

THE SOIL OF THE FARM.

ITS FORMATION, ITS PREPARATION FOR VEGETATION, AND HOW PLANTS FEED FROM IT.

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It is generally admitted to-day that the "rule of thumb" is not a good rule in dairying, and it is rapidly being superseded by more practical and common-sense methods, with, as we know, the most gratifying results. Yet the mainspring of production of the farm crops, the cultivation of the soil and the feeding of the plants, is almost universally in the country done by "the rule of thumb." Few know what soil is, how it originated, or what constitutes a soil in proper condition for the highest production of all kinds of plants. Our soils are the result of the action of natural forces, principally fire, frost, air and water, acting upon and grinding up the rocks. These ground up rocks have been moved forward by the action of water in floods and ordinary flows, the heavier or coarser portions sinking earlier in the stream, the finer or lighter portions at various times being carried further from the coarser and finer soils. Upheavals have also occurred causing the shifting of these deposits. Various kinds of soil are also due to the elements contained in the different kinds of rock, as for instance, the clay soil resulting from the disintegration of feldspathic rock.

Now, such soils as I have described were almost wholly of a mineral nature, and contain in varying degrees mineral elements. These elements are nearly all necessary to plant production, but, as plants are found to possess also the elements of atmospheric air, it was necessary that these soils should in some way become possessed of the atmospheric elements. No doubt the slight acquisition of these elements obtained by the admixture of air and water sufficed for the nourishing of many forms of wild plants, but experiment has unerringly shown that the cultivated varieties which are grown on our farms to-day will not yield crops of any importance in such soils. How then did these soils become what we term fertile?

The perfection of natural law produces a class of plants which can grow and thrive in these mineral soils. This class of plants is found to contain an enormous supply of the element of the atmospheric air needed. These plants, which we term the legumes, or food-producing plants and clovers, obtain the atmospheric element by feeding upon the micro-organisms in the soil, which convert the atmospheric elements into food for them. All that is required is that the soil shall have a sufficient proportion of available phosphate of lime to bring into life these organic bodies in the soil. The vegetation thus formed dying on and in the surface soils render up, by decomposition, a form of nitrogen of atmospheric origin, upon which the other classes of grasses and grains develop and feed themselves to perfect growth and ripening. Also the acids of this vegetable humus act upon the mineral elements in the soil making them available plant food for higher types of vegetation.

The plants which we grow to-day on our farms are not the original wildlings,

but they are selections which the farmer has assorted from his seeds, breeding, as it were, to the best and most suitable, and developing them by care and feeding to produce the most and the best food for man and beast.

Experience has taught us that to properly grow and improve our crops certain conditions must be obtained. The soil must be thoroughly worked; air must be incorporated with it, as the plants breathe through their roots; water must be held in it so that each particle of the soil is surrounded with a film of water, for the plants must drink; vegetable humus must be present to supply nitrogen to everything except the legumes. So you see plowing and harrowing are important factors, in fact, the very meaning of the word manure is "manual laboring of the soil." There is some diversity of opinion as to whether this working of the soil should be shallow or deep. A shallow soil is all that is required for the grains and grasses if the mineral element is in some way added to and mixed with the humus; but, upon

maintenance of fertility in it to reproduce again. Plants need for their perfection some eight or ten of the mineral elements of the soil and the elements of the atmosphere, but the elements entering into most of the farm crops which materially impoverish the soil are potash, lime and phosphoric acid from the mineral elements, and nitrogen from the atmosphere, which is four-fifths nitrogen. As far as it is now known all the plants, except the legumes (clovers, peas, vetches, lupins, etc.), must have the nitrogen converted from the air by being first taken up by some other bodies which give it up when decomposing; consequently the necessity for some kind of humus matter, as stable manure, mulch or green crop ploughed or harrowed in, to supply this element to grains, roots, and other farm crops. Of these elements the straw of the grain crop used for litter carries back to the soil most of the potash and much of the nitrogen removed by the crop. The lime and phosphoric acid is perceptibly diminished by the removal of the grain, as nearly all this



Diagrammatic representation of the relations of the root-hair to air and water in the soil. The angular bodies are earth particles sheathed with a surface film of water. The root hair descending from the root has a similar water film upon it. Larger portions of water fill in the interstitial angles. The numerous blank spaces, similarly film-encircled, are portions of air distributed among the mass.—From *Saunders*.

analyzing the produce of shallow cultivation, it will be found not to contain as much feeding value as the produce of deeper cultivation, nor as much bone making material. This is quite reasonable, as a shallow soil to be rich must contain a very large proportion of humus in the form of animal or vegetable manure, from which the bone earth has been extracted by the animals or the ripened grain. It is not like the virgin soil, where the whole vegetation of a variety of plants has been allowed to die and their bodies decompose in the soil. A richer soil results, as these plants with their stronger root acids have dissolved and made available through the rotting of their dead bodies much mineral food, which our farm crops could not themselves convert to use from the earth.

Now that we have an idea of what soil is, and particularly of what virgin soil from the prairie or new forest is, let us inquire what effect growing farm crops from it has, and we may be able to judge if we have been treating it in a rational manner with a view to the

element passes to the ripened grain, and in fact ripening is largely due to it. If we feed the produce of the farm and return only the manure got from the animals, together with the straw litter, again we find a great loss of lime and phosphoric acid, which for the sake of shortness we will now mention as phosphate, the name given to the two combined. The reason for this is quite easily found, for the animals do not return in their manure much of the phosphate, using it instead to build bone and muscle. The bone is largely indestructible so that the phosphate assimilated from the feed is not wasted, only that portion of it which is not digested therefore passes off. It is quite different with the other elements. The continuous waste of the flesh is carried off by the sewage of the body as manure and contains most of the nitrogen and potash consumed from day to day. As the ripened grains and fruits of the farm are all used to build bone and muscle in the animals and people on the farm, and are sent to the cities there also to build bone and

muscle, and, as this muscle does not waste rapidly, and the bone practically not at all, in the life of the animals and man, the element which forms it is gradually but surely carried away from the farm, and can only be returned by finding some substance containing this same element in a form available to plants. This is imperative on us, and the attempt to supply it has taken various forms from insoluble ground bone to super-phosphate, which is a chemically dissolved phosphate of lime. It is not my intention to discuss the various forms of phosphate, but merely to direct your attention to the necessity of in some way supplying phosphoric acid and lime in combination. There is no longer room for doubt that we can supply nearly all the potash and nitrogen required for ordinary crops by the careful saving and using of our animal manures and litter. As regards the potash, we have the further benefit of having large quantities of it in most mineral soils, particularly in clay soils, which is easily brought into form for plant food by adding plenty of vegetable humus to the soil, the humic acids of which assist in freeing it. As for nitrogen, it is an elusive element, very expensive to buy and very difficult to hold when obtained, as it is inclined to pass off again into the air from which it comes. During recent years a means of obtaining it has been found in the growing of peas, vetches, or clovers to plow down as green manure, so that even without any stock we are enabled to supply the land with it. Moreover, in this manner it is obtained free. This is a most important matter which you may better appreciate when I tell you that Dr. Dehlinger, in Germany, found that by growing peas and vetches in the grain stubble and plowing them down in the late autumn or spring he obtained from 178 to 267 pounds of nitrogen per acre free from the atmosphere. This is equal to from twenty to thirty full-weight gross tons of the very best carefully preserved stable manure.

Now, I must again refer to the importance of phosphoric acid. Phosphoric acid exerts a dissolving influence in the plant so that the nitrogen, potash, and other elements are kept in solution while the plant grows, and finally passes into the ripened grain or fruit. It has been very clearly demonstrated that without it the other elements are wasted, and this will account for many failures with farmyard manure and other manures. So much for the soil and its fertility, and we will now take a peep at the plants themselves and see how they obtain and utilize this food which, we will presume, is prepared for them.

The seed put into the ground is really the food of the plant. This food contains the germ of life which under the influence of warmth and moisture asserts itself, and begins to feed upon the food supplied to it in the fruit. This food is in a concentrated form, and if the food is perfect, nourishment is provided to give the little germ great strength, and it emerges from the womb and puts forth its little tentacles or roots to attack and eat the food of the soil, both mineral and atmospheric. There is a general impression that there is something wonderfully mystical in this process of root feeding. Not so,