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LECTURE

DELIVERED IN THE

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ON THE ADVANTAGES OF A KNOWLEDGE OF CHEMISTRY TO THE FARMER.

By the Rev. William Henderson.

Mr President, Ladies and Gentlemen,

Ancient philosophers divided all matter into four principles or elements, viz., Fire, Air, Water, and Earth, from which they supposed all the diversified forms that we see around us to be composed. The researches of modern Chemistry have taught us, that none of these are elements, for all of them have already been resolved into a number of simpler bodies.

In Lectures formerly delivered in this place, I have directed your attention to three of these, Air, Water, and Fire, and now we come to the fourth, namely, Earth. This, however, presents so extensive a field of investigation, that if we were to enter into the subject in all its ramifications, it would take us through a complete course of Lectures on Inorganic and Organic Chemistry. This the nature of your Institution does not admit of; a selection therefore becomes necessary. Wherefore, passing over the former department, or Inorganic Chemistry, I select from the latter, or Organic Chemistry, one of those departments which will be more suitable to the present circumstances of our Province, namely, Agricultural Chemistry. This, however, is a very extensive subject, and therefore in the present Lecture, which will only be a kind of introduction to the subject, I shall confine my remarks to the simple point of shewing the advantages which the farmer would derive from possessing a knowledge of the principles of Agricultural Chemistry.

Agriculture is a science of the greatest importance to mankind, as it teaches how to procure, by the simplest and easiest means, the most abundant supply of the most wholesome and nutritive food. A good supply of food is absolutely necessary to man's comfortable subsistence, and hence a science whose object it is to teach the means of procuring, with the greatest ease and certainty, the necessary supply for the wants of the body, is one to which all the tribes of human beings should unite to do honor; for every human being, of whatever rank or condition he may be, is interested in its successful cultivation.

Agriculture has accordingly been the most universally cultivated, as it is the most ancient of all the arts. The employment of our first parents in a state of innocence was Agriculture, for they were appointed to keep and dress that garden of delights, which was their primeval abode. As vegetable food alone was used by man before the flood, Agriculture must have constituted the chief occupation of the antediluvian world. Immediately after the flood we find that Noah, the father of the new world, began to be a husbandman, and planted a vineyard.* All the ancient nations, who attained any degree of civilization, paid attention to this art. The Chinese, Japanese, Egyptians, Chaldæns, and Phœnicians early cultivated the science of Agriculture. The Carthagenians paid even greater attention to this art than any of their contemporaries, and Mago, one of their ablest generals, wrote no less than 28 books on Agricultural subjects. Nor were the Greeks inattentive to this useful art. Hesiod, a celebrated Greek poet, the contemporary and rival of Homer, wrote a poem called "Works and Days," which is still extant, on the subject of Agriculture. It is also related that during the life time of the two poets, they had a dispute, which of them deserved best of mankind, and that the decision was given in favor of Hesiod, because he was the poet of Peace and Agriculture, while Homer was the poet of War and Contention. Xenophon, and Theophrastus, and several other Greek writers, whose works have perished in the lapse of years, also wrote on this subject. Among the Romans, many wrote on Agriculture. Marius Cato, the Censor, composed a voluminous work on Agriculture. Columella, who flourished in the reign of the Emperor Claudius, wrote a complete treatise on this subject in 12 books. Pliny, Varro, and Palladius also wrote on Agricultural subjects: and Virgil, the prince of Latin poets, has employed the majesty of verse, and the harmony of numbers, to allure the attention of mankind to the husbandman's labours.

In modern times the greatest attention has been paid to the improvement of this art. Societies have been formed, experiments have been made, and means used to diffuse information, and to direct the attention of the farmers to the various improvements that are continually making: but it was not till of late that scientific Chemistry was called in to direct the efforts of the practical farmer. Before this was done, much useful information had indeed been acquired. Long experience had enabled farmers to collect much information in regard to the nature of soils, the application of manures, the draining of land, the selection of seeds, the introduction of useful implements for abridging labor, and the improvement of their breed of cattle. But it is only within the last half century that Chemistry has carried its researches into organic substances, developed the processes of their growth, and the matter of their composition, and thus has taught scientifically and surely, many means of contributing to the advancement of Agriculture.

The chemical researches of Sir Humphry Davy, Professors Shier and Johnstone, the French chemists Boussingault and Payen, the German Liebig, and many others, who have directed their attention to Organic Analysis, have communicated to the farmer a certainty in regard to the mode of cultivating his grounds, which he could not otherwise have attained.

All plants arise out of the earth, and draw their nourishment, either from the earth in which they are planted, or from the surrounding air. They are not created out of nothing, but are made to spring out of the ground. Not a particle enters into their composition, but what is supplied to them either from the earth, the water, or the air. This matter thus supplied forms the nourishmeet of the plant, and is as necessary to its growth, as food is to the human body. This nourishment is drawn in part from the air by respiration through the instrumentality of the leaves, but principally from the earth through the roots, which have the power of drawing in the necessary nourishment, which is then, by the circulation of the juice, conveyed to every part of the plant.

Plants strike their roots into the soil, and scatter them around in all directions, that they may come into contact with as great a quantity as possible of the soil, from which, by means of those minute fibres that are attached to the root, they suck in moisture impregnated with minute particles of those substances which enter into the composition of the plant. This moisture, together with the particles of matter dissolved in it, constitutes the sap, and this sap, by means of a series of curiously-constructed vessels, is conveyed through every part of the plant, furnishing in its progress those materials which contribute to the growth of the plant, in the same way as the nourishment taken into the body is converted into blood, and by the arteries distributed into every part of the body, to supply the waste of the animal substance continually taking place, and to furnish materials for its further increase.

Now, in order that any plant may grow, the sap, which circulates through its stem, must contain all the materials, from which the nourishment of the different parts of that plant is obtained; and as the sap is drawn out of the ground, it is evident that all those substances must be contained in the soil, otherwise the plant will not flourish there.

Now, here is one of the advantages resulting from a knowledge of Chemistry. It teaches to analyse the different plants and herbs, and shews the various substances which enter into their composition, and the proportions in which they are required. It teaches also to analyse the soils, and to find out the materials of which they are composed, and the proportion in which these materials enter into the soil: and from this the farmer learns what soil will be most suitable for any particular kind of crop, and also what materials would require to be added to any portion of soil to render it more productive.

Plants are found to consist of twelve or fourteen simple substances, namely, oxygen, hydrogen, nitrogen, carbon, potash, soda, lime, magnesia, oxide of iron, oxide of manganese, silica, chlorine, sulphuric acid, and phosphoric acid. All these elements do not enter into the composition of every vegetable and plant; neither do any two plants take any of these in the same proportion. On the contrary, Chemistry has shown that there is a very great diversity in the composition of the different plants and vegetables that are raised, and consequently that some plants will flourish better in some kinds of soil than in others.

For example, Professor Johnstone, in his Catechism of Agricultural Chemistry and Geology, tells us that a ton of Italian rye grass hay, takes into its composition 81½ lbs. of silica, whereas a ton of red clover hay contains only 5 lbs. of this ingredient. Again he tells us that a ton of Italian rye grass hay contains only 13¾ lbs. of lime, while a ton of red clover hay contains 55½ lbs. of that substance. Hence the farmer would discover that Italian rye grass would produce a most abundant crop on a sandy soil, and red clover on a calcareous soil.

Now, as Chemistry teaches to analyse the vegetable productions, so it also teaches how to analyse the soils, and thus enables the farmer to discover their components parts, and consequently their productiveness. Professor Johnstone has given us, in his Catechism of Agricultural Chemistry, the analysis of three different kinds of soil. The first, of a soil, which had produced crops for sixty years, without manure, and which still contained a sensible quantity of all the substances required by plants; the second produced good crops when regularly manured, and the third was hopelessly barren.

I. The first, or that which was fertile without manure, contained in 1000 parts of soil, 97 parts of organic matter, 648 of silica, 57 of alumina, or clay, 59 of lime, 8½ of magnesia, 61 of oxides of iron, 1 of oxide of manganese, 2 of potash, 4 of soda and 2 of chlorine in combination, forming chloride of soda, or common table salt, 2 of sulphuric acid, 4½ of phosphoric acid, and 40 of carbonic acid in combination with the lime and magnesia.

II. The second, or that which required constant manuring to render it fertile, contained 50 parts of organic matter, 833 of silica, 51 of alumina, 18 of lime, 8 of magnesia, 30 of the oxides of iron, 3 of the oxide of manganese, a trace, or just only enough to be perceptible, of potash, no soda nor chlorine, ¾ of one part of sulphuric acid, 1 3-4 of phosphoric acid, 4½ of carbonic acid in combination with the lime.

III. The third, or that which was barren, contained 40 parts of organic matter, 778 of silica, 91 of alumina, 4 of lime, 1 of magnesia, 81 of the oxide of iron, ½ of a part of the oxide of manganese, a trace, or just what was perceptible, of potash, no soda, nor chlorine, no sulphuric acid, no phosphoric acid, and no carbonic acid.

From these specimens you will observe that silica, or that earth which forms the chief component part of flint, quartz, rock crystal, or sand, constitutes a very large proportion of most soils, and it is a component part of all vegetable productions. Alumina, or clay, enters into the composition of very few of the productions of the soil. Its use is principally to retain moisture, and other soluble ingredients, in the soil, sufficient to supply sap for the vegetable productions. A very sandy soil, unmixed with clay, would allow the rain that falls very rapidly to percolate through it, and to carry the lime, and other manures spread upon it, in a very short time down below the space to which the roots of plants could reach. Hence such a soil is soon exhausted, and requires a great deal of manure. A thin coating of clay spread over such a soil would enable it to retain the moisture, and other materials necessary for the nourishment of plants, and hence would greatly assist its productiveness.

In regard to the organic manner, you will observe that while in the very fertile land there were 97 parts, in that which required constant manure, there were only 50 parts, and in that which was barren only 40, or not nearly half of what was in the very fertile soil. Again in regard to lime, in the very fertile land there were 59 parts, in that which required manuring 18, and in the barren only 4 parts. The very fertile land contained 40 parts of carbonic acid in combination with the lime and magnesia; that which required the application of manure had only 4½, while the barren land had none at all. Again, the fertile land had a considerable portion of soda, chlorine, sulphuric acid, and phosphoric acid, while the barren land had none of these. But on the other hand, while the good soil had but 61 parts of oxide of iron, the barren soil had 81; and this may have contributed in part to its barrenness, as this substance is injurious to the growth of plants.

Hence it appears that there may be two causes for the unproductiveness of land; first, a deficiency of some of the substances necessary to supply nourishment to the plant, or secondly, a superabundance of some pernicious ingredient.

For example, hardwood contains a considerable quantity of potash in its composition: it would be folly therefore to plant the oak, the maple, the ash, or the birch, on a soil which contained no potash.

Wheat and oats contain a very large proportion of silica in their composition: it would therefore be useless to sow them on a soil which contained no silica.

Peat moss forms a very valuable manure, when mixed with other soils containing a superabundance of silica or sand, but it would not do to sow either wheat or oats on a soil of pure peat; because it would not obtain a sufficient quantity of silica, which enters largely into the composition of these grains.

But as a deficiency of some ingredients in a soil will render it unproductive, so also will a superabundance of some even of those ingredients which are necessary for the support of vegetables, and which, applied in small quantities, form an excellent manure.

For instance, chloride of soda, or common salt, is one of the component parts of a fertile soil, and salt has often been applied by farmers to their land as manure. Sir John Pringle maintains that salt in small quantities assist the decomposition of animal and vegetable matter, and this prepares them for entering more freely into new compositions. It is also offensive to insects, and hence it has often been employed in gardens, especially on onion beds, being thinly sprinkled over the ground in dry weather, and then watered, to carry down the salt, which destroys the maggot that attacks the roots of this plant when young, and drives away the worms. But when used in large quantities, it renders the ground sterile. Hence it is sometimes sown thickly on garden walks, to prevent weeds from springing up in them, and in scripture we read of sowing a land with salt, as an emblem of consigning it to perpetual sterility.

[Remainder next week.]