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AN

ESSAY ON MANURES,

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FOR

PROMOTING AGRICULTURE,

FOR THEIR PREMIUM.

BY SAMUEL L. DANA.

Manures are the riches of the field.—CHAPTAL.

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ESSAY.

SECTION I.

CLEARING AND BREAKING UP, AND MAKING COMPOST.

THERE is one thing settled in farming, stable manure never fails. It always tells. There are no two ways about it. There is here neither theory, nor speculation, nor doubt, nor misgiving. "Muck it well, master, and it will come right," is an old proverb. It is considered a fact so well established, that nobody thinks of disputing it. There is advantage in asking why barnyard manure never fails. The answer is easy. It contains all that plants need for their growth. If we know then what plants contain, we can easily tell what is in manure. The whole doctrine of manures, then, falls into two plain principles, on which hang all the law and the "profits" of agriculture.

1st. Plants contain and need certain substances which are essential to their growth.

2d. Manure contains all those substances which plants want. If, then, we would find out what it is which manure contains, that makes plants grow, we must first find out what a grown plant contains. This cannot be done without some little, a very little knowledge of chemistry. Do not be startled, reader. I suppose that you may know nothing of chemistry,

no, not even its terms. As a very sensible man, who wrote letters on botany to a young lady, said, to encourage his pupil, it was possible to be a very good botanist without knowing one plant by name, so is it possible to become a very good agricultural chemist, without knowing little more than the chemical names of a very few substances. You know nothing of chemistry, it may be, and as little of law; yet you will go to law, and learn some of its terms by a dear-bought experience. The law terms are harder to learn than the chemical terms.

NAMES OF SUBSTANCES FOUND IN PLANTS.

Now I fear that some persons, who have followed me thus far, will shut up the book. It is, say they, all stuff, book farming, and beyond us. If one may not understand what manure is without this learning, we may as well begin where our fathers ended, and that was where our forefathers began ages ago. By a little law, however, picked up as a jurymen, or witness, selectman, town clerk, justice of the peace, yea, perhaps, hearing an indictment read, men do come to understand what a lawyer means when he talks. So, too, by a little chemical talk, a man may learn what a chemist means when he talks of oxygen, hydrogen, nitrogen, chlorine, and carbon; potash, soda, lime, (ah, these are old friends, the very names make us feel at home again,) alumina, magnesia, iron, manganese, and silex, sulphur, and phosphorus. Here is a long list. Long as it is, perhaps it will be thought worth learning, when you are told, that these are the names of all the substances found in plants, every substance which they want. Out of these is made every plant. Every part of every plant, from the hyssop on the wall to the mountain cedar, contains some or all of these. Be not disheartened. Look over, reader, the list again carefully, see how many

are old names of things which you know. Of the fifteen, you know nearly one half by name and by nature. These are potash, soda, lime, magnesia, iron, sulphur. Perhaps you will add, that you know carbon is coal, or rather coal carbon. You have heard from some travelling lecturer at your town Lyceum, that oxygen and hydrogen together form water; that oxygen and nitrogen form the air you breathe; that nitrogen and hydrogen form ammonia, or sal volatile, which gives the sharp smell to the smelling bottle. Besides, the thing has been said so often that you must have heard it, that chlorine, the substance which bleaches in bleaching salts, united to soda, makes common salt; or if chlorine is united to ammonia, sal ammoniac is formed. Now by changes and combinations among these fifteen things, nature makes everything we find in plants. Many of these are invisible as is the air. The substance called chlorine perhaps you have never seen, but if you ever smelt it you will never forget it. It is often smelt in a piece of bleached cotton, when opened in the shops. It gives the smell to bleaching powder used to disinfect the air, during cholera and other diseases. If you could see it, it would appear merely a faint yellowish-green air. It is all-powerful on vegetation. As it forms a part of common salt, say half of its weight, we may dismiss the further consideration of it, by saying, that, in some shape or other, chlorine is universally diffused in soil and plants.

CHEMICAL SUBSTANCES DEFINED.

THE list above may be divided as follows:—First, the airy or volatile; secondly, the earths and metals; thirdly, the alkalies; fourthly, the inflammables. Only the third and fourth divisions require to be explained or defined. The substances called potash and soda are termed alkalies. They are said to have alkaline

properties. Touch your tongue with a bit of quicklime: it has a hot, burning, bitter taste. These are called alkaline properties. Besides these, they have the power of combining with and taking the sours out of all sour liquids or acids; that is, the acid and the alkali neutralize each other. This word alkali is of Arabic origin; its very name shows one of the properties of alkalies. *Kali* is the Arabic word for bitter, and *al* is like our word *super*: we say fine and superfine; so kali is bitter; alkali, superlatively bitter, or truly, alkali means, the "dregs of bitterness."

I wish, reader, for your own sake, as well as my own, that you should fix in your mind what I have said about alkali and alkaline properties. Alkali is a general term. It includes all those substances which have an action like the ley of wood ashes, which you use for soap making. If this ley is boiled down dry, you know it forms potash. Now lime, fresh slacked, has the alkaline properties of potash, but weaker, and so has the calcined magnesia of the shops, but in less degree than lime. Here we have two substances, earthy in their look, having alkaline properties. They are called, therefore, alkaline earths. But what we understand chiefly by the term alkalies, means potash, soda, and ammonia. Potash is the alkali of land plants; soda is the alkali of sea plants; and ammonia is the alkali of animal substances. Potash and soda are fixed; that is, not easily raised in vapor by fire. Ammonia always exists as vapor unless fixed by something else. Hence we have a distinction among alkalies which is easily remembered. This distinction is founded on the source from which they are procured, and upon their nature when heated. Potash is vegetable alkali, derived from land plants; soda is marine alkali, derived from sea plants; ammonia is animal alkali, derived from animal substances. Potash and soda are fixed alkalies; ammonia is a volatile alkali. Potash makes soft soap, with grease, and soda

forms hard soap. Ammonia forms neither hard nor soft; it makes, with oil, a kind of ointment, used to rub a sore throat with, under the name of volatile liniment. But though there be these three alkalies, and two alkaline earths, I want you to fix in your mind, reader, that they all have common properties, called alkaline, and which will enable you to understand their action, without more ado about their chemistry.

The inflammables, or our fourth division, are sulphur and phosphorus; both used in making friction matches. The phosphorus first takes fire, by rubbing, and this sets the sulphur burning. Now, the smoke arising from these is only the sulphur and phosphorus united to the vital part of the common air. This compound of vital air, or oxygen, as it is called, and inflammables, forms acids, called sulphuric and phosphoric acids. So if you burn coal, or carbon, it is well known you form fixed air, or carbonic acid. That is, by burning, the coal or carbon unites with the oxygen or vital part of common air, and forms carbonic acid. The heavy, deadly air, which arises from burning charcoal, has all the properties of an acid. And now let us see what these properties are. All acids unite or combine with the alkalies, alkaline earths, and the metals. When acids and alkalies do thus unite, they each lose their distinguishing properties. They form a new substance, called a salt. It is very important you should fix well in your mind this definition of a salt. You are not to confine your idea of a salt to common salt. That is a capital example of the whole class. It is soda, an alkali, united to an acid, or chlorine; or, to speak in the terms the most intelligible, to muriatic acid. So saltpetre is a salt. It is potash united to aqua-fortis. Yet in saltpetre you perceive neither potash nor aqua-fortis. These have united, their characters are neutralized by each other. They have formed a neutral salt. Our list of sub-

stances found in plants is thus reduced from things which you did not know, to things which you do know; and so we have saved the trouble of learning more of their chemistry.

We have reduced the airy or volatile into water, formed of oxygen and hydrogen; or volatile alkali, formed of nitrogen and hydrogen; or into acids, as the carbonic, formed of oxygen and carbon—as the sulphuric, formed of oxygen and sulphur—as the phosphoric, formed of oxygen and phosphorus; and having thus got water and acids, these unite with all the alkaline, earthy, and metallic bodies, and form salts. To give you new examples of these, I may mention Glauber's salts and Epsom salts. Glauber's salt is formed of soda and sulphuric acid; Epsom salts, of magnesia and sulphuric acid; alum, of alumina, or clay and sulphuric acid; green vitriol, of iron and sulphuric acid; white vitriol, of zinc and sulphuric acid; plaster of paris, of lime and sulphuric acid; bones, of lime and phosphoric acid; chalk and limestone, of lime and carbonic acid. These are all examples of salts; that is, an acid, or a substance acting the part of an acid, united to an alkali, metal, or earth.

ANALYSIS OF PLANTS.

WE have thus gone over, in a very general way, enough of chemistry for any one to understand the chemical nature of manure. You see, reader, that with common attention, bestowed for an evening's reading, one may learn these chemical terms and their meaning. And now, having learned this first lesson, let us review the ground gone over, and fix, once and for all, these first principles in our minds. Let us do this, by a practical application of the knowledge we have gained. Let us analyze a plant. Do not be startled at the word. To analyze, means to separate a compound substance into the several substances

which form it. This may be done by a very particular and minute, or by a more general division. It may be done for our present purpose, by separating the several substances of a plant into classes of compounds. You are already chemist enough to undertake this mode of analysis; in truth you have already done it, again and again. For our purpose, the ancient chemists had a very good division of all matter into four elements; fire, air, earth, and water. Now, by fire you separate plants into the other three elements. You are, reader, though perhaps you do not know it, somewhat of a practical chemist. Whenever you have burned a charcoal pit, what did you? You separated the wood into air, water, and earth.

You drove off by heat or fire the airy or volatile parts of the plant: you left its carbon, or coal; if you had burnt this, you would have left ashes. Now these ashes are the earthy parts of plants. If you burn a green stick of wood, you drive off first its water and volatile parts, which form soot. You burn its carbon, and leave its ashes, or salts. So that by simply burning, you reduce the substance or elements of plants to water, carbon, salts. All plants then, without exception, contain the several substances in our list above, as water, carbon, and salts. To apply this knowledge to manure, we must say a word on the form in which some of these, which we call the elements of plants, exist in them. The sap is water; it holds dissolved in it some salts of the plant. This sap, or juice, forms a pretty large proportion of the roots, say seventy-five to eighty parts in one hundred, of potatoes, turnips, beets, &c. This may be called the water of vegetation. If we dry beet root, or any other plant, we merely drive off this water of vegetation. Now what have we left? To go back to our process of analysis, let us char the dried root. We drive off more water and volatile parts. This water did not exist, as such, in the plant. It existed there as hydrogen and oxy-

gen gas. Now this word gas is a chemical term, and it means any substance in vapor, which cannot be condensed into a liquid or solid, at common temperatures. Different gases may unite, and so become solids or liquids. Steam is not gas, for it is the vapor of water, and immediately returns to the state of water, below 212° . Perfect steam is invisible, so are most gases. The air we breathe is composed of two gases, oxygen and nitrogen. We do not see them; we cannot, by cooling or compression, make air take other shape than invisible air. This is the general property of gas, as distinguished from vapor or steam. Oxygen and hydrogen, in plants, exist in just the proportions to form water, but we do not know that they are united in these proportions. We have compelled them to unite, by heating the substance or root. The carbon is by this same process consumed, and, you know, has thus formed carbonic acid. Besides this, a portion of the carbon unites with some of the hydrogen of the plant. This forms light, inflammable air. Now you may collect this light, inflammable air, in any stagnant water where plants are decaying. Decay gives exactly the same products as are formed in making charcoal. Decay is only slow combustion, or burning; no matter whether we char the plant or leave it to decay, we obtain exactly the same products as we did by our analysis, that is, carbon and salts.

MOULD.

BUT because there is not heat enough, we leave by decay a portion of the hydrogen and oxygen still united to the coal. A slow *mouldering* fire leaves products more like those of decay. Decay is a slow, mouldering fire; hence the products of the decay of plants are very aptly termed *mould*. It is the product of a mouldering fire; that is, an imperceptible union of the oxygen of the air with the carbon of the

plant. A union so slow, that it gives out neither heat nor light. And yet it is in its results, the same as if fire had actually been seen and felt. Mould contains, then, a part of the carbon, oxygen, and hydrogen, or, if you like the terms better, mould of soil consists of the water and coal and salts of the plants. Mould is truly manure. If the mould of soil, as it has thus been defined, were separated from the earthy portions of soil, it would deprive that soil of the power of growing crops. Here, then, we come to a broad distinction between soil and manure. The soil is the earth on which plants grow. The mould is the manure of that soil. The soil is the earthy—the mould, that is, the carbon and salts, together with the elements of water, are the vegetable part of arable land. But though the earthy part, the soil, as it is usually called, acts as a support, on which plants grow, it does not play a merely mechanical part. It has a distinct, decided, and important action upon the manure. This action is chiefly chemical; and the fact that soils and manures do mutually affect the growing plant, is proved by the circumstance, that the first plants which grew derived their salts from the earth.

MANURES—THEIR ACTION, ETC.

BUT this chemical action of soil does not belong to the present discussion. We can understand what manures are, without deciding how they act. We can theorize and guess about the how of their action, when we have learned what they are. That is chiefly what the farmer wants to know. He wants to know what manure is, and what is likely to act as a manure. To these points, we shall confine our present remarks. Pointing out the great principles applicable to all manures, the nature of soils, and the manner in which they affect manures, must be left for another essay. The vegetable or manure part of soil alone, is now to be considered. Consider, now, reader, the great results to which our analysis has led us; that a slow,

mouldering fire gives us the same products as are formed by decay; that this is only a slow, mouldering fire, and that mould, its product, is the natural manure of plants. It follows, that whatever substance produces mould, that is, water, carbon, and salts, may be used instead of this natural manure. Among the salts found in mould, some are volatile, and are easily dissolved by water. Others are fixed, that is, not evaporating easily, or not at all, and are quite insoluble in water. Now the first, or volatile and soluble, first act when used in manure. They act quick, and are quickly done. The fixed and insoluble act slower, they last longer. The volatile act in the early stages of growth, the fixed in the later periods. The great difference in the action of manures, depends almost entirely upon the salts which they contain. These are the most important and essential. It is not so much the vegetable mould of manure which you want, as the salts which it contains. This is a well-settled principle. Land which has undergone the skinning process, old, worn-out, and run-out land, still contains a very large portion of vegetable matter; the coal or carbon of mould without its salts. Give this worn-out land salts, and you may, by these alone, bring it back not only to its first virgin freshness, but you may even by salts alone make it fairer and richer than it was before man ever cultivated it.

Too much stress has been all along laid upon the kind of soil. Go now to "Flob," in West Cambridge; no better farms or farmers, look the world through. Ask any of these practical men, whether the sandy and gravelly soil of Old Cambridge Common, or even of Seekonk Plain, can be made to bear as rich crops as their land? They will tell you yea. If your land will hold manure, muck it well and it will be as good. Now, this holding of manure belongs to the subject of soils, and throwing that out of consideration, it is found that even lands which do not hold manure, which have been worn out and exhausted by cropping,

hold yet a great deal of insoluble coal of mould. They want salts, and something which will make this inert, dead vegetable matter of the soil active. The mould is active in proportion as it is more or less dissolved by water. Mould consists of two parts; one is dissolved, though only in a slight degree, by water; the other is not dissolved by water. Some substances, however, do render mould very easily dissolved by water. Hence, if you reflect a moment on these facts, it will be seen that mould itself, being valuable in proportion to the ease with which water dissolves it, that whatever substance so enables mould to dissolve, may be added to it, and thus increase its value. Now the things which do this are the alkalies, soda, potash, and ammonia. These principles being well settled, we may enter on the consideration of each different manure. They will be valuable in proportion to the quantity and kind of salts each contains, added to the power they may have of producing by their decay substances which make their mould soluble. Now this last property, that is, the property of producing a substance which makes mould soluble, depends wholly upon the nitrogen of the manure. This nitrogen, in the process of decay, becomes volatile alkali or ammonia. The word ammonia will occur so often in the present discussion, that we should endeavor to fix some definite idea to it. You need not, reader, be acquainted with all its chemical properties. I suppose every man who will be likely to read these remarks, has smelled ammonia. It has been already said, that it gives the peculiar pungent smell to the common smelling bottle.

This is volatile ammonia. It is always formed when animal or vegetable bodies decay.

It has been already said, and is now repeated, in order that it may never be forgotten, that ammonia is formed by the union of hydrogen and nitrogen. Hydrogen and nitrogen, two airs, nitrogen forming four fifths of the air we breathe; let that be borne in mind,

and without going into the chemistry of ammonia further, or the mode of calculating how much ammonia a pound of nitrogen will make, it may be laid down, and must be remembered, too, that every pound of nitrogen may be called two and a half pounds of sal volatile, or smelling salts, of the smelling bottle. Two and a half pounds of volatile ammonia formed from one pound of nitrogen. If, then, we can determine, as chemistry may, how much nitrogen exists or forms a part of manure, two and a half times that will be the ammonia of that manure. If then the vegetable part of manure is, as we have said, valuable and active, in proportion to its degree of being dissolved by water, then, as ammonia gives it this easy solubility, we may safely say, that the quantity of nitrogen in manure is the measure of the value of its vegetable part. One thing must be guarded against, not to place from this view the whole of the value of manure upon its ammonia. Remember that manure consists of carbon, water, and salts. The whole are equally essential to its action. There is no eye, nor ear, nor foot, nor hand in manure, which may say to the other members, "I have no need of thee." The whole act together; but it is not to be doubted, that ammonia is the heart of manure, and keeps up the healthy circulation among the other members.

SECTION II.

SHOVELLING OVER THE COMPOST HEAP.

THE above remarks may be called our compost heap. It must be well shovelled over. You must, reader, before you cart it out and spread it, understand well what this compost contains. Now just let

me turn over a few shovelfuls, and fork out the main points to which I wish to call your attention.

1st. That all plants find in stable manure everything they want.

2d. That stable manure consists of water, coal, and salts.

3d. That these, water, coal, and salts, consist in all plants of certain substances, in number fifteen, which are called,

1. Oxygen, 2. Hydrogen, 3. Nitrogen, 4. Carbon, 5. Sulphur, 6. Phosphorus, 7. Potash, 8. Soda, 9. Lime, 10. Magnesia, 11. Alumina, or clay, 12. Iron, 13. Manganese, 14. Chlorine, which last, as we have said, forms about one half the weight of common salt, 15. Silex. And if you always associate with the word chlorine, the fertilizing properties of common salt, you will, perhaps, have as good an idea of this substance as a farmer need have, to understand the action of chlorine.

4th. These fifteen substances may be divided into four classes.

(1.) The airy or gases, oxygen, hydrogen, nitrogen, and chlorine.

(2.) The earths and metals, lime, clay, magnesia, iron, manganese, and silex.

(3.) The alkalies, potash and soda.

(4.) The combustibles, carbon, sulphur, and phosphorus.

You may be surprised that I have not turned up ammonia, but this exists in plants as hydrogen and nitrogen.

5th. The term salt includes a vast variety of substances, formed of alkalies, earths, and metals, combined with acids. Fix well the meaning of this term in your mind, and remember the distinction pointed out, that some salts are volatile, and act quick in manure, and others are fixed, and act slower.

6th. When plants die or decay, they return to the earth or air these fifteen substances. Those returned

to the earth form mould, which, thus composed of carbon, salts, and water, is natural manure.

7th. Mould consists of two kinds, one of which may be, and the other cannot be dissolved by water. Alkalies put it into a state to be dissolved, and in proportion as it is dissolved, it becomes valuable as a manure.

8th. If then manure contains only water, carbon, and salts, any substance which affords similar products may be substituted for it. Hence we come to a division of manures into natural and artificial. The consideration of these is the carting out and spreading of our compost. And we shall first consider in detail the natural manures.

That is, those which are furnished us by the dung and urine of animals, and the manure or mould formed by the decay of animal bodies or plants. These are truly the natural manures, consisting of water, mould, and salts. This is all that is found in cattle dung. This being premised, we may divide manures, reader, for your more convenient consideration, not by their origin, but by their composition. We may divide manures into these three classes: First, those consisting of vegetable or animal matter, called mould; Secondly, those consisting chiefly of salts; Thirdly, those consisting of a mixture of these two classes. And, beginning with the last first, we will now proceed to their consideration.

SECTION III.

CARTING OUT AND SPREADING.

THE general chemical information set forth in the preceding sections will be of no service to you, reader, if it conducts you not beyond the result arrived at in

the close of the last section, that cattle dung is composed of water, mould, and salts.

You want to know what salts, and how they act. If you understand this, you may be able to say beforehand, whether other things, supposing their nature understood, can take the place of the mould and salts.

The mould, then, of cattle dung, as of all other mould, contains the following substances:—

The water consists of oxygen and hydrogen.

The mould consists of carbon, oxygen, hydrogen, nitrogen, and ammonia.

Thus it is seen, that the mould contains all the substances found in the first class into which the elements of plants were divided. The salts contain the sulphur, phosphorus, and the carbon as sulphuric, phosphoric, and carbonic acids, and the chlorine, as muriatic acid, or spirits of salt.

The acids, formed of the elements of the fourth class of the substances entering into plants, are combined with those of the second and third classes, namely, the potash, soda, lime, clay, magnesia, iron, and manganese. Here, then, we have all the elements of plants, found in cattle dung. Let us detail their several proportions. We have all that plants need, distributed in cattle dung, as follows:—

In 100 lbs. of clear cattle dung are,	
Water,	83.60
Mould, composed of hay,	14.00
Bile and slime,	1.275
Albumen, a substance like the white of an egg,	0.175
Salts, silica, or sand,	0.14
Potash, united to oil of vitriol, form- ing a salt,	0.05
Potash, united to acid of mould,	0.07
Common salt,	0.08
Bonedust, or phosphate of lime,	0.23
Plaster of Paris,	0.12

Chalk, or carbonate of lime,	0.12
Magnesia, iron, manganese, clay,	
united to the several acids above,	0.14
	<hr/>
	100.00

SECTION IV.

OF THE ACTION OF MOULD IN CATTLE DUNG.

HERE, then, we have cattle dung with its several ingredients spread out before us.

We have now to study its action. We need here consider only the salts and mould. The water is only water, and has no other action than water. The mould includes the hay, for that has by chewing, and the action of the beast's stomach, lost so much of its character, that, mingled with the slime and bile, &c., it more rapidly decays than fresh hay would, placed in similar circumstances. During this act of decay, as you have already learned, the volatile parts of the mould are given off in part. These escape as in burning wood, as water or steam, carbonic acid, and ammonia. In consequence of this slow mouldering fire or decay, the manure heats. Here then we have three very decided and important actions produced by the vegetable part or mould of cattle dung. First, carbonic acid is given off; second, ammonia is formed; third, heat is produced. Let us now consider each of these, and their effects.

Firstly, the great action of the carbonic acid is upon the soil, its earthy parts. It has the same action on these, that air, rain, frost, have; it divides and reduces them. It not only reduces them to powder, but it extracts from the earth potash, and the alkalies. This is a very important act, and shows why it is necessary that decay, or fermentation, should take place in and under the soil among sprouting seeds

and growing roots, in order that they may obtain from the soil the salts they want.

If well-rotted manure contains abundance of these salts, ready formed in its mould, then there will be less necessity of this action of carbonic acid. But here again it must be remembered, that this abundance of salts, ready formed in mould, can be produced only at the expense of great loss by fermentation of real valuable parts; for,

2d. The next great action of the mould of cattle dung is, to produce or form ammonia. This plays a threefold part: its first action is, to render the mould more soluble; this action it possesses in common with the fixed alkalies—potash and soda. All the alkalies put a large, but undefined portion of mould, into a state fit to become food for plants. The second action of ammonia is this, it hastens decay. It is the bel-lows, we may say, kindling the slow mouldering fire. The third action of ammonia is, to combine with any free acids, such as vinegar, or even an acid formed of mould itself, but especially with aqua-fortis, or nitric acid, which is always produced where animal or vegetable matters decay. This is a highly important fact. The result of this action, the production of ammonia and aqua-fortis, during the formation of mould, is, that a kind of saltpetre is thereby produced. That is, the ammonia and aqua-fortis unite, and form a salt, with properties similar to saltpetre. But we want the first and second action of ammonia to occur, before the third takes place. Consider now, reader, whether a more beautiful and effectual way can be devised, to hasten decay, and render mould more fit for nourishing plants, than this which nature has provided. The ammonia is volatile. It remains, not like potash and soda, where it is put, incapable of moving unless dissolved by water, but ammonia, like steam, pervades every part. It is as expansive as steam. Heated up by the slow mouldering fire of decay, it penetrates the whole mass of mould. It does its work there.

What is that work? It has already been told. But, if it finds no acid to combine with, it then unites with the mould itself. It is absorbed by it.

The mould holds it fast; it stores it up against the time when growing plants may need it. Now it is only where the abundance of ammonia produced satisfies these actions of hastening decay, making mould soluble, and filling its pores without combining with it, that the formation of saltpetre takes place. So where animal matters, which are the great source of ammonia, decay, there we may expect all these actions to occur. How important, then, is that action of mouldering, which produces ammonia. If, reader, you will reflect upon the consequences of this action, you will at once see, that if the mould is in too small a quantity to retain the ammonia, it may escape. If by a wasteful exposure, you allow your mould to dissipate itself in air, as it certainly will, you not only incur the loss of that part of the mould, but you diminish at the same time the chance of keeping the ammonia which has been formed. No doubt all cattle dung exposed to air, forms more ammonia than it can retain. Hence the necessity and the season of forming composts with this substance. "Keep what you have got and catch what you can," must never be lost sight of in manure. The third action of mould is the production of heat. Little need be said upon this. That a slight degree of heat hastens the sprouting of seeds, you well know. That different manures produce different degrees of heat, that some are hot, some cold, you well know, and adapt your seed and manure to each other. The degree of heat depends upon the rapidity with which decay occurs. And this is affected by the quantity of ammonia which each manure can afford. The great point, to which your attention should be directed, when considering the power of mouldering to produce heat, is, that it shall not go so far as to burn up your manure, just as hay will heat and take fire.

SECTION V.

OF THE ACTION OF THE SALTS OF CATTLE DUNG.

HERE it is we find ourselves thrown on a sea of opinions, without chart, compass, or pilot, if we trust to the conflicting theories which have been set up for landmarks and lighthouses. Let us, therefore, reader, trust to ourselves, aided by the little chemistry we have learned from the preceding remarks about the composition of salts.

I have endeavored to impress on your memory, that the term salt is very comprehensive. But then, to encourage one, it is also to be remembered, that salts are compounds of alkalies, earths, and metals with acids. Now the earths, alkalies, metals, may be united to each of the known acids, (and their name is legion,) yet you may not, by this change of acids, alter the nature of the earth, alkali, or metal. That always remains the same; every time you change the acid, you alter the character of the salt. Thus soda may be united to oil of vitriol and form Glauber's salt, or to aqua-fortis and form South American salt-petre, or to muriatic acid and form common table salt. The soda is called the base, or basis, of this salt: that is always soda; you do not change its character by changing the acid. To give another example, lime may be united to carbonic acid and form chalk, or marble, or limestone, or it may be united to oil of vitriol and form plaster of Paris, or to phosphoric acid and form bonedust. Now, in each case, the base of the salt, that is, the lime, remains unchanged; but, changing the acid, we change the nature of the salt, and of course its effects will be different.

Now it is plain, that where the base of the salt remains the same, that will always act the same, but

different effects will be produced by different acids. Each base acts always one way, but each has an action similar to every other. Each acid acts also one way, but each has an action distinct from every other; impress this on your mind. Reflect upon it a moment, and you will perceive that salts produce different effects, according to the nature of their acid. Now this may be illustrated thus: You take every day, probably with your every meal, common salt; that is, soda, a base, united to muriatic acid. Your digestion and health are all the better for it. You give your cattle a little salt. It does them good. Suppose now you change the acid of that salt, leaving soda, its base, in the same quantity you daily take. Instead of the muriatic, suppose you substitute the nitric acid, or, what is the same thing, suppose you use saltpetre from Peru, instead of common salt. You need not be told, that you would poison yourself and your cattle by so doing. You can drink, I dare say you have, cream of tartar punch. You feel the better for it. It is refreshing, cooling, opening. Now cream of tartar is a salt of potash; it is potash and tartaric acid. You have a fever. Your doctor gives you a sweat with Silviu's salt; that is, acetate of ammonia, a salt composed of that and vinegar; or you take, perhaps, an effervescing draught, formed of lemon juice and pearlashes. All does you good. But suppose now you change these cooling, vegetable acids for a mineral acid, say oil of vitriol. You may not take potash, united with a dose of oil of vitriol equivalent to the tartaric acid in the cream of tartar, without serious injury. So is it, reader, in farming, the acids of some salts are not only harmless, but beneficial to plants; others are actual poisons.

In the first case, salts help to nourish plants, as common salt helps to nourish yourself; in other cases, they poison plants, just as they would impair your constitution, perhaps kill you. But it is to be remembered, as in our own case, even those that

poison, in a small dose become medicines, so, in plants, a small dose is not only good, but truly essential. Now if we divide the acids into two classes, the nourishers and the poisoners, such will also be the nature of the salts. When we therefore attempt such a general division of the salts, it may be said that all the acids derived from the vegetable kingdom are harmless; so are the acids called mineral, yet whose components are, in part, like those of the vegetable acids; for instance, aqua-fortis, or nitric acid. But the true mineral acids are poisonous; such are oil of vitriol and spirits of salt. One thing is here to be borne in mind. It must never be out of sight, in trying to understand how salts make plants grow. You cast your salt upon the ground; it lies there; no action occurs. It rains; your salt is dissolved and disappears; it seems to do no good. Cast your salt now among sprouting seeds and growing roots; here is life. Well now, life is just as much a power or force as electricity is. It exerts its force, no matter how; that is quite another consideration. I say, life exerts its force here to separate the acid and the base of a salt, just like a chemical force. We can and do separate the components of salts by other substances; nay, we do it by electricity alone.

Now this is all which it is necessary for you to know, and to understand about this action of plants upon salts; it does disunite the components of the salts. What is the consequence? The alkali, earth, and metal act as such, the same as if no acid was present. The acid also acts by itself: if it is a nourisher, it helps the plant; if it is a poisoner, it hurts it. It produces either a healthy, green crop, the effect of alkali, or a stunted, yellow, sickly plant, the effect of acids. Now neutralize this acid, kill it. You see your crops start into luxuriance, and reap where you have sowed. So much for illustration. Let us now apply this view of the action of salts to those contained in cattle dung. In the first place, we have

salts of potash, of soda, of lime; these are the most abundant and active. Then we have salts of iron, manganese, of clay, and magnesia. These last, existing in small proportion, may be thrown out of the account, bearing in mind, however, that, though we set these aside, a plant does not; they enter equally with the others into its composition.

Let us begin with the salts of potash. It is found combined in cattle dung, first, with a vegetable acid, the acid of mould. It is a nourisher of plants. Secondly, with sulphuric acid, or the acid of sulphur, called oil of vitriol. This is one of the poisoners, existing only in small proportion in cow dung; it ministers to the wants of a healthy plant. The same is true of the common salt, or the muriate of soda of dung. If it existed in larger quantities, it would poison the plants to which it might be applied.

The next salts are those of lime, phosphate and sulphate of lime, or lime united to sulphuric and phosphoric acid, forming plaster and bonedust. The acids here, if abundant, would have a decided bad influence, they are poisoners; but the carbonic acid, in the carbonate of lime, is a nourisher. Now, from the small quantity in which these all exist in cattle dung, they act only beneficially. But if you apply a great excess, even of cattle dung, you may be sure of an unfavorable result. It will be produced by the acids of those salts which we have called poisonous.

To continue our remarks on the acids of salts of dung, it is to be observed, that they act also upon the soil. They decompose that. That is, they extract from the soil alkalies, or other substances, like those in the original salt. Now though applied, as they must be, in very small doses in cattle dung, yet, because of their decomposing action on soil, they continually renew themselves, they last till all their acid is taken up to supply the wants of growing plants.

Let us now, reader, if you understand how the

acids of the salts of dung act, turn to the bases or the alkalies and metals and earths of these salts. What is their action? What purpose do they serve in dung applied as manure? First, they enter into and form a part of the living plant, they form a part of its necessary food, as much as do the constituents of mould. Secondly, when these alkalies and metallic bases are let loose, by the disuniting power of a growing plant, then they act as alkalies upon mould. They hasten decay, render mould more soluble, fit it to become food for plants. This account of the action of mould and salts in cattle dung may appear to you, reader, long and hard to be understood. I do request you not to pass it over on that account. A patient reading, perhaps some may require two or more readings, will put you in possession of all you need know, to understand the why and the wherefore of the action of mould and salts of whatever manure may be used. What has been said of the action of mould and salts in cattle dung, is equally applicable to all manures. If, then, you bend your bones to this subject, and master it, your labor of understanding the action of other manures will be reduced to the mere statement of the several substances which they may contain. We therefore proceed to point out other manures, composed of the droppings of animals.

SECTION VI.

OF NIGHT SOIL, HOG MANURE, HORSE AND SHEEP DUNG.

THESE have not all been analyzed with the same degree of care and as often as has cattle dung; some, s, for instance, night soil, have been examined thoroughly but once. Now it is not quite fair to base our reasoning upon these single analyses, and say that

this or that manure contains this or that salt in greater or less quantity than another.

The quantity and kind of salts are materially affected by several circumstances, which will be considered in the next section. An analysis, made when the animal is fed and worked one way, will vary from the result which would be obtained when the circumstances are varied. It is, therefore, quite useless, in the general consideration of the composition of manures, to enter upon the details of each. General results, general expressions of facts, are sufficient for understanding the nature of animal droppings. It is well ascertained, however, that all these droppings of various animals contain essentially the same salts as does cattle dung. They all contain portions of each of the substances which form plants. It will be enough for the purpose of this essay, to present to your eye, reader, a table, showing the proportions of water, mould, and salts, which the dung of yourself and your stock presents.

	Water.	Mould.	Salts.
Night soil and hog manure,	75.3	23.5	1.20
Horse dung,	71.2	27.0	0.96
Sheep dung,	67.9	22.5	3.06

SECTION VII.

OF THE CIRCUMSTANCES WHICH AFFECT THE QUALITY AND QUANTITY OF ANIMAL DUNG.

THAT we may reduce to some general principle, easily understood and easily remembered, the facts scattered up and down, among the mass of writers and observers, about the different quality of manure afforded by different animals, or the same animals at different times, let me, reader, request your company

while I walk into a new department of your chemistry. You may not understand the reasons of this difference in manures—why, for instance, fattening cattle give stronger manure than working oxen—without going a little into the mode how animals are nourished. The whole may be stated in plain terms thus: All food serves two purposes. The first is to keep up the animal heat, and this part of food disappears in breathing or in forming fat; that is, after serving its purpose in the animal body, it goes off in the breath or sweat, or it forms fat. It is so essential to the action of breathing, that we will term it food for breathing, or the breathers. The second purpose answered by food is, to build up, sustain, and renew the waste of the body.

Now all this is done from the blood. To form blood, animals must be supplied with its materials ready formed. They are ready formed in plants; and animals never do form the materials for making blood. We may, therefore, term this kind of food the blood formers. We have, then, two classes of food; the breathers and the fat formers, and the blood formers. If we look to the nature of these different classes, we find that sugar, starch, and gum are breathers. Now there are three principles found in plants, exactly and identically the same in chemical composition with white of egg, flesh, and curd of milk. Now these three principles, exactly alike, whether derived from animals or from plants, are the only blood formers. I shall not, reader, tax your attention further upon this subject, than to say and to beg you to remember these important facts: First, all food for breathing and forming fat contains only these three elements, oxygen, hydrogen, and carbon. Secondly, all food for forming flesh and blood, in addition to these, contains nitrogen.

This is the gist of the whole matter, so far as relates to manure. Bear in mind, as you go on with me, reader, this fact, that of all the food animals take, that alone which can form flesh and blood contains nitro-

gen. The door is now open for explaining why age, sex, kind of employment, difference of food, difference of animal, can and do produce a marked difference in the value of different manures. And first, let us consider how the quantity is affected; this depends on the kind of food. The analysis of cattle dung which has been given is that of cows fed on hay, that is, herd's grass, red top, &c., or what is usually termed English hay, potatoes, and water. The cattle kept up the year round; an animal, so treated, consumed in seven days,

Water,	611 lbs
Potatoes,	87 "
Hay,	167 "

During this time, she dropped clear dung 599 lbs., or very nearly a bushel of dung a day. Every attention was here paid to accuracy of measurement and weight. The annual amount of dung from one cow exceeds by this account that which is usually assigned. But, as it is a matter of some importance for the farmer to estimate what the produce of his stock may be in dung, the following statement, containing the results of a large establishment, will probably give that average.

At this establishment, the cows were kept up the year round for their dung. It was collected for use free from litter, and measured daily into large tubs of known capacity. The average number of cows kept was fifty-four for nine and a half years. During that time, they consumed of beets, meal, and pumpkins, brewery grains, cornstalks, turnips, potatoes, carrots, and cabbages, 942,436 lbs., giving an average of green fodder, for each cow per year, 1,837 lbs. Average consumption of hay for each cow per annum, 8,164 lbs. The total dung for nine and a half years was 120,520 bushels, or per cow per annum, 235 bushels. This gives a daily consumption of green food, 5 lbs.

and 22 lbs. of hay per cow, and two and a half pecks of dung per day, or about 56 lbs. per cow.

But according to some experiments, made to determine how much the quality of the food affected the quantity of dung, it appears that the solid and fluid excrements, partially dried, were, compared with the food, as follows:—

	Cattle. lbs.	Sheep lbs.	Horses. lbs.
100 lbs. of rye straw gave dung,	43	40	42
“ “ hay, “ “	44	42	45
“ “ potatoes, “ “	14	13	
“ “ mangel-wurtzel, “	6		
“ “ green clover, “	9 $\frac{1}{2}$	8 $\frac{1}{2}$	
“ “ oats, “ “		49	51
“ “ rye, “ “			53

My own experiments on this subject gave for 100 lbs. of hay and potatoes as above, estimating both as dry, or free from water of vegetation, 32.9 lbs. dung, and this estimated as dry is reduced to 5.6 lbs., or 26 lbs. of dry food gave 14 lbs. of dry dung. But as a general fact, we may say, that well-cured hay and the grains give one half of their weight of dung and urine; potatoes, roots, and green grass, about one tenth. It will be easily understood why the quality of food should affect the quantity of dung. The more watery, the less in bulk is voided, because there is actually less substance taken. And as the animal requires this to form his flesh, and blood, and fat, and to keep up his breathing, so will he exhaust more completely his food. More going to support him, less is returned by the ordinary channels. So when much vegetable fibre exists, as in chopped straw and hay, then, as it goes but little way toward supporting breathing or forming blood, a greater bulk is rejected. In grains, on the contrary, which afford much of all that the animal requires, less is extracted and more

voided. These circumstances are intimately connected with

THE QUALITY OF THE DUNG.

It is affected, first, by the season; second, by the age; third, by the sex; fourth, by the condition; fifth, by the mode of employment; sixth, by the nature of the beast; seventh, the kind of food.

1st. The season. It is, because digestion is worse in summer than in winter, a general fact, that summer manure is best. And where cattle are summer soiled, it is said the manure is worth double that from stalled winter cattle. I do not think much is to be attributed to the worse digestion in summer; but the cause of this great difference in value is to be found in the fact, that soiled cattle generally get a large proportion of blood-forming food.

The wear and tear of their flesh is little, and hence, requiring little of their food to keep up their flesh, a greater portion goes off in dung, which thus becomes rich in ammonia. The green plants, rich in nitrogen, afford abundance for milk, which, being rich in all the elements of cream, should afford large returns of butter.

2d. Age. From the fact, that young and growing animals require not only food to form flesh and blood to repair the incessant waste and change taking place in their bodies, as in older animals, but also a further supply to increase the bulk of their frame, it is evident that their food will be more completely exhausted of all its principles, and that also less will be returned as dung. All experience confirms this reasoning, and decides that the manure of young animals is ever the weakest and poorest.

3d. The sex. This is one of the most powerful of the causes which affect the strength of dung. From

the remarks which have been already made, and which I trust, reader, are now fresh in your memory, of the important part acted by nitrogen in dung, it must be plain why sex should exercise such influence.

Firstly, in all food, as we have explained, that only which contains nitrogen can form flesh and blood, or substances of similar constitution; that is, requiring a larger proportion of nitrogen, as milk. Hence, an animal with young, that is, a cow before calving, requires not only materials for its own repair, but to build up and perfect its young. Hence the food will be most completely exhausted of its nitrogen, and consequently the dung become proportionably weaker.

Secondly, the young having been formed, then milk is required for its sustenance. Milk contains a large proportion of nitrogenous or blood-forming elements, and so the cause which originally made the dung weak, continues to operate during all the time the animal is in milk. Sex, then, it is evident, affects materially the quality of the dung.

4th. The condition. If the animal is in good condition, and full grown, it requires only food enough to supply materials to renew its waste.

Hence the food, supposing that always in sufficient quantity, is less exhausted of its elements, than when the animal is in poor condition. In the last case, not only waste, but new materials must be supplied. If the animal is improving in *flesh*, (and here, reader, I would have you bear in mind the distinction between flesh and fat,) if the animal is improving in flesh, then the manure is always less strong than when he is gaining fat. There is no manure so strong as that of fattening animals. An animal stall-fed, kept in proper warmth, requires but little of his breathing food to keep up his heat. All the starch, gum, sugar, &c., go to form fat. Having little use for his muscles or flesh, that suffers little waste, and the nitrogen, which should go to form flesh, is voided in du.g. If it is a

she, no milk is given during this period, for a cow, in milk, fats not.

The dung, then, of fattening animals contains more of all the elements of food for plants, than at any other period, and is peculiarly rich in nitrogen. I trust, reader, it is not so long since you have met the word ammonia, that you have forgotten that its source and origin are due to this nitrogen. Now, the source of this nitrogen is in the food, and as, during fattening, grain is supplied for its starch, &c., to make fat, and very little waste of the body taking place, the extra nitrogen of the blood-forming materials of grain is nearly all voided in dung.

5th. The mode of employment. Your working beasts suffer great wear and tear of flesh and blood, bone and muscle, thews and sinews. Hence, their daily food supplies only this daily waste; the food is very thoroughly exhausted, and of course, the dung is weak. It derives its chief value from the excretions of those parts of the body which are voided as waste materials among the excrements. There is a distinction to be noted here: excretions are the worn-out flesh and blood elements, excrements the undigested and unused food; dung includes both excretions and excrements. Now, the chief value of the dung of working cattle depends upon the excretions.

6th. The nature of the beast. If his coat is wool, he requires more sulphur and phosphorus, the natural yolk, or sweat of his wool, more lime and ammonia than does the hairy-coated animal. Hence, sheep produce manure less rich in many of the elements of plants than cattle; but as at the same time it contains a larger portion of nitrogen, and is very finely chewed, it runs quicker into fermentation. It is a hotter manure, quick to eat, quick to work, and is soon done.

7th. The kind of food. We have already spoken of this as affecting the quantity of dung. Its effects are no less marked on its quality. Now, all that re-

quires to be said on this subject, is to remind you, reader, of the two divisions of food, the fat formers, and the flesh and blood formers. It must be evident, that the more of this last the food contains, that is, the more nitrogenous is the food, the richer the dung. Hence, grains of all sorts, peas, beans, &c., will always give a richer dung than fruits, as apples, &c. The more nitrogenous the hay, the richer the dung. Meadow cat-tail and rye grass are nearly six times stronger in ammonia than oat straw. Red clover is twice as rich in nitrogen as herd's grass; wheat, barley, and rye straw, green carrots, and potatoes contain only about one third to one fifth the ammonia of herd's grass, and turnips only about one sixth. The quantity of ammonia contained in these different grasses and straws, shows at once the effect they must have in the compost heap. The kind of litter must have no small effect upon the value of manure. And while we are upon this subject, it may not be out of place to mention, that the kind of a green crop, turned in, materially affects the value of the process. While the straws of the grain-bearing plants afford, for every ton of green crop turned in, about three quarters of a pound of ammonia, green cornstalks and herd's grass about five pounds of ammonia per ton; red clover affords about seventeen pounds of ammonia per ton.* The very great value of clover in enriching land is thus made evident. But to return to the quality of the dung, as affected by the food, it has been proved, that animals fattening on oil-cake give manure in value double that of common stock. Here abundance of nitrogen is supplied where very little is required, and consequently much is voided in dung. The point to which we have arrived is a breathing place. The remarks which have been offered upon the action of

* This is the relative, not the absolute, proportion of ammonia. The analysis of Boussingault gives about fifty, and one hundred and seventy as the absolute quantity.

salts, have prepared the way for our entering upon the next section—the second class of manures.

SECTION VIII.

MANURES CONSISTING OF SALTS.

IN using the term salts here, to designate a class of manures, I wish to distinguish between these and mineral manures, as they are usually termed. These manures are similar in kind to the salts, whose action in cow dung we have already considered. They are truly mineral salts, derived from the mineral kingdom, entering into and forming a part of plants, and from this source introduced into the dung of animals. Their action, whatever be their name, has been explained. But the salts composing the second class of manures now under consideration, are not of mineral origin. They are derived from the animal kingdom. The source from which they are formed is the living process of the animal body. They are animal salts. Here, then, let us divide the second class of manures into animal salts, which are truly manures, both their base and their acid acting as nourishers of plants, and into mineral salts. Here again, reader, you will find that the few facts which we have pointed out, relating to the food and nourishment of animals, will help us on our way, in tracing the source of these animal salts.

It has been already said, that the food of animals is divided into two classes: that which does, and that which does not contain nitrogen. All domestic animals eat these classes together. In a few words, let us trace their course after the animal has digested

them. The one class goes to form fat, or to support the natural heat of the body, and passes off by the skin in sweat, or in moisture of the breath, and all its excess or undigested part goes off in dung. The excess of nitrogenous food, all that not required for repairing the daily waste of the body, or to increase its growth, also passes off in dung, as excrement. This is a small portion, and its effects on the strength of dung have been pointed out. But the wear and tear, as we may call it, of the flesh and blood, the parts which are daily and constantly thrown out of the body, as excretions, or old materials, enter the circulation, and pass out of the body in urine. This is the point to which I would call your attention. The undigested food, and the excrements not containing nitrogen, go off in dung. The food and the spent parts of the body, containing nitrogen, go off in urine. This last, too, is the course of most alkaline salts taken into the body. They pass off in urine. Here, then, we come to the subject quite prepared to understand it. The urine is a collection of salts, some of mineral, others of animal origin. But that which gives the urine its peculiar and characteristic properties, is a substance formed from the nitrogenous food, and termed *urea*. Now you need hardly trouble yourself to remember this new name; all I want you to understand about it is, that when urine is exposed to air it rots, and this peculiar substance is changed to ammonia. That is the point to be remembered. In considering urine, therefore, as a manure, it will not be necessary to point out further the mode of its action, than to refer that of every animal to its salts and power of forming ammonia. The quantity of the last will be in proportion to the quantity of urea. There are other salts of ammonia in urine, and also mineral salts. These affect but little the value of urine as a manure.

It is the urea, essence of urine, that substance which forms ammonia in rotting urine, which alone makes this liquid more valuable than dung. Hence, reader,

if this is impressed on your mind, you will perceive that the chiefest things to be regarded in urine are, first, the circumstances which affect the quality and quantity; second, the best mode of promoting a change of urine to ammonia; third, the time required for the process; and fourth, the best mode of preserving the ammonia, when formed. You will perceive, reader, that all along, I have endeavored to point out the principles on which manures act. If you go by general principles, then for a plain practical farmer, like yourself, with only chemistry enough to understand a few of its terms, it must be quite a thankless service, to point out to you in detail all the various things contained in urine. It would confuse you more than the names, ay, and hard ones too, which are given to the varieties of pears and apples. All you want to know is this, Does urine contain, as solid dung does, water, mould, and salts?

It does. The mould is so small a part, it may be left out of view. The salts are like those in the solid dung, mineral salts, and then we have the peculiar principle urea, which, for all practical purposes, may be called ammonia. We may then, with this division, present in a table the composition of the urine of various animals at one glance:—

	Water.	Salts.	Ammonia.
Cattle urine, per 100 lbs.,	92.62	3.38	4.00
Horse “ “ “	94.00	5.03	0.70
Sheep “ “ “	96.00	1.20	2.80
Hog “ “ “	92.60	1.76	5.64
Human “ “ “	95.75	1.88	2.36

Now cast your eye carefully over this table: the figures at once tell you the value of these different liquids. The last column gives the true value. The other salts vary much in quantity, and this affects the quality. The actual amount of ammonia in human urine and cattle dung is about the same; yet in actual

practice it is found the effects of urine are nearly double those of dung. Look now for the reason of this. In the first place, the principle which gives ammonia in urine runs at once by putrefaction into that state. It gives nothing else; whereas in dung the ammonia arises from a slower decay, and the principle which here affords ammonia may, and without doubt does, form other products. Hence, we have a quick action with the liquid, a slower one with the solid. A second cause of the better effects of the liquid is, that it contains, besides its ammonia, a far greater amount of salts, and these give a more permanent effect. The amount of salts in human, cow, and horse dung is about one pound in every hundred; while the urine of the same animals contains nearly six pounds in every hundred. A third cause of the greater fertilizing action is found in the peculiar character of some of these salts, which are composed of soda, potash, lime, &c., united to an acid formed from urea, in the animal body. This acid is like the acid of saltpetre; it is a nourisher of plants, as much so as is carbonic acid.

SECTION IX.

OF THE CAUSES WHICH MAKE URINE BETTER OR WORSE, MORE OR LESS, AND THE MODES OF PRESERVING IT.

THERE can be no doubt that the same causes which we have pointed out as affecting the value of dung, affect also the urine.

We have already alluded (p. 38) to the four chief circumstances to be regarded in urine. And first, of its composition. It will be affected by the age, sex, food, and difference of animal. The process of form-

ing urine is the same in man and animals. Now if we reason here, as we surely may, from analogy, then the effect of age and sex upon the quantity of the essence of urine or urea, will appear from the results of one hundred and twenty analyses of urine.

In 24 hours there are disch'd by men,	432	grs. of urea.
By women,	293	" "
By old men, from 76 to 80 yrs. of age,	122	" "
By children, 8 years of age,	208	" "
By children, 4 years of age,	70	" "

It will be recollected, that each grain of urea is equal to a grain of carbonate of ammonia of the shops, so that a healthy man discharges daily about an ounce of this salt. If, then, other animals are affected by age and sex, as is the human species, then we may say that bulls and oxen give a better urine than cows, steers better than calves, and a venerable old cow gives as much of the essence of urine as two calves.

Food affects the quantity of water, and that acting merely to dilute the urine, renders it weaker in salts for a given amount, though perhaps not the daily amount of salts. Supposing the animal well fed, so as to keep up the wear and tear of his blood and flesh, then as the urine derives its chief value from the worn-out materials of the body, the actual amount of urea daily discharged may be the same, though the amount of the urine may vary considerably. We may increase the amount of salts and acids by particular food, but this can never be continued long enough to change materially the character of urine as a manure.

Difference of animal has also a great effect on the quality of urine. The more active, the greater the wear and tear of the flesh, the better the urine in working animals. Where the animal is stall-fed, there, no doubt, the urine is still richer, and the urine of fattening animals is still more valuable. Hence, of all animals, commend me to swine, as manufacturers

of ammonia. Cast your eye on the table (page 38) of the amount of urea or ammonia furnished by various animals. No one exceeds the hog. He seems specially formed by nature for this office. He eats everything. His habits require very little of that class of food which forms flesh and blood. He is a fat former, a magazine of lard, a real oil butt, and demands, therefore, the food essential to form fat and keep up his heat. He returns, of course, having little lean meat to form, (nobody would praise him for that,) having little flesh to form to increase his size, he returns quickly the waste his body suffers as urea, which becomes ammonia. But it is only the still, and quiet, and penned animal, which gives this valuable product. If we would cause him simply to produce the greatest amount of his manufactory, without taking into account his labor in shovelling over the compost heap, perhaps no better rule can be given than the Shaker practice of feeding with lettuce leaves. Having little brains to replenish or build up, and not quick in his nerves, (for be it known to you, reader, the opium of lettuce leaves is supposed to contribute mainly to the formation of brain and nerves,) the opium-eating hog will return a vast amount of the nitrogen of his lettuce, in the shape of ammonia. If now you add to the facts, common to the nourishment of swine, the action of ammonia on mould, as it has been explained, you will see that he who neglects to fill his yards with mould, and swine to convert it, overlooks one of the cheapest, most effectual, and certain modes of forming manure, which practice and theory unite in pronouncing the surest element of the farmer's success. Not only is the quality of urine affected by age, sex, food, difference of animal, but the season also exerts an influence upon this liquid. The urine of cattle often contains ammonia ready formed in summer, but never in winter. In cold weather, the amount of ammonia, or rather the principle affording it, is less; often it is not one half in winter what it is in summer. This cer-

tainly is a misfortune to the farmer, who generally keeps his cattle up only in winter; but then it is an argument also for the practice of summer soiling.

Secondly, with respect to the circumstances necessary to change urea to ammonia; or, in short words, to fully ripen urine, or to make it a fit manure. These also depend upon the season, in part. It is to be remembered, reader, that this rotting of urine is only fermentation. It takes place, because there is a principle in urine which brings on fermentation, just as it does in new cider. Now if it is by fermentation that urine rots, it will take place, as all fermentation does, best at a moderate temperature. The cold of winter will prevent it. Hence your winter manure must be allowed time, as the heat of spring comes on, to ferment, that the urine may be changed to ammonia; and every means must be taken to prevent the heat rising beyond, in the manure heap, or falling below a moderate temperate warmth. These are the circumstances which chiefly promote the change from urea to ammonia.

Thirdly, in regard to the time in which this change will take place, it will require at least one month; and six weeks are better. If urine be allowed to rot for a month, it fully doubles its quantity of ammonia. In fact, it would have contained more than double the ammonia of fresh urine, had not a portion escaped.

This brings us to our fourth point, the best mode of preventing the flying off of the ammonia when this change has taken place. Much has been said about tanks, and vats, and urine pits, and many plans devised for preventing the escape of volatile ammonia. But when once the action of ammonia upon mould is understood, as we have already pointed it out, I am persuaded, reader, that these tanks, and vats, and urine carts will appear to you not only expensive and cumbersome, but useless. Your first point is, to save your ammonia; your second is never to use urine in its caustic or burning state. If you do, you will as

assuredly burn your crop, as the puddle formed by a cow burns the grass upon which she empties her watering pot. Here the urine, forming caustic ammonia, acts as would caustic potash, or a lump of stone lime, left to slack upon the grass. You want to change this burning or caustic ammonia into mild ammonia, or to combine it with some substance which has not only that effect, but also keeps it from flying away. Unless you understand, then, the principles of these actions, and apply them too, your labor is all vanity, when you attempt to save your own or your cattle's urine.

These principles are in number, two. First, the principle which changes caustic to mild ammonia is carbonic acid, derived from air, or decomposing mould. Second, the principles which render ammonia less volatile, or wholly fixed, are certain acids, formed in mould, as sour mould, or certain salts which give up their acid to the ammonia. Plaster of Paris does this, by changing its lime for ammonia. Now let us go into the reason of this a little, and see if we can understand it. Very slowly, and supposing moisture present, the oil of vitriol of the plaster quits its lime, and unites to the ammonia, and so changes a volatile into a fixed salt. Now this is a change which has been of late much insisted on, and the practice recommended, of strewing the stable and barn cellars, and even the privies, with plaster, to save the ammonia, which escapes in these places. But it is doubtful whether the saving is as great as is usually supposed, for the ammonia arising from the urine is caustic, it flies off as caustic ammonia, that has no effect upon plaster. To produce this mutual effect of ammonia and plaster, the caustic ammonia must previously have been made mild. However, this plan is applicable only on a small scale. Copperas, alum, common salt, potashes, and wood ashes, all act to fix the volatile ammonia, and have all been recommended for this purpose. But it is easily seen, that, in employing

some of these substances, is to buy ammonia almost at apothecary's price. These practices will be followed, therefore, only by those who place the crop and its value upon ammonia. This is a limited and narrow view. The true and farmer-like, as well as the most scientific and natural mode of preserving the ammonia of urine, is to fill your yards and barn cellars with plenty of mould; by which I mean truly decayed and decaying vegetable matter, as well as loam. There is no mode more effectual, no mode more economical. Consider now for a moment, how mould formed and forming, and ammonia act. Have I not said, again and again, that ammonia hastens decay? that it makes mould more easily dissolved? and cooks the food of plants? That action having occurred during its progress, acids were formed. The ammonia unites with them, loses its burning properties, and becomes fixed. The acids having been satisfied, the ammonia is actually imbibed and retained by mould.

It does not drink it in like a sponge, but the mould forms a peculiar chemical compound with ammonia. This peculiar compound, while it does not render the mould an easily-dissolved matter, yet holds ammonia by so feeble a force, that it easily yields to the power of growing plants. It gives up the stored ammonia at the place where, and the time when, it is most wanted. If you remember these actions of mould and ammonia, it will be as plain as day, that what we have said of the inexpediency and expense of vats, and tanks, and urine carts, must not only be true, but is confirmed by the experience of a host of hard-working, thinking, practical men. In connection with urine, the dung of birds, for instance, domestic fowls of all kinds, and pigeons, may be here mentioned. These animals discharge their solids, and what we may term their liquids, together. Their urea comes out combined with, or forming part of their dung. Now reflecting a moment on the nature of their food, strongly nitrogenous, being seeds, grains, &c., or ani-

mals, bugs, grasshoppers, &c., we can understand why their droppings are peculiarly rich in ammonia and salts. The strongest of all manures is found in the droppings of the poultry yard.

But since these form but a small portion of the farmer's stock, and are never regarded as a principal source of manure, their further consideration may be omitted. It may perhaps be here added, that as from their nature bird droppings run quickly into fermentation, with warmth and moisture, so they act quickly, and are quickly done. They are more allied to sheep dung than to other manures. Their mould not being great, droppings of poultry require to be mixed with decayed vegetable matter, or loam. To this class belongs the manure brought from the Pacific Ocean, under the name of *guano*, a Spanish word for excrement. New-England farmers can find cheaper sources of salts, to which the main value of guano is owing, and therefore, reader, we shall detain you no longer on this point.

SECTION X.

MINERAL SALTS, OR MANURES.

HAVING thus considered the salts derived from the animal, let us now proceed to those derived from the mineral kingdom. Among these, we shall find some whose action is similar to that of the animal salts; that is, they are true nourishers of plants.

They afford, by the action of the growing plant, the same elements as the animal salts. Of this nature is saltpetre. Now, reader, I want you to understand by saltpetre, not only that well-known substance, but also that which has lately been much used in farming, South American saltpetre. This differs from common

saltpetre, by changing its potash for soda. One step more. I want you to understand by saltpetre, not one salt, but, in farming, a class of salts; that is, a number, having the same acid, which may be combined with several different bases which all act one way. Saltpetre being a salt, of course must be composed of an acid and a base. The acid is always aqua-fortis, or nitric acid. The base may be potash, or soda, or lime, or ammonia. These all may be called saltpetre. In forming saltpetre, it is generally that variety which contains lime and aqua-fortis which is procured. So far as we understand the action of salts, and this has been fully explained, the action of the varieties of saltpetre is the same; and were it not for the peculiar nature of the aqua-fortis, or acid of saltpetre, the explanation of the action of this salt might be referred to the general laws above set forth. But the acid of saltpetre is composed of volatile ingredients. It is nothing more nor less than a compound of the common air we breathe. Surprising as it may seem, reader, yet it is not the less true, the common air is a mixture of oxygen and nitrogen. What a bland and harmless, yea, what a healthful blessing is air, not only to us, but to plants! It is a mere mixture, not a chemical compound, a mere mixture. In every hundred parts, eighty of nitrogen, twenty of oxygen. Yet if you compel, as natural operations are continually compelling the air to unite chemically, so that fourteen parts of nitrogen shall unite to forty parts of oxygen you will form aqua-fortis. Now, I do not mean to trouble your head further with the chemistry of saltpetre, than merely to say, that having thus shown you the composition and origin of the acid of all kinds of saltpetre, you will readily see, that a substance which affords such an abundance of nitrogen cannot but be beneficial to plants. This nitrogen may, and probably does, form some portion of ammonia in the soil. It may enter as nitrogen into the plants, dissolved in water, as a very weak aqua-fortis.

We have said so much upon the action of ammonia and nitrogen, that you will perceive how important a part nitre is likely to play in manure. Not only does the nitrogen act here, but the oxygen, the other component of the acid, also acts. It acts upon the mould as air itself would. Besides, the mould of soil and manure imbibes and condenses this oxygen in its pores, and consequently heats a little; so that saltpetre, whether added as such to soil, or formed in manure, as it is always, helps to warm a little the soil, like fermenting manure. So far as these effects are desirable they may be expected from the use of saltpetre. But this, reader, if you buy your saltpetre, is procuring a small effect at a great price. The action of the alkali of saltpetre is not different from alkali in other shapes, and therefore if you have money to lay out for salts, let me advise you, reader, to spend it rather for ashes than for saltpetre.

SECTION XI.

OF ARTIFICIAL NITRE BEDS.

BUT there is a fashion in manures as well as in other things, and saltpetre is now so fashionable that you may be inclined to use it. Be it so. I will show you, reader, how to make it for yourself, and at the same time form a large pile of capital mould. But as you have begun to inquire a little into the reason of things, let us go a little into the reasons why the earth under all barns where cattle are kept, why the plaster of old houses and cellar walls, always afford saltpetre. You well know that this is the case, and why? We have already told you, that the acid of saltpetre, that is, the aqua-fortis, is formed of the air we breathe. Now

alkalies and porous bodies compel the constituents of air, under certain circumstances, to unite and form aqua-fortis, and this immediately unites to the alkali, and forms saltpetre. The best alkali to compel this union, is ammonia. Hence, where plenty of animal matter is fermenting, or rotting, or where plenty of urine is, there, porous bodies being present, saltpetre will be formed. Now this is enough for you, to understand the principle upon which I propose to you to form an artificial nitre bed for your own use. It has been found that the manure of twenty-five cows, asses, and mules, in layers of about four inches thick, with layers of the same thickness of chalky soil, first one and then the other, and now and then damped with the urine of the stable, produces from 1,000 to 1,200 lbs. of saltpetre in four years.

The heap is formed under cover, and occasionally shovelled over. At the end of two years, it is a mass of rich mould. It is left two years longer, with an occasional turning over, but it is not wet with urine for the last few months. The dung the farmer has always; he wants the porous chalky body. This may be furnished by spent ashes, mixed up with its bulk of loam. Hence the following rule may be given:—One cord of clear cow dung, one cord of spent ashes, one cord of loam or swamp muck. Mix the ashes and the swamp muck well, and having hard rammed the barn cellar floor, or that under a shed, lay a bed upon it four inches thick, of these mixed materials; then a layer of dung, three or four inches thick, and so on, till the pile is two or three feet high, topping off with loam. Wet it occasionally with urine, keeping it always about as moist as garden mould. Shovel over once a fortnight for two years. The pile now contains about fifty pounds of several varieties of saltpetre, and mixed throughout with nearly three cords of excellent manure. It may, therefore, be now used, according to the farmer's judgment. By thoughtful management, he may, after the first two years, annually col-

lect as many fifty pounds as he employs cords of cow dung. But, however prepared, nitre affords, by its elements, nourishment to plants. All its parts act. Its alkali acts, and its acid acts.

SECTION XII.

ASHES.

It is easy to see that salts, whatever be their name or nature, which are likely to be of any service to the farmer, are those only which either enter into and form part of the plants, or which, by the action of their acid or base, act on the earthy parts of soil, or upon the mould. Salts either poison or nourish plants. The first, like the medicines we take, are good in small doses; the second can hardly injure, even by their excess. If we recur to the principle, with which we set out early in this essay, that the ashes of plants contain all their salts, then, rightly to know what salts are likely to produce good effects as manure, we should first study the composition of ashes. We have, in ashes, a great variety of substances. They come from the soil. They form a part of plants. The dead plant returns them again to their mother earth, or we, losing the volatile parts of a plant, its mould and ammonia, by burning, collect its salts as ashes. Let us see what these salts are made of. In the first place, you know, all salts are composed of an acid and a base.

The bases are,

The acids are,

Potash and soda,	{ Carbonic, or carbon united to oxygen,
Lime,	
	Phosphoric, or phosphorus, do.

Magnesia,	{ Sulphuric, or sulphur united to
	{ oxygen.
Clay,	{ Muriatic, essentially composed of
	{ chlorine.
Iron,	
Manganese,	
Silex, or the earth of flints.	

Now if we throw out the carbonic acid, which has been formed in burning, we have left in ashes three acids, which are united with the bases, and may form the following salts in plants, namely:—Glauber's salt, Epsom salt, common table salt, bonedust, a salt of lime, and what we may term a bonedust salt of iron, or phosphate of iron, plaster of Paris, or gypsum, copperas, alum, and some other salts, which need not be enumerated. Our list comprises the principal, and those most likely to be used in farming. Well, now, the lesson to be drawn from this composition of ashes is this, that there is scarcely any salt occurring in commerce, which may not be used in agriculture, instead of those found in ashes. In fact, almost all salts which occur in a large way, as refuse materials from manufactures or other sources, have been used, and all with greater or less success, as manures. And if you cast your eye over the acids and bases of common ashes, this seems quite reasonable. It is not expected that a plain farmer, possessing little or no chemical knowledge, should be able to tell beforehand what the effect of a salt would be, applied to his land; but if he understands what the composition of ashes is, he may be sure that in any quantity in which the salt is likely to occur, it cannot be injurious, provided it is mixed up with plenty of mould, and a little ashes, or alkali, which will kill or neutralize any excess of the poisonous acid.

In ashes, we have one part which may be leached out, and a part which remains after leaching, called spent ashes. Let us see then, in leaching, what parts

we take away. First, we take away all the acids except the phosphoric. Secondly, we take away nearly all the potash and soda. What is left? All the other bases and phosphoric acid. It is evident, therefore, that the strength of ashes can never be wholly leached out, if that depends upon the salts. In spent ashes, we have nearly all the bonedust left; and, besides this, a portion of what is usually considered the real strength, that is, the potash. This is chemically united to certain of the other constituents of ashes. You cannot leach it out, leach you ever so long. Upset your leach tubs, shovel over your spent ashes, mix it up with fermenting manure, where a plenty of fixed air is given off. Here is the secret of the value of spent ashes, so far as the potash or ley strength is concerned. This exposure to air, to carbonic acid, lets loose the potash, which was chemically combined with the other matters. Water would never have done this. Mark now a practical lesson, taught here by chemistry, and confirmed by experience. Leached ashes must never be used on wet soil, if we want its alkali to act. The close wet soil, perhaps even half covered at times with water, excludes the air. The carbonic acid of air, that which alone extracts the alkali from spent ashes, cannot here act. There is this other lesson to be learned from these facts, that it is chiefly the alkaline action which is wanted from spent ashes. Hence no one who thus understands the source, and the true value of ashes, will allow the alkaline portion to be first leached out, unless he can find a more economical use for it than its application as a fertilizer. Perhaps no fact speaks louder, that the great action of spent ashes is that of its potash, than this, that where we prevent that from being extracted, the spent ashes are of little value. If, then, spent ashes derive their great value from the potash, much more will unleached ashes derive their value from their potash.

Now, reader, the point to which I have led you,

in these remarks, is this, that the more alkaline any salt is, the better is it for manure. Hence, as a general rule about the use of salts, it may be laid down that the alkaline salts, that is, potash, pearlash, common ashes, barilla ashes, white, or soda ash, are the best. And as these, in all their various shapes, are the cheapest and most common articles, so you need not run after a long list of other salts. Next in value to the real alkalies, are spent ashes, used in a light, porous, open, sandy soil, if you would derive the greatest benefit from them. Next to these come peat ashes. You well know these are of no value to the soapmaker. But not so to you. They show only traces of alkaline power. But treat them as you did spent ashes. Their power, independent of their bonedust, which is by no means small, and their plaster, which is still greater, and their lime, which is perhaps the greatest, lies in the alkali, which is locked up, as it is in spent ashes. Treat them, therefore, as you did spent ashes, and then peat ashes will and do afford alkali. So too coal ashes, even your hard anthracite ashes, yield all the substances which spent ashes do. It is easily seen, therefore, when, how, and where spent ashes, peat ashes, coal ashes, are most likely to do good. Perhaps we may not have a better place to state the fact, that a cord of soap-boilers' spent ashes contains about fifty pounds of potash. When we add to this, one hundred and seventeen pounds of bonedust, and about a ton and a half of chalk, or carbonate of lime, which acts chiefly on the soil, and so comes not now under consideration, it is seen that there is no cheaper source of alkali and salts, to one within reasonable carting distance of a soap-boiler, than spent ashes. They are marl, bonedust, plaster, and alkali combined.

SECTION XIII.

MANURES COMPOSED CHIEFLY OF MOULD.

THESE are of vegetable or animal origin. And first, of animal mould. Here we shall find that we come, perhaps, better prepared to understand this part of our subject, than either of the preceding classes. We have explained the principles which enable us to understand why it is that animal and vegetable substances produce, by decay, identical matters. The only difference consists in the quantity of these matters.

Let me here, reader, call to your remembrance the facts we stated respecting the two classes of food, and the two classes of substances formed from that food by animals. A certain portion of that food contains none of that principle which forms ammonia. This portion of food makes fat. Another portion of food contains the substance which forms ammonia. This part of the food forms flesh and blood, and the other parts of the body, skin, hair, feathers, bristles, wool, horns, hoofs, nails and claws, thews and sinews. Now, when a body dies and decays, the mould which it forms will be rich manure, or poor manure, just in proportion as it contains more or less of the substances formed out of that portion of food which furnishes flesh and blood. The fat, therefore, in animal mould, plays a very inferior part to that acted by the flesh and blood. In a word, as I wish to dismiss the fatty matters from our present consideration, I may do this, reader, by stating to you all that you need know, that in decay, fat forms chiefly carbonic acid. If, therefore, you call to mind what we have said about the action of that, you will see how fat acts in manure. But the flesh and blood, and the substances formed from it, give precisely the same things as vegetables do when they decay; that is, water, mould, and salts.

The great difference between the decay of animal and vegetable matters is this, that as the animal bodies are far richer in the substance which forms ammonia, so they afford a richer source of manure. The animal body contains that element in quantity enough, not only to fill the pores of its own mould, but also enough to impregnate a large quantity of mould from other sources. The vegetable body, on the contrary, contains scarcely enough ammonia to fill its own mould. Vegetables differ in the quantities of the elements of food which can furnish flesh and blood; and hence those vegetables are best for manure which furnish most ammonia. We have already remarked on the difference, in this respect, between straws, grasses, and clover. But without going further into this comparison, which can have no other practical bearing than to show you the immense difference in value, in animal and vegetable bodies, in forming manure, we may here resolve the subject into one great principle. The substance which forms flesh and blood, whether derived from plants or animals, alone forms ammonia during their decay, and the mould thence arising is rich or poor manure, just in proportion as it contains the substance fit to form flesh and blood. Starting from this principle, we find that animal substances, as flesh, fish, fowl, the body generally, including its various forms of covering, hair, wool, feathers, nails, hoofs, horns, claws, &c., afford, in the process of decay, about ten times more ammonia than the straws and grasses usually entering into the compost heap. The animal bodies give more volatile alkali than their mould can contain.

It is given off in such quantity that decay is rapidly hastened. All the signs of putrefaction, therefore, rapidly take place. The quantity of mould being small, nothing holds the volatile parts; they escape and are lost. Now common sense and practical foresight have stepped in here, from time immemorial, and taught mankind the necessity and the utility of pre-

venting the waste of the volatile and most valuable parts of the decaying animal substances, by covering them in with earth, soil, &c. These imbibe the escaping virtue or strength, and become rich and fertilizing. It remains to state, that every pound of animal carcass can impregnate ten pounds of vegetable mould; or, taking our arable soils as they usually occur, one pound of flesh, fish, blood, wool, horn, &c., can fertilize three hundred pounds of common loam. You will see, therefore, reader, how little you have now to learn of the necessity of saving everything in the shape of animal matters, and converting them to manure, by turning them into your compost heap. It is to be remarked, that the dry forms of animal substances undergo the process of decay when left to their own action very slowly. Wool, hair, flocks, horn shavings, &c., or even leather chips and curriers' shavings, bear long exposure, and seem quite indestructible. They yet are rich in all the true virtue of manure. They want something to bring this out, to set them a-working, to bring on fermentation. Well, on this head we may lay down two rules. The first is, that if buried among a heap of fermenting matter, that communicates a similar change to these dry, animal substances. This is slow work.

The second rule is, that if these dry matters are buried in the soil among the roots of growing plants, then these act more powerfully than fermentation, and the dry substances are converted to manure with a speed which may be called quick, compared to the fermenting process. The practical lesson to be drawn from these differences of action between the fleshy and horny parts of animals is, that when you want a quick and short action of manure, to use the fleshy and fluid parts. Where you want a more slow and permanent action, to commence and long last after the first is over, to use the dryer and harder parts.

If now we turn to the other division of mould, that from vegetables, we find it lacking in the very thing

which was superabundant in animal mould. That thing is volatile alkali. The great mass of vegetable mould is always impregnated, but always slightly charged, with volatile alkali. There is not enough of the flesh and blood forming element in vegetables to hasten the decay of vegetable matter, or to convert them, after decay, into rich manure. Now here again not science, but practical common sense steps in, and did step in long ago, and as she taught mankind the necessity of adding soil or mould to the decaying animal matter, so here, to enrich vegetable mould, she teaches that animal matter, or that which is its representative, *alkaline salts*, must be added to vegetable mould, to make it active. It is not the mould alone which plants want. We have seen all along how nature provides a certain amount of salts in her virgin mould; we, by cropping, exhaust these faster than the mould. We have tons of that, yet our fields are barren. They want, as has been explained, salts.

And now, reader, having been brought by this course of reasoning to what the mould wants, consider what tons and tons of useless mould you have in your swamp muck and peat bogs, your hassocks, and your turfy meadows. All these, foot upon foot in depth as they lie, are truly vegetable mould, in a greater or less degree of decay. If you dig this up, and expose it to the air, that itself sets it to work, decay is hastened, volatile matters escape, yea, ammonia, the master spirit among manures, is secretly forming and at work, warming and sweetening the cold and sour muck. Without further preparation, practice confirms what theory teaches, that this process alone furnishes from these beds of vegetable mould a very good manure. It is already highly charged with all the salts which a plant wants. But experience, doubtless led by the light of the good results of mixing mould with animal matter, to preserve its strength, has also reversed the practice, and taught the utility of adding to vegetable mould quickening salts; that is, either the volatile alkali, by composting

the mould with stable manure, or alkali in the shape of ashes, or potash, or soda ash, or lime, or a mixture of these. In fact, whatever substance can by putrefaction give off volatile alkali, will and must and does convert vegetable mould, of itself dead and inactive, into a quick and fertilizing manure.

If then, reader, you pause here a moment upon this fact, and then cast your view backward over the principles we have endeavored to impress on your memory, you will perceive that there is not, among all the classes and kinds of manure which we have shown you, one which may not be added, or, as is the phrase, composted with peat, meadow mud, swamp muck, pond mud, or by whatever other name these great store-houses of vegetable matter are called. These are the true sources of abundant manure, to all whose stock of cattle, &c., is too small to give manure enough for the farmer's use. It is the farmer's business to make a choice, if he has any but Hobson's, of what substance, or mixture of substances, he will use. We have shown him how small a portion of animal matter, one to ten of pure mould, will impregnate that substance. Taking then a cord of this swamp muck, we shall find it contains, in round numbers, about one thousand pounds of real dry vegetable mould. So that the carcass of an animal weighing one hundred pounds, evenly and well mixed up with a cord of fresh-dug muck, will make a cord of manure, containing all the elements, and their amount too, of a cord of dung.

But it is not from the carcasses of animals that the farmer expects to derive the quickening salts for his muck. This can be the source of that power only to the butchers, (what fat lands they all have!) or to the dwellers near the sea, where fish is plenty. A barrel of alewives, it is said, fertilizes a wagon load of loam. The carcass of a horse converts and fertilizes five or six cords of swamp muck. A cord of clear stable dung changes two cords of this same muck into a manure as rich and durable as stable manure itself.

These are all the results, reader, of actual practice. The explanation of the principle has only come in since the practice, and showed the how and the why of this action. But the merit of explaining this action would be, is nothing, if it had not conducted one step further.

The explanation of the principle of action of animal matters, animal manures of all kinds, whether solid or liquid, on muck or peat, has led chemistry to propose, where these cheap and common forms of quickening power are not to be had, to mix ashes, or potash, or soda ash with swamp muck. Now, reader, this is not an idle, visionary, book-farming scheme. It is perhaps one of the few successful, direct applications of chemistry to farming, which speaks out in defence of such book-farming, in tones and terms which bespeak your favorable consideration for the attempt which science is making to lend you, reader, a helping hand. This proposal, the offspring of science, has been carried out successfully by practical men in our own country, and has made its way abroad. Though this is not the place to give you the details of their results, you may rely upon the fact, that alkali and swamp muck do form a manure, cord for cord, in all soils, equal to stable dung.

Well now, after your patience in going over these pages, I hope you will find your reward in this statement. To be sure, it might have been said at once, and so have done with it, but I hoped, reader, and I am sure I have not been disappointed, that you liked to dive a little into the reason of things, and felt that you had farmed too long by the rule of thumb, to be satisfied that it was the road either to improvement or profit. And so among your first attempts at improving your worn-out lands, always supposing that you have a barn cellar, hogs, and swamp muck, so aptly called by one of your own self-made practical men, the "farmer's locomotive," I presume you may like to know the proportions in which you may mix

swamp muck and alkali. You can hardly go wrong here by using too much ; the great danger is, you will use too little alkali. But calculating on the proportion of mould in fresh-dug swamp muck, or peat, it may be stated as a rule, grounded on the quantity of quickening power in a cord of stable manure, that every cord of swamp muck requires eight bushels of common ashes, or thirty pounds of common potash, or twenty pounds of white or soda ash, to convert it into manure equal, cord for cord, to that from your stable. Dig up your peat in the fall, let it lie over winter to fall to powder, calculate your quantity when fresh dug, and allow nothing for shrinking in the spring ; when your alkali is to be well mixed in with the mould, and, after shovelling over for a few weeks, use it as you would stable manure.

These quantities of ashes and alkali are the lowest which may be advised. Three or four times this amount may be used with advantage, but both the quantity of alkali and the number of loads per acre must and will be determined by each for himself. It is a question of ways and means, rather than of practice. But supposing the smallest quantity of ashes or of alkali to be used which we have advised, then at least five cords of the compost should be used per acre. This may be applied to any soil, light or heavy. But there is another form of this same swamp muck and alkali, which should be used only on light, loamy, sandy soils, to produce its greatest benefit, though even on heavy soils, if not very wet, it may be used with great advantage. This is a compost of one cord of spent ashes to three cords of swamp muck. This is decidedly the best mixture which has yet been tried. We have in this all that mixture of various salt and mould which plants want, and both by the action of the mould and by that of the air, the alkali of the spent ashes, which no leaching would extract, is soon let loose, and produces all the effects of so much clear potash or soda.

I have thus, reader, given you a few of the ways by which you may convert your peat bogs and swamps into manure, when you have neither cattle nor hogs. I have not thought it worth while to go into this subject further, and give you directions for lime and salt, or other matters which might be used. I have given you the most common, and those well known and at hand. All you want, then, to apply these principles of forming composts, is to give them that little attention which will enable you to understand them. And the rest must be left to your practical common sense, without some share of which, farming, like everything else, would be vanity and vexation of spirit.

End.