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Nec araneorum sane textus ideo melior, quia ex se fila gignunt, nec noster vilior quia ex alienis libamus ut apes.

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LECTURE IN NAPAN.

(Continued.)

The substances which are found in soils capable of bearing crops, and which are essential to that object, should claim the best attention of every Farmer. These substances, few in number, are not more difficult to remember than the names of as many of your cattle. I will repeat the names of these substances slowly, and afterwards describe their properties and appearances separately:—*Alumina, Lime, Magnesia, Potash, Soda Manganise, (or iron), Silica (or sand) Phosphoric acid, Sulphuric acid, and Chlorine.* (Mr Caie then described minutely the appearance, properties, &c. of each of these substances.) Now these ten substances are to be found in greater or less proportions in all soils, and upon the presence in sufficient quantities of five or six of them, depends the power of any land to produce crops: Vegetables contain the whole of these substances, except alumina (base of clay) and manganese, (iron)

If you take any vegetable substance, such as wood, and make it red hot, it will begin at once to diminish in size; and if flame be continued and air admitted, it will go on diminishing in bulk till all the wood be consumed, except the ashes, and the quantity of this ash will vary according to the kind of wood you burn. Now, the parts that have burned away are called *Organic* parts, whilst those that are left are called *Inorganic*. The ash, or inorganic part was derived from the soil, which produced it, being earthly in its nature, and when examined by analysis, it is found to contain these substances which I have described as existing in the soil. (Mr Caie illustrated this by setting fire to and consuming a few rags, describing the substances contained in the ash, as well as those that had disappeared.)

That these Inorganic substances have very great influence over the growth of plants, and that they are absolutely necessary for such growth, I will prove to you by one or two considerations of a very familiar kind:

If you examine those trees that can grow on what are termed barren soils, you will find that they take out a very small portion of the substances constituting the soil. You will all have observed, I am sure, that the pine tree will grow almost anywhere; on a sandy plain, on a barren heath, on the top of a mountain, or in the fissure of a rock, where only a scanty nourishment can be procured. Now if you try, you will find that the wood of the pine will not yield more than about one half per cent of ash. That is to say, if you burn 100 lbs. of the pine you will not have more than 5 to 7 oz. of ash. Take, on the other hand, a hard wood tree, say the oak, the maple, or the beech tree, it will not grow on a sandy soil, but delights in a deep clayey soil.

Now if you take the wood of any of these trees, the per centage of ash will be much greater than in the case of the pine. Out of 100lbs of wood consumed from fifteen to twenty pounds of ash may be obtained. Take wheat now:—The straw of this crop upon which the farmer has to take great pains, takes about 7 1/2 per cent. out of the land, and the ear say 2 1/2, in all 10 per cent, and hay nearly as much.

I will now endeavour to convince you of the vast importance of this inorganic matter. Many people, you know, have foolishly maintained that these substances are of no use whatever. Now I will strive to show you, that they are most serviceable, in fact invaluable, and that without their presence in sufficient quantities, certain plants will not grow at all. The reason why a hard wood tree, say the maple, will not grow so well, if at all, where the pine prospers, is this:—There are not a sufficient number of substances in the soil rendered sol-

uble, that is dissolved by rains, or otherwise to supply each year the inorganic matter to the maple, though there may be quite enough for the pine; and to supply the necessary inorganic substances, for wheat and other crops requires the labor and intelligence of man. I take it for granted, you all know that plants absorb—that is—drink in through their roots these substances in a state of solution (dissolved state) and not mechanically.

Let us now consider the nature of Farm-yard manures. Experience has proved that farm-yard manures contain substances that are beneficial to the growth of all plants. Let us then see, as I promised, if we cannot trace the sources of these manures, and in this way discern why they are so useful. Take that then which you would call good farm-yard manure. How do you make it? Is it not by mixing the urine and excrements of cattle with straw, hay, or other fodder, and allowing the whole mixture to undergo a kind of chemical process, or fermentation? Well after fermentation has proceeded so far, the manure is deposited in the soil, and as I have just remarked, it is invariably found to be beneficial for all crops; there are substances in it which, when placed within reach of their roots, tend to promote the growth of all plants. Let us then enquire from whence do these substances come. Can the animal have any means of producing them by some sort of manufacture of its own? We all know that such is not the case. An animal, say a cow or a horse, in order to sustain life eats vegetable food. Well; this vegetable food, after undergoing a variety of processes in the interior of the beast, is at length cast out, and when examined, a discovery of what has been retained in the animal is easily made. A horse of full growth, which feeds on hay and oats, consumes none of the earthy or inorganic portion of its food. He has to sustain his own animal heat, and to repair the daily waste of his muscles, by the application of other substances similar in their nature to the muscles of his body. Now, the food he eats contains certain principles which go to supply these and other wants. Gluten (a carbonic, gluey kind of substance) goes for example to replace the muscles, and certain other combinations of carbon, such as sugar and starch go to afford the heat; they are in fact, like the coals in the blacksmith's forge, or the Franklin stove—they are consumed to afford the animal warmth. Exactly the same thing takes place I say in the horse, or any other animal as in a Franklin stove. When you put coals in the stove you find that heat is given out, and certain vapours are carried out the pipe or chimney, and if more coals be not added, nothing will remain but the ash, or earthy matter, which will not burn. Now, in like manner, the animal requires each day a certain quantity of vegetable food, this is consumed in the body by the air taken in by the lungs, and the impure air is breathed out in the form of what chemists call carbonic acid gas. You thus see, that in the excrements there are contained all the earthy or inorganic matter, without any of the organic substances, except, perhaps a fractional part, that may not have been but partially acted upon, so that these excrements which you find so valuable, are purely vegetable substances, with the organic matter taken away from them.

I may remark in passing, that the dung of the cow giving milk, is not so valuable as that from full grown cattle, because a considerable portion of the inorganic substances contained in her food is taken away in the milk; and in the case of growing animals too certain earthy or inorganic ingredients have to go to form their bones: so that their dung is not so rich as that of a full grown animal. With the exception, however, of what is required for these purposes; the inorganic portion of the food, is all expelled from the system, in the forms already mentioned.

Now with respect to the straw, &c., which is used to mix with the excrements, it is derived from the same source

exactly as the excrements were: namely—the soil, the animal receiving its nourishment from the vegetable food it eats, and the plant or vegetable deriving its nourishment from the earth and the air.

Let us then enter upon the enquiry whether all vegetable substances are equally valuable as manures, or whether some are not more valuable than others I will show you if I can, that plants which takes the greatest amount out of the soil, will be more valuable for manure, than those which derive most of their substance from the air, and you are already aware of a very simple process by which you may ascertain their comparative merits, viz: by computing the weight of ash remaining after their consumption by fire. You know, as I before reminded you, if you allow manure to rot it gets dissipated (that is separated). The change is brought about in this way: when the heap is wet with the excrements (liquid or solid) fermentation takes place. The oxygen of the air, as already described, forms combinations (that is it unites or mixes) with the organic portions of the manure, which instantly fly off in the form of gasses and vapours. Great heat attends this process, indeed there have been instances of the manure heap taking fire. Now what is the effect produced upon the mass by this process? Why a reducing of that portion of the manure which was derived from the air, and yet you all know, that weight for weight, the remainder of the manure is of more value than was the whole heap at first. Is it not then very evident that the value does not rest in the organic portion of the manure, so much as in the inorganic. It is not denied, however, that organic matter is exceedingly useful, and subserves its purposes in the economy of nature, with equal force and efficacy as the other. Nevertheless I am strongly of opinion that it is not half so essential as many have imagined, and if you will promise me an attentive hearing for a few minutes, I will I think be able to convince you that it is quite possible to grow crops in soils containing no organic matter whatever.

You have all read of a mountain in Italy called Vesuvius. This volcanic mountain every now and again pours out large masses of melted lava (that is sulphurous inorganic matter) in a red hot state. Upon this lava, after it has cooled, the inhabitants of the district around its base, are in the habit of growing crops of wheat without the application of any manure. They take a crop of wheat, then for two years they sow other seeds, and then wheat again, thus they have a crop of wheat every third year without the aid of organic matter of any kind.

There is a country in Germany, where the wood cutters, as they are called, have the privilege of cutting down and burning the underwood of the forest every twenty years, and in this way covering the soil with ash, or pure inorganic matter. As soon as the wood has been burned they are allowed to sow wheat, and reap it at maturity, receiving in this way a crop of wheat every twenty years, out of the inorganic matter collected by the brushwood from the soil in nineteen years.

Do you know what is meant by the expression, Virgin Soils? They are accumulations year after year of rich inorganic matter. Plants have lived and died in the same spot for ages, consequently no inorganic matter has been removed from the soil. Instead of this these plants have been accumulating it from the depths of the soil, and conducting it to the surface.

The Virgin Soils of Virginia on this continent, afford a warning proof that the very best soil, may be ultimately ruined by the removal of its inorganic properties, unattended by a corresponding return to it in the shape of manure. These lands, once the most fertile in the world, grew wheat and tobacco year after year without manure, for the long period of nearly two hundred years. The whole of these crops were either sent away from the country altogether, or at

all events, not a particle of the materials withdrawn, ever found their way back to the land, and what has been the consequence? Why, the boasted fertility of these regions is now no more, except in some few spots, here and there, no crop will grow without an exorbitant expenditure of manure.

I will give you another instance, to show that those substances which contain the largest amount of inorganic matter, are the most valuable for manures. *The case of Bones.* Bones are produced from the vegetables on which an animal feeds; and the vegetables in their turn, derive the substances of which the bones are formed from the soil on which they grew. Until lately, you know people looked upon bones as useless substance: no attention was paid to them, but it has been discovered that bone dust by itself, produces amazing effects in fertilizing the soil. Now, how does this arise? Just by furnishing the land with an inorganic principle, of which it had been deprived by cropping. Some have indeed asserted that the fertilizing effects, produced by an organic substance in the bone, called Gilatine, but you may easily ascertain that this is not the case, by burning the bones, when you will find that the dust or ash will be more powerful than crushed bones. It is therefore evident that it cannot be the organic portion of the bone that produces the fertilizing effects; because during the process of burning, every particle of the Gilatine must have escaped in the form of vapours, &c. This inorganic matter then, which is contained in bones, acts by supplying the soil with a substance of which it is generally the most in need. Owing to the fact that phosphate of lime and magnesia (bone-dust) are only found in small proportions in any soil, and to the prevailing practice of mankind everywhere, of burying the bones of their species, in portions of the earth set apart for that purpose; most soils are more deficient of these elements, than of any other inorganic substance. The application, therefore of bone dust, is only an endeavour to repay the soil, a debt of long standing. But I must have done.

From these statements, then, you may easily perceive, what astonishing advantages the scientific Farmer possesses, over men such as yourselves. By analyzing his soil, the former can at any time ascertain correctly the substances that are best adapted to prepare his fields for the intended crop. In Scotland it has become quite customary for farmers of remote districts, to apply to the Royal Agricultural Society, for a person of scientific information, to visit their localities in order to furnish correct analysis of the various soils subjected to his inspection, and thereby enable the Farmers who employ him, to administer that description of manure which will best replace those properties of which by recent cropping their fields had been deprived. And in many parts of England and Scotland, it is no unusual thing for farmers of best information, to order from the dry salters, the precise article they require, that is, manure, composed of these substances of which their fields stand most in need: just as doctors do when they send prescriptions to be put up by a chemist or druggist.

My aim on the present occasion has been to convince you of a fact which lies at the very foundation of your prosperity, viz., that unless you attain to a far higher degree of knowledge of your business of farming, than you now possess, it will be impossible for you to cope with those who are intimate, not only with the Art, but the Science of Agriculture; and let me tell you, that upon the newly concocted principles of Free Trade, all farmers of all countries, must stand upon the same footing.

I have not ventured to point out any particular method as the best, for the diffusion of that information, which is deemed so desirable. I would, however, in the meantime, be allowed to recommend by way of commencing, the careful perusal of "Dr Johnson's of Edinburg Catechism, and his book of the Farm." The cost of a dozen or two of the former