mere performance of an analysis would have been of no use, unless it could have shown the *quantity*, as well as the mere presents of the several constituents of a soil.

A qualitative analysis could have shown the latter, and done no good. A quantitative analysis was wanting, to show, not only the presence of the different substances necessary to a fertile soil, but at the same time to determine their quantity, to define their proportion, to see whether they existed in sufficient quantities to produce a crop, and to enable the farmer to supply any deficiency which might exist by the application of the particular substance or substances wanting. The quantity of the substance to be applied, depends, of course, upon the quantity of that already present, which can be shown only by a quantitative analysis. A qualitative analysis would have conformed to the letter of the law. This would have been of no use. A quantitative analysis only could carry out its spirit, which I have done in all of my operations, though it takes ten times the trouble, care, and labor, of a qualitative analysis. Another great defect of the law is, that sufficient time is not given to carry out its provisions. The quantitative analysis of a soil is said by Parneill, an analytical chemist of the highest authority, to be "the most difficult and tedious of all analytical operations." All who are at all familiar with chemical research, know the great care, labor, and time required to perform it. The utmost attention must be given to each step in the process. The most exact and cautious manipulation is necessary to avoid all sources of error, and its termination cannot be hastened, except at the expense of its correctness. Many different varieties of soil and marl had to be examined in some of the counties, which would take more time, of themselves, than that allowed by the law to remain in them; but, besides this, the different parts of each county had to be visited in person, a suitable place to be obtained for the erection of the apparatus to perform the analyses; lectures to be delivered in the different districts, and a report to be written ; and, in addition, numerous enquiries by letter, for information, had to be answered ; all in the short space of six weeks. Those, who attentively consider the nature of the duties to be performed, and the time allotted for them, cannot fail to be struck with its total inadequacy to that end. To have gone over some of the counties, in the time which the law allowed, would have been useless to the farmers, and have produced no present or future good results. It was utterly impossible for any one to have performed the duties of the law in the time, and with the *means* allotted for them. I, therefore, carried out in this, the spirit and not the letter of the law. The mere letter of the law carried out, howsoever faithfully, would have been a mere shadow without a substance, and would have subjected any one to merited ridicule and contempt, who, under any circumstances, might have professed to have done it.

Another, and a great defect in the present law, is requiring the State Chemist to fit up his Labaratory in the different counties, and there make the analyses, instead of allowing him to fix it permanently in one place. Though it is *possible*, to carry the necessary apparatus through the country, and make the analyses, yet it is at the sacrifice of much time, which could be more profitably spent in other duties, and requires much fruitless labor, which should be avoided. The rooms in which I had to place my apparatus, were such as I could procure, and *always* unfit for that purpose. Great injury, even with the utmost care, has sometimes happened to the materials, and considerable damage was frequently done to the more delicate and costly parts of the apparatus. Without the most delicate and accurate balances, no analyses can be performed, for upon their truth and correctness hang the whole value of an analysis. They should, therefore, be preserved from every thing likely to impair their accuracy. Faraday, the first authority on this subject, and, indeed, on every other connected with chemical manipulation, says, without the most delicate balances, no analyses can be made, and all who are in the habit making analyses as delicate as those which I have to perform, keep their balances *out of* the room where the analyses are made, though this room (that for analysis,) has all the means and appliances to carry off all vapors which may corrode or injure the balances. It is especially enjoined never to touch them, except for the purposes of weighing, when their case should be immediately closed, and that when once they are fixed, that they should not be moved. It can be readily perceived, now, what difficulty I endured to keep mine correct, and the time which I had to spend to preserve them from harm, and the derangement which they must have suffered in their frequent removals from place to place.

The law also, in its 5th section, makes it a duty to publish notices of lectures, but makes no appropriation for defraying the cost. I do not know whether the Legislature intended that the State Chemist should pay for it himself. I have always given full notice in all of the county papers, where I have been, both of my presence in the counties, and of the time and place of giving my lectures, and paid for the publication from my own funds. Nor is any provision made for defraying the expense of removing my laboratory, or for the rent of rooms for it.

There is, moreover, this general defect in the law, viz: *that it requires an amount of duty to be performed, in a given time,* *which no man can perform, as it ought to be done. And no one having any respect for his own reputation, and capable of performing its duties, will ever pretend to do it.*

Knowing the time to be inadequate, to perform all of the duties, I devoted myself to that particular class, which would confer the greatest benefit to agriculture, viz: the analysis of soils, marls, &c., leaving myself little or no time for the preparation of lectures, though from them one might gain much greater credit in the community, than from any thing else. I have been content to give the result of my investigations in the plainest style, being satisfied that it was better to spend my time in acquiring a large number of facts, otherwise unattainable, than in ornamenting a small number, by studying and writing out lectures. It was better to attend to their substance, than to lose time in improving their form.

With a law as defective as the one for the creation of the office of State Agricultural Chemist, it is apparent, that to carry it out to the letter, would have been to render it null and void, and have subjected myself to the imputation of charlatanry and ignorance.

I, therefore, in good faith, devoted myself, with all the energy and knowledge which I possessed, to fulfil its spirit, and so to execute it as to meet the wants of those for whom I was appointed to labor.

All will bear witness that I have diligently discharged its duties, devoting myself *exclusively* to them. I have had no other end in view but that of serving faithfully the agricultural interest, promoting its welfare, and saving it from imposition and loss. The performing of the letter of the law, would have taken but little time and trouble; in carrying out its spirit, great labor and incessant application was necessary. It cannot be charged, therefore, that it was from any unworthy motive that I disregarded the letter of the law, since, by so doing, my duties were an hundred fold more arduous, my responsibilities and my labor greatly increased. I preferred to act right, and to perform my duties, so that they might lead to the knowledge of sound principles, and the true philosophy of agriculture. I rely with implicit confidence on the knowledge and good sense of the agricultural community, for my justification. I have, at least, the testimony of my own conscience, that I have exerted all my ability to "act well my part," a solace, greater than all human praise could be, for duties imperfectly performed, even though they should meet with public approval.

Your honorable body will also recollect, that the present law was originally formed for a principal and assistant, but that on its final passage, the section for the appointment of an assistant, was stricken out, while that detailing his duties was retained. There was thus left for me a *double* duty to perform, and, had I taken *double* the time indicated in the law, I still would have been within the time allotted by the original bill.

Having thus pointed out to your honorable body the defects of the present law, I will respectfully offer such suggestions for its amendment, as my experience in its duties have taught me to be necessary.

Frst.—The laboratory should be fixed permanently in one place.

The analysis of a soil, is one of the most difficult and delicate of all analytical operations. Any error in it, besides subjecting those who might be governed by its results, to loss, in making improper applications of manures, would also retard or destroy confidence in its ability to render aid to the art of Agriculture, and thus cause farmers to reject assistance from the source most capable of rendering it at the cheapest rate. As *every thing* de-depends on the accuracy of an analysis, *every* care should be taken to insure that accuracy. A much greater number, also, could be performed in a fixed laboratory, and every analysis, is one certain step towards forming a true system of Agriculture. If one analysis be of service, a greater number would confer proportionally greater benefit. With a fixed laboratory, no time would be lost, in moving it from place to place; the soil or marls capable of being easily moved, without injury, should be moved to the laboratory—which can be moved only with risk of injury—and not the laboratory to them. During the past year, could my laboratory have been permanent, many young gentlemen capable of affording me valuable assistance, would have been with me; who would in time have become so many sources for the diffusion of scientific knowledge, derived from the application of Chemistry to Agriculture. In this way the State would secure a much greater amount of profitable work, for the same cost; the benefits of the law would be more quickly and generally diffused, and means would be given for furnishing to a large number of our citizens, without cost, knowledge of practical analysis, now scarcely attainable at the highest expeuse. So that, while the principal was employed in collecting specimens, taking a general survey of the country, and giving to the community, by lectures or otherwise, the fruits of his investigations, the data of these results would still be accumulating, and their education would not be suspended with his absence from the laboratory.

3rd. The lectures are too numerous, they should only be given at such times and places as to secure a good attendance. Written instructions for publication should take their palce, whenever, in the judgment of the Chemist, it would best subserve the ends of the law.

4th. The time for the examination of any particular county or district, should be left, also, in a great measure to the judgment of the Chemist, under certain restrictions.

It is an acknowledged principle, that the followers of every profession or art, are the best judges of the manner in which the duties of their respective callings can be performed. This is conceded to those who follow occupations, of which all in the community have some knowledge:—much more then, should it be granted to those who follow a profession, of which, almost every one in the community is profoundly ignorant. It is useless to bind one as to time in doing a particular thing, where no ability exists to know whether that thing be correctly done or not. The State Chemist may be restricted within a certain time to make particular investigations, but no restriction can force him to make these investigations, if he chooses not to do it. None but himself ever knows whether they be made or not, and since the performance of his duty, must be left to his integrity and sense of honor, there is no good reason why the mode of doing it should not depend upon the same security.

A law embracing the general features which I have given above, would much more expeditiously and perfectly supply the wants of the Agricultural community, than the one at present in existence. In this I am sustained by all who are competent judges.

I have given thus frankly and freely my opinions as to the present, and my views as to the construction of a future law, having in view only, the benefit of those for whom the law was made.

To any one who will do his duty faithfully, the office is one of incessant toil and labor, and the object which I have in view is, to make that toil and labor effective when incurred.

Your honorable body will perceive, from a comparison of the letter of the law, with the manner in which it has been carried out, that I had in view, principally, its objects, and only a general regard to that time and mode by which those objects were to be attained.

I believed it was more in accordance with the law, to fulfil its spirit and intent, though its form might be violated, than to pay attention to form, while its substance should be disregarded. Under this belief, I acted. I sought the counsel of some of the maturest judgments in the State, who coincided with me in opinion; and I feel sustained in my course when I recollect, that to have acted in any other manner would have been to injure the interest which I was selected to benefit. There is at this time great and increasing interest felt in Agriculture throughout our State. The great question every where amongst our farmers is, how can soils that have been worn out by improvident cultivation, be restored, most cheaply and quickly, to their original fertility, and how that fertility can be retained? The only answer to these questions has hitherto been that afforded by naked, isolated experiments; its voice has led some to success, while others who have obeyed it, lament time lost, labor gone, and capital expended in vain. There have been no certain rules to solve these questions, no rational way to unravel the seemingly complex laws which govern the production of crops.

At this juncture, the State pointed out and presented to the Agriculturalist, the Science of Sciences, as a key to the unlocked mysteries of Agriculture:—as a lamp, whose clear, certain light, was to illuminate the path hitherto obscured by "shadows, clouds, and darkness." Had this science been so applied as to have utterly failed in its object;—had all felt that no benefit could have been derived from it;—that it was powerless for good:—as would have inevitably been the case had the letter of the law only been observed—Agriculture would have received a severe check. The ardor of those foremost in the march of improvement, would have been dampened, and the only oracle of truth to the anxious enquirer after the philosophy of Agriculture, would have been contemptuously spurned. Then would have followed a retrogade movement in the farming community, bearing it back beyond the point from which the present progress commenced. Other States, too, were looking on the experiment in Maryland with an anxious eye, ready to follow her example, if successful, but not able to profit by her errors, had the present law failed,—as it must have done, had the strict letter of it been observed. The State of Virginia, at the last session of her legislature, had a bill under consideration for the general application of Chemistry to her Agriculture; which did not then pass, doubtless because she wished to see the result of the law of Maryland. One of the southern States, Mississippi, has a similar law in contemplation, and all will follow the example so worthily begun by our State. When, therefore, the future application of Chemistry to Agriculture, not only in our State, but in others, depended upon a *demonstration* of its utility, every motive of patriotism, and the plain demands, of duty alike required, that the demonstration should be effected.

When I became the humble Minister of Chemistry in its application to Agriculture, justice to the one and duty to the other alike demanded, that I should only speak its precepts, only give utterance to its oracles, which could be done only, by laboring in each county, for a longer period than the law allowed. Its oracles would, with true inspiration only speak, after a more protracted devotion at its shrine than that contemplated by the law. Appointed to speak the truths of Chemistry for the benefit of Agriculture, I was obliged, either to speak those truths, which by its immutable laws are attainable with great labor and time—or to have submitted to the public, mere fictions of the imagination, and thus have been a traitor to the science—faithless to the Art—false to myself, and to those whose influence placed me in my present position. The choice was not difficult. I have discharged my duties in a way capable of doing the greatest amount of good. The results are before the public—and to the judgment of enlightened and instructed public opinion, I am content to submit. By its decision I willingly abide.

At the present time it may seem almost a matter of supererogation, to speak of the utility of Chemistry to Agriculture. The State has made provision for its application, and favorable testimony from those who are too sincere to flatter and too intelligent to be deceived, has been given to its efficacy.

Why should not science benefit Agriculture? Its study will afford all the pleasure, which the Roman orator claimed as the peculiar property of literature "Studia literarum," says Cicero, "adolescentiam alunt, senectutem oblectant, secundas res ornant, adversis profugium ac solatium præbent, delectant domi, non impediunt foris penoctant nobiscum perigrinantur, rusticantur,"*—whilst its practice will give those comforts, which, though more homely, yet cannot be supplied by mere literary studies. Its study affords all the delights of literature, with the addition of the necessaries of life. Farmers should not be mere hewers of wood and drawers of water. Let them know, not only the necessary elements of fertility, but let them also understand how these act, in supporting vegetable existence, and how mere matter is indispensable to that function of organization, which we call life. Let them not look upon the earth as a mere source of food, while living; a mere place of repose when dead: but rather as a casket, whose treasures they may obtain if they apply their minds to the investigation of its formation. Let them seek to understand the properties of each component part of the soil, and it will be a volume of endless pleasure and instruction: then indeed will the toil, as well as "the sleep, of the laboring man be sweet,"—for he can read "sermons in stones," and see "good in every thing." It has been the peculiar province of science, ever to benefit the human race; ever to afford pleasure in its pursuit, and profit in its application; to lighten toil, to lessen labor, to assuage care; to relieve the wants of the body; to supply the desires of the mind. It is to the mind, what hope is to the affections, dispelling gloom—and in the darkest hour, giving assurance of a brighter dawn. The student, in his closet, demonstrates a principle—and, straightway, millions of his fellow creatures receive the benefit; are blessed with its advantages; and but too frequently, alas, bless not in return! The principles of science perfected the steam engine, giving life and beauty to that, which before was only a crude misshapen mass—straightway nations used it, to multiply their comfort in a thousand ways! Scientific knowledge in the hands of Archimedes, was a safeguard to his countrymen, more powerful than walls of stone or armies of men:—its power, with the same universality as death, is felt in the hovel and feared in the palace:—its influence, equally potent to relieve the sickness of the infant, and to stay the power of the thunder-bolt. Let it not then be refused the Agriculturists. If he, through misfortune, cannot obtain it for himself, let the State, that he supports with his labor, and defends with his life, supply it. Let him but receive it, and the return will be, all blessings to herself, all benefits to him.

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* Literature nourishes and strengthens our youth, affords delight in old age, adorns prosperity, gives help and consolation in adversity; delights us at home, is not in our way when abroad; gives pleasure to us at night, in our travels abroad, and wanderings at home.

Of all the sciences, Chemistry has ever stood foremost in meliorating the condition of the human race. It has been to the body almost what Christianity has been to the soul of man. Other sciences are partial, this is universal; other sciences benefit the few, this blesses the many; other sciences are of use to but one particular class, this embraces all. The highest, and the lowest, are equally its debtors. Applied to mechanics, it gives one the strength of thousands;—to medicine, and, in disease, it lulls the infant as calmly to sleep, as when in health it rests on its mother's breast. It frequently snatches one from death, when it impends, and softens its pangs when inevitable. Let it then be applied to furnish the "staff of life."

But it is not enough to make mere scientific researches. After being made, their results should be carried to the doors of the people.

THEY SHOULD BE DIFFUSED THROUGH THE LAND.

The experience of all should serve to guide each one that tills the soil, and to all should be given the benefit of whatever knowledge is otherwise beyond their reach. To effect this diffusion, agricultural societies, or clubs of practical farmers, are of great use. In their meetings, the knowledge of one becomes the property of all, each adds something to the general stock and receives something beneficial in return.

By the very act of communicating knowledge once acquired, we *improve* our minds, cultivate our understandings, enlarge our capacity for the observation of new facts, and increase our ability to investigate them correctly, when observed. But the benefit is not merely one of a mental or pecuniary nature, the social good accomplished is of vast consequence. Farmers would think favorably of each other, as they become better acquainted. They would be more united to resist aggression, more united in all efforts to promote their common welfare, and ever "in union there is strength." Frequent association and the habit of free discussion, do much to promote the intelligence and good feeling of every class. This is especially remarkable in the legal profession. Though often adversaries, they are always united in whatever concerns the best interests of their pursuit. We can easily see what excellent results would follow from a more intimate union of those, who have a common interest to advance and who meet not to confute, but to aid and assist each other. I have witnessed the great good done by associations of *practical farmers*, with frequent meetings for the discussion or Agricultural subjects, and as great aids to improvement, would recommend their formation in every neighborhood of our State.

The Press, too, is all powerful in the diffusion of Agricultural information.

This great instrument of human knowledge, speaking a language whose utterance can be recalled at pleasure, has done much and can do more to spread the amount of existing knowledge, and by inducing investigations to increase it.

It is well for farmers to recollect, that as they increase the subscription of papers devoted to their interests, they increase their ability to benefit it, so that each one who takes a paper has a personal interest in increasing its subscription as much as possible.

But it is not only the present race of farmers who should be thought of. The next generation should be taught *now,* the true principles of agriculture. There are at this time, thousands of children in the State, who should be receiving elementary instruction in Agricultural Chemistry, taught them in a plain and comprehensive manner. There will then be done for the next generation, what can, at best, but be imperfectly done for this. I must not be understood as advocating the teaching of analytical chemistry in our common schools and academies. This is *impossible* and should not be attempted; but only the *elementary principles* of chemistry, in its application to agriculture. Farmers from these schools, would be better able to understand treatises on their profession, and comprehend the language which belongs to the science nearest allied to their art. They would become acquainted with many facts of great practical benefit, and by having their minds directed to this study when young, would more certainly apply to it when old. The benefits from this, all can see.

The benefits that have arisen from the execution of the present law of Maryland, are vast and important. It has determined the composition of many deposits of marl, giving to the owners thereof, guidance for its application, which before they had not.

By determining the compositions of many variety of soils, it has been able to recommend the specific manures for them. There have been expended hundreds of thousands of dollars, in the application of magnesian limes to soil, which already contained a sufficient abundance of magnesia. There have been expended hundreds of thousands of dollars, in the application of limestone containing no magnesia, to soils equally destitute of it: thus withholding from them a necessary constituent, when no expense would have been incurred in applying it.

Some soils are injured by deep ploughing, and these I have accurately described to their owners, as far as it was possible to do so. Other soils require deep ploughing. The surface soil, from long and shallow cultivation, was almost entire exhausted of lime, magnesia, and potash, and besides, its mechanical texture was unfavorable to vegetation. The subsoils capable of counteracting the faults of mechanical texture, and having constituents to supply the chemical defects were analysed, and their value insisted on. In many sections of the State, the subsoils lying only three or four inches below the surface, contain from eight to twenty-five bushels of lime per acre, for every inch in depth, besides also magnesia and potash. These had been undisturbed for years, and would have remained untouched forever, unless some chance experiment had dictated their cultivation: the experience of others on different soils being against the mode of cultivation to bring them into use. In no single solitary instance has the farmer been disappointed in the mode of cultivation, predicated on the analysis of these particular subsoils. Men of the highest knowledge and education bear testimony to their value; men of the surest practical knowledge have become converts to a system of cultivation opposed to their former usage, and unsanctioned by any custom of which they were cognizant.

The products of these lands in their first crop have been greatly increased, and will, if the rules laid down by the teachings of science be followed, give as large crops as when they were first cleared. There has been besides, as one of the fruits of this office, and by no means the least important, a spirit of enquiry and investigation set on foot, which, carried on by men who know "no such word as fail," will confer great benefits on practical Agriculture.

I have also analyzed and determined, the value of many specimens of bog iron ore: there is a prejudice against the iron made from this ore, amongst farmers, who say, that the iron from it is always very "brash." This is owing, I am certain, to the carbon, (charcoal,) in the iron, and not to any intrinsic quality of the ore from which the iron is made. This charcoal is to be destroyed by more skilful preparation of the iron. This not being in the strict line of my duty, I did not follow up my investigations on this most interesting subject. I am satisfied however,—other things being equal,—that the *specific gravity and tenacity* of iron is in direct ratio to the quantity of charcoal which it contains.

Farmers have been directed to the true sources of knowledge, and when sufficient time elapses for its application, fruits will be seen in more improved lands, and happier homes, than yet have blessed many sections of our State. I have been informed by one of the largest booksellers in the State, that he has sold more scientific works on Agriculture since the existence of the present law, than have ever before been sold in the city where he lives.

The community, too, have been saved much in avoiding nostrums, which, under the guise of manures made on scientific principles, are frequently based on ignorance of the first principles of science, are false in theory, and even have not always the merit of being compounded in accordance with that theory.

These truths are the best evidence of the necessity of this law, and I can refer for their evidence, to every county of the State where I have been. The testimony is living, present, and unimpeachable, and I may safely say, will be given from more numerous sources as its practical operations develop it.

We can confidently look forward, as the fruits of this office, to a system of Agriculture founded on sound principles of induction. The facts collected by it, when systematised, will make the culture of the soil as certain, as any of the arts which depend on the exact sciences for aid.

It will settle, in reference to the soils which may be investigated, the following questions: —*The best kind of manure; the best time, and form, for its application; and the quantity to be used; so as to produce the greatest yield at the least cost.*

It will enable us to guard against and counteract some of the diseases to which our most valuable crops are subject, and save in this manner thousands to the State. I have, as far as my limited time allowed, been making some observations on the nature and causes of rust in wheat, a disease which frequently, in a few hours, destroys the labor of a whole year, and I am certain that a remedy will be found for this destructive enemy of the wheat crop. I shall give a brief abstract of the reasons on which this belief is founded, so that they may be corrected by the observations of others, if unsound: and I hope that some who may have greater opportunity than myself, may study the subject, and give the public the benefit of their investigations.

Rust in wheat has been attributed to many and various causes, but as some of them are not always present, and in some cases all are absent, it cannot be said that the exact cause of it has hitherto been determined. Many circumstances may attend the development of this disease, but until some connection be shown between them and the production of the disease, they can only be viewed as accidental and not as essential attendants.

If we find rust occurring always under particular circumstances, all of which are in action when it is produced, we must attribute its production to the influence of those circumstances. We shall then know, from a knowledge of the causes, how they can be counteracted. To understand fully the nature of these causes, it is necessary to remember that the stalk of wheat is filled with numerous sap vessels, by which the matter in the soil necessary for the perfection of the grain, is carried to it. If those vessels be broken, burst or injured in any manner, the supply of nutriment to the grain being cut off, it cannot be perfected. I believe that the rust is nothing more than a fracture or bursting of the vessels of the stalk, destined in the economy of the plant to carry nutriment to the grain—I believe it for the following reasons: It always occurs in warm damp weather, at a time when the external pressure of the atmosphere, from its lightness, is least, and when the outward pressure of the *juices* of the stalk, from heat, is greatest. We have here two efficient causes for the bursting of the vessels, either one of which being absent, rust is never produced; for no matter how damp the weather may be, if it be cool, there is no rust; and no matter how warm it may be, if the weather be dry, (in that condition in which the pressure of the atmosphere is greatest,) there is still no rust. Again, rust occurs in that particular stage of the growth of wheat when the stalk commences to harden; it does not happen before, because the vessels would expand without breaking, it cannot happen afterwards, because they have become sufficiently strong to resist the expansion of whatever sap they may contain.*

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*These fractures are distinctly visible by means of a good microscope. This instrument, which has afforded such great facilities to many other branches of science, had never, as far as I can

Here are two causes in action sufficient to explain all the phenomena which attends in wheat, and which are explained by none other. We know that if the vessels which convey the materials that form the grain be destroyed, the grain cannot be formed. We see here causes in action sufficient to produce that destruction, and we never see it produced without the existence of those causes. But this is not all. Whenever we find any causes present, able to counteract the influence of either of the above, rust is not produced; whenever, in the composition of the soil, sufficient materials exist to give a firm strong stalk, rust is never seen.

On land exposed to the influence of the spray from saltwater, wheat always escapes the rust, though that in the same neighborhood may suffer. A narrow belt of trees frequently separates fields, that are uninjured, from those which are entirely ruined: this belt of trees arresting the spray from the water. This spray contains soda, one of the substances which assists to form a strong hard stalk. Upon soils precisely identical, except in location, and in what was derived from salt water, I have found the above fact to exist, which can only be accounted for by materials in the salt water. Wherever the soil contains the materials in proper proportion for forming a strong stalk, rust does not injure the crop.

In localities where rust was before troublesome, it has almost ceased to exist, after the application of green sand marl, which is rich in those substances which form the stalk. Again, common salt has been recommended to prevent rust, by its *antiseptic* power, that is, its power to prevent putrefaction. Its effect against the rust, may be better explained by its power to strengthen the straw. I shall institute during the present season a series of experiments on this subject, and confidently expect to determine the true nautre of this blasting, blighting disease. If it be from the causes which I have given above, then the remedy will, in preventing the effects of the injury, greatly increase the product of this, the staple crop of the Union.

The material to prevent this is in very great abundance in our State, and now deemed worthless. At this time its owners will pay for its removal.

If in the present report, or in the labors which preceded it, any good shall have been conferred on the Agriculture of the State, those labors will be abundantly rewarded. If I have only awakened such an interest in our Agriculturists, as will induce them to study and apply the sciences of their art, my ambition will be satisfied.

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learn, been applied to the diagnosis of the constituents of soils, until used by myself. I have not been able as yet to make but few investigations with it; though it may not confer the same advantages on the prosecution of the study of the components of soils, as the telescope has done in the study of Astronomy, yet I am certain that it will be of *very great utility*. During the present year I intend to devote much time in order to see how far that utility extends.

In conclusion I must state, that since my appointment to the office of State Agricultural Chemist, I have been cheered by the warmest and kindest greetings in every county of the State where my duties have called me. All have welcomed, all have tendered me their hospitality to the fullest extent.

In the performance of the duties of my office, many privations, known only to those acquainted with them, had to be endured. The office was looked upon by many with distrust; to many its purposes had to be unfolded; to all its utility had to be demonstrated. Cheered by the kindness and full appreciation of those by whom I was surrounded, *sustained by the* ONE *first in my heart* and *heartiest in my prayers,* I have to be devoutly thankful for the *pleasures* which attended my labors.

I here tender to all my most sincere and heartfelt thanks, and give my most sincere prayers for their present prosperity and future happiness.

I shall ever remember their friendship and kindness with devout gratitude, and while wishing for them, that the produce of their fields may be as generous as their hearts, devoutly pray, that they may enjoy the happiness of everlasting life.

JAMES HIGGINS

GLOSSARY.

ANALYSIS, as a chemical operation, consists in the separation of compound substances into their component parts.

QUALITATIVE ANALYSIS, is the operation of showing merely *the nature* of the bodies making up any compound.

QUANTITATIVE ANALYSIS, is the operation to discover the *exact amount* of each separate constituent.

A SPECIAL QUALITATIVE OR QUANTITATIVE ANALYSIS, is that which shows the nature or exact quantity, as the case may be, of any number of bodies composing a compound, short of the whole number.

ELEMENT, a simple body—Elementary bodies are those which are not composed of two or more *different* substances.

ATOM, the smallest particle of matter, necessarily incapable of further division.

CHEMICAL AFFINITY, or AFFINITY, is that property of the atoms of bodies which causes them to form new combinations, producing new bodies different from those which existed previous to the developement of this property. It is the *force* which occasions the union of *different* kinds of matter, whether simple or compound, and the greater the difference of the properties of bodies the stronger appears to be this species of attraction between them.

ACID, a substance whether sweet, sour or tasteless, which *combines with bases*, forming with them a class of bodies called salts.

BASE, a term extended to embrace a large group—compounds of the metals, (with the exception of ammonia) with those substances which support combustion—which having any taste *are not sour*, which are not disposed to unite with each other, but unite readily with acids forming with them a class of bodies called *salts*.

ALKALI, an Arabic word applied to bodies having a peculiar caustic taste, in all of their properties the reverse of acids—all alkalies are bases. Caustic potash is a familiar example of an alkali.

SALTS, bodies formered by the union of an acid and a base, having properties distinct from either the acid or the base which enter into their composition.

GAS, matter existing in an æriform state, differing from vapour in requiring a much greater force for its condensation. It has different names according to the substance of which it is composed; sometimes it exists as an element, and is then named from some prominent characteristic—thus we have carbonic oxide gas, composed of carbon and oxygen, and oxygen gas, which is an element.

OXYGEN, a gas most extensively diffused throughout nature, always in combination with some other substance, either mechanically, as in the air; or chemically as in water. It has strong affinity for almost all bodies, and received its name from two Greek words, *oxus*, signifying sour or acid, and *gennaein*, to produce, because when first discovered it was supposed to be the source of acidity—it sometimes is called Vital Air, because it is necessary to the life of animals and vegetables.

COMBUSTION.—The union of oxygen with any other body accompanied by light and heat.

OXIDATION.—The union of oxygen with another body, without the concurrence of light and heat. When oxygen unites with metals it produces what is called Rust.

HYDROGEN.—A body very extensively diffused through the world, forming a a large part of all vegetable matter, and about two thirds of all water. It is the lightest of all bodies, and on that accoun used to fill balloons; with oxygen it forms water. This is a good example of the change produced by affinity; here two invisible bodies unite to form a third different in all of its physical properties from those of which it is composed. It receives its name from two Greek words, *Hudor*, signifying water, and *Gennaein*, to produce, because without it water cannot be formed.

Nitrogen.—A gas very extensively diffused through the world, entering largely into the composition of the plants and animals, and forming about eight tenths of the air we breathe; with hydrogen it forms ammonia. It is sometimes called azote from two Greek words signifying not, and zoe, life, because when breathed alone, life will cease to exist.

Ammonia.—A compound of hydrogen and nitrogen, and very generally diffused throughout nature, being a general product of the decay of animals and vegetables; it exists in the air we breathe, as has been satisfactorily proven, united to carbonic acid. It is called ammonia, because first made in large quantities at the Temple of Jupiter Ammon, from the dung of camels—when united to carbonic acid it forms what is familiarly known as smelling salts, volatile alkali from its great volatility; hartshorn, because made from the horns of Stags, &c.

Carbon.—Charcoal in common language; forms a very large proportion of the structure of animals and vegetables, and is the residue left when they are subjected to a red heat, without the access of air. *Coke* is the charcoal from coal—Ivory Black is the charcoal from bones—Lamp Black the charcoal from Resin. The Diamond is but chrystalised charcoal, and Black Lead contains from 90 to 95 per cent. of it. Wood charcoal has the property of absorbing many times its volume of different gases, and of giving them up again when heated. This depends entirely on its mechanical structure, all porous substances acting in the same way to a greater or less extent.

Carbonic Acid, formed by the union of oxygen with carbon, and exists in the gaseous form when not combined with some other body; it is extensively diffused through the earth, air and water; is always produced by the burning of wood, and is expired from the lungs of animals in breathing. It is found united to quick lime, and with it forms marble and the different varieties of lime-stone, from which it is expelled by burning. It is the escape of this acid which produces effervescence when soda or seidlitz powders are mixed, and which also causes effervescence when vinegar is poured upon marl.

It is this gas which sometimes causes death to persons who go down into wells; it extinguishes burning bodies, and is called from this fact fire-damp, sometimes also *choke-damp*, from its causing, when breathed, spasms of the windpipe. Death has sometimes occurred to persons sleeping in a close room, from the production of this gas by a pan of burning charcoal.

This is another good example of the changes produced by affinity; here charcoal which can be seen, felt and handled, when united to oxygen, assumes the gaseous form, becoming invisible and intangible.