WHAT IS A GOOD SOIL*

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My part in these Food Production broadcasts is to talk to you for a few minutes about the part the soil plays in growing the crops, and to explain very briefly why some soils are good and others are bad; how good soils can be kept good and poor soils can be improved.

But first of all what is soil? If you went into York Street and pulled up a paving stone on the footpath and smashed it up into pieces so small that it would blow about like dust would that be soil? Or

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if you went onto the shore and chose the cleanest of sand could that be accurately described as soil? The answer to these two questions is emphatically No, because, although the particles might be just about as small as those of the earth in your garden, or on your estate or small-holding, they would lack a certain quality of stickiness which soil possesses, and which it gets from two sources; first from the decayed remains of plants and animals, and second from the chemical action of water in which some of those products of decay are dissolved. This stickiness, properly controlled, is a most important property as I shall try and show you later, and it is those ingredients in a soil which the soil scientist calls colloids, (a word which really means 'like glue.' but sounds more mysterious because it has a Greek origin), that are the most important ingredients.

The decayed and decaying vegetable and animal remains in soil are referred to agriculturally as humus, and it needs no emphasis to make it plain that the soils which are likely to be the richest, other things being equal, are those whose surface layer is most richly provided with humus, in particular from forest and luxuriant grass land. It is fatally easy, however, to place too much reliance on the apparent luxuriance of the vegetation that grows on the land, especially in tropical climes. Nature is never so economical with her goods, never so to speak so good a housekeeper as she is in forest land, but she is slow, and it takes hundreds and thousands of years to lay down that fertility which we associate with the humus of virgin land. When we bring such land under production, we require that our crops should grow at an altogether different speed from that of the forest. The minute we fell a jungle or break up a grass land we speed up the release of plant foods in the soil by the mere letting in of sun and air, and by breaking up the surface we accelerate still further those processes which Nature has hitherto managed with such care. That is the price we have to pay for the prospect of quick-growing crops and high yields, but unless our preparations are done with care it may turn out to be a bitter price in soil impoverishment and, in this country, soil erosion.

That brings me to the first point I wish to make in relation to soils and food production, that no cultivator worthy of the name should be content to exploit the accumulated fertility of virgin soil. If he does, he will soon face, in greater or lesser measure, conditions similar to the dust bowls of America, the barren acres of Australia, or the scarred gullies of far too much of our Ceylon hill country. Wherever steady productive agriculture is carried on, in England in the west, in China in the east, the fertility of the land is in a real sense man-made, and rich soil reserves are constantly being re-created by sound agricultural practice. Only so can we think of fertility in terms not of two or ten seasons but of hundreds of years. True, our minds are at present concentrated on what we can do in the next few years, but let us not ruin the land permanently in the meantime.

In certain respects a fertile soil is like a fertile mind: it must be ALIVE: it must be WELL CULTIVATED: it must NOT BE SOUR. Let me explain these three points and show how they fit in with one another, and with the production of food. The mixture of mineral and dead vegetable particles which I have already called soil, even before any crop is grown in it is the home of a vast population of living plants in the form of fungi, which we meet frequently in everyday life as moulds and toadstools, and of bacteria with which ordinarily we have hardly a nodding

acquaintance because they are too small to see. If you put some soil in a glass tumbler mixed with a few teaspoonful of tea dust and keep it just moist enough to be able to turn it out in its shape without breaking it, you will see in a matter of five or six days a gossamer film of fungus between the soil and the glass. It was there all the time, but having given it some tea to feed on, it has rapidly grown and made itself visible. The bacteria you will not see, and you will have to take my word for it that if you made a little heap of fertile soil on a one-cent piece there would be at the very least two thousand million bacteria in that heap. These two kinds of minute organisms each in their proper place break down the raw plant remains in the soil and on the soil, prevent the soil from getting cluttered up with such debris, turn it into the humus and 'glue' of which I spoke earlier, and in the process release food for the growing plant in the form it best likes. This they do minute by minute, year in and year out. The medical world has popularised bacteria as nasty things that make us ill. Well, some of them do, but others are wholly beneficent and our food, health and life depend on them. Of course these bacteria and fungi are neither entirely nor consciously philanthropists: they use these vegetable remains as their own food. So in order that a soil shall be alive it must be fed with vegetable remains in one form or another. That is why it is important not to exploit the original fertility to exhaustion. Compost, cattle manure and green manure are the appropriate food for micro-organisms and your food production should be based on using any or all of these to capacity.

The tale of the good that soil bacteria do is only half told when we have considered how they contribute to the larder on which the food crop will draw. The roots of the plants need air and water and not too much of either, and a good soil is one which, when the weather is dry, will retain enough moisture to tide the plant over till the coming rain. Similarly, first-rate soils allow surplus water to drain to lower depths to underground reserves and never become water-logged. Now the secret of such versatility lies largely in the size of the soil particles and in the way they are grouped together. A soil that is all small particles or all large ones is not a good soil. It either holds water too firmly in the pores between the particles because they are too small, or not firmly enough because they are too large. A judicious mixture is best, formed into crumbs in which large and small lie cheek by jowl. And when it rains, as only our tropical skies know how to rain, it is imperative that the fine particles shall not wash down and silt up the crevices. That is where the glue, the colloid, comes in. It holds the water like a sponge in dry weather, it keeps the soil crumbs intact, open and well drained in the rainy season and, equally important, thus prevents the surplus rain from merely running over the surface causing soil wash and erosion.

To preserve this wholly desirable state of affairs a soil must be well disciplined or cultivated. The plant remains have to be well mixed with the soil so that the colloid humus coats every particle. Humus is not indestructible, and cultivation ensures that new and suitable combinations of particles are formed into crumbs from time to time, and that sufficient crevices exist for young and exceedingly delicate roots to penetrate and ramify in the soil without being damaged. A soil can be over-cultivated, or cultivated in unsuitable conditions, as for instance when it is too wet or too dry. But the margin of safety that lies between these two extremes is greatly increased by the presence of adequate supplies of organic

matter broken down by the living population of the soil.

The water held in the pores of the soil is never pure water; it is not even of quite the same composition as the raindrops. As the humus in the soil is slowly dissipated, burned up by contact with the air which occupies roughly one half of the volume of what looks like solid earth, part of it is changed into carbon dioxide. Dissolved in the soil water this produces a weak acid, carbonic acid, which dissolves the valuable mineral foodstuffs more readily than would pure water. From this very weak solution the plant absorbs its mineral food, but as it is the mineral elements in the soil that keep it sweet, in time even a good soil will lose its sweetness and become sour. At this stage poisonous substances begin to dissolve which the delicate roots of most plants cannot tolerate and the crops begin to fail on such soils. The sovereign remedy for this is lime which checks the acidity and restores sweetness to sour land.

In order to tell you how the soil behaves I have taken it to pieces so to speak, and perforce I have spoken of the nutrients it contains, the bacteria, the colloids and the mineral particles as if they all played separate parts. In reality all the aspects I have been speaking of dovetail into one another like the pieces of a jig-saw puzzle. Lime for instance helps the bacteria and fungi to break down the raw vegetable matter; so does the air that permeates the soil when it is properly cultivated. Again, these micro-organisms would cease to function if sufficient moisture were not present. But it is by the work of these same bacteria and fungi that the balance of air, water and food is so happily maintained. That is why the answer to the question, What is a good soil is "Soil that is alive, that is well cultivated and is sweet."