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SOIL AND HEALTH

William A. Albrecht, Ph.D.

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Some Imbalances, Deficiencies and Deceptions via Soil and Crops

It may seem to be a far stretch of the imagination to make a connection between **soil** and **health.** But when degenerative diseases are increasing, they remind us that we have no scapegoat but our own nutrition. Proper nutrition is the total support of the body and the guard of its health. We shall eventually come around to see the soil, and what it grows in our food, as the basis of what our bodies (and minds) really are. It was a geologist who said "We are what we are because of where we are." Then it was a geographer who added weight to that remark when he said, "We are what we eat." In summation, those two generalizations connect our soils with our bodies and our health.

All of us are ready to grant that any living body must be nourished if it is to survive. But we do not grant so readily that the soil is the producer of that nourishment. We might accept the latter as true for the nourishment of microbes, or plants, or animals. But we have not been well enough informed to grant that man, as another animal, is also limited by the soil, even though he is not fixed in one place. He refuses to grant that he too must fit himself into the biological laws of nature, so well exemplified by other life-forms below his. Instead, he assumes that he might take over the control of nature.

In pursuance of that ambition, man has lived according to the behavior pattern suggested by Col. C. L. Boyle, who said,

> "For generations, the conquest of nature has been accepted as man's prerogative, but man is a part of nature, it being his essential environment and unless he can find his rightful place in it he has poor hope for survival. Man's present behavior often resembles that of an over-successful parasite, which in killing its host accomplishes also its own death. Man's environment is the whole natural scene, the earth with its soil and water, its plants, its animals. In many places these have reached a natural balance which man disturbs at his peril."

By failing to see that man must fit into the soil pattern just as any other life form fits into that great scheme, man has about destroyed all the surface soil. He has left nothing that would still represent the original soil patterns of Nature to guide his maintenance of the soil according as Nature would make her recommendation or She would maintain it. Man has not heard the "Voice of Nature" in these respects.

If we study the geography of primitive man, it is interesting to note that he seems to have been located in areas of lesser rainfall, or in regions of even occasional famine, if Joseph's story may be taken as an indication. He was located for survival where the winds mixed the soils by dusts blown in, by mineral matter delivered by the waters in their river floods. With his high requirement for fertility essentials from the soil, naturally the soils which supported man as a primitive had to contain all the essential, both major and minor, inorganic nutrient elements. They had to offer the calcium, the magnesium, the potassium, the phosphorus, the copper, the zinc, the manganese, the cobalt, and all the inorganics which we now know are required in the nutrition of the warm-blooded, high-protein bodies, like man, his flocks and his herds.

In those primitive locations man's numbers would soon reach the saturation point or the population limit set by the area. The population problem of too many of the primitives did not reach

very large numbers in any locality before it pushed some of them out. Accordingly as technologies were introduced, man was compelled to colonize other areas under the struggles involving him in serious and bloody wars. He ventured out only short distances each time because, as he went away from the soils which had been guaranteeing a survival, he moved to those which would not be so much of a guarantee unless he had lifelines reaching back to the soils where he had learned, by experience, that his survival was possible. He moved, then, into areas where primitive man had not been, and very probably because the nutritional level of that soil was not equal to the fullest requirements for his survival without some lifelines reaching to other more fertile areas.

All Populations, Whether Man or Microbe, Depend on Food

If we study the growth of the populations as numbers of the human species on the earth—plotted as a graph in relation to time—we find that the curve fits exactly the same laws which are demonstrated when we drop a single microbe into a large quantity of sterile nutrient medium and count the microbes as they multiply and populate the limited volume of that food source. In that microbial demonstration we have the biotic, or the sigmoid, curve shaped like the letter "S." (Figure I). With but one microbe put into a large volume of medium at good incubation conditions, the growth or multiplication of the population at the outset is relatively slow But soon it increases until the numbers of microbes seem about to reach infinity. At that moment, the curve is rising almost vertically. But soon it turns toward the horizontal and the increase in numbers ceases. That upper, horizontal part of the curve demonstrates the increasing food troubles for the rising populations. Those troubles may, in part, be brought on by accumulated waste products. But more commonly they are due to the decreased food supply. Just as such microbial population curves level or flatten off, so many of the human population curves have already flattened off in the world's older areas of exhausted soils under extended and intensive use. (Figure I).

At this moment in our population problem in the United States, we are apt to emphasize various political situations. We seem to have forgotten the serious biological situation of man in relation to his foods, particularly the supply of proteins. A look at the curve of the population of the United States during several decades of the past leads us to believe that we can go on increasing our population forever at the rate of one percent per year without ever dreaming that our curve of population must flatten off as those of all populations eventually must. We do not imagine that it might drop suddenly, or have partial rises as recoveries, and that it never can go back up to the maximum height again with the favorable health conditions of the once maximum.

We have excellent examples in some of the older countries where the population curves have flattened off long ago and where their struggles for "lebensraum" have been quite evident for some time. In the United States, we are in the vanguard among the populations of the world. But even we are about to get around the world to the starting point in the ancient East or in the Orient from which apparently, the earliest population took off for the Westward March of multiplication in the open territories. Our ancestry was a part in the dash to the open country to the West across the Atlantic and farther. We scarcely appreciate some of the significant historical facts connected with problems of feeding the many in the expanding populations. We scarcely think of that as the situation when MacArthur completed that Westward march around the world and was held up politically in what would have started the second circuit of food search around the globe by the hungry human populations.

The streams of human population have always flowed from arid soils to humid ones. Those flows occurred only as the technologies helped in the travel and as they lengthened and maintained the life-lines reaching back from the newly established peoples, when they had gone to less productive soils without first considering those as guarantees of food for health. Moved to those newer soils, we indulge as populations in an agriculture of which we speak as "specialized" when it would be more fitting to say "limited." It is limited because the soils are not complete enough in respect to the list of essential inorganic elements in their fertility supplies; nor are those supplies large enough in their stores of individual elements; nor are those soils amply stocked with organic matter to represent higher potentials of proteins in plants and all else associated with them to guarantee the health of humans and other warm-blooded species, both wild and domestic.

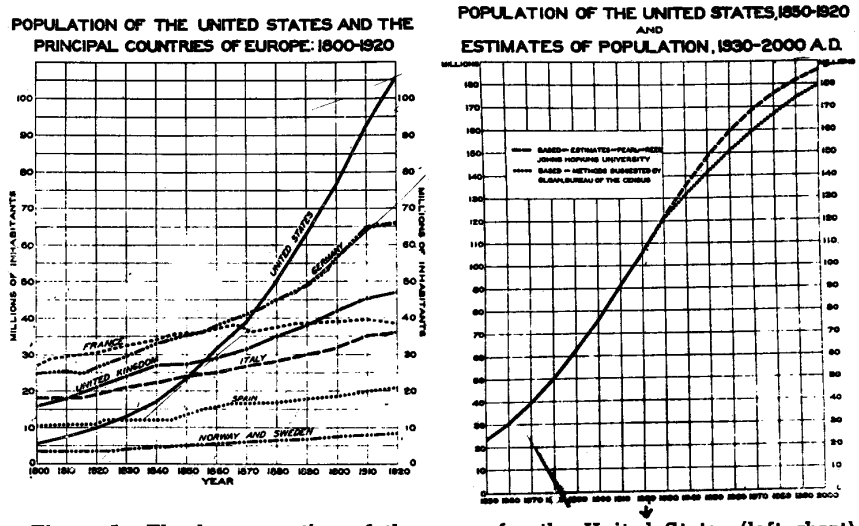

Figure I.—The lower portion of the curve for the United States (left chart) suggests a start of a population. The curves for the other and older countries suggest the congested populations. The predicted future curves for the United States (right chart) point to a horizontal part in prospect as the curves for the older countries already have it.

Virgin Vegetation Suggested the Health Potential of the Soil

Each new soil, as we discovered it, originally had its climax of virgin vegetation and, in case of more fertile soils, had also its climax of animal life. But in the absence of animals there, we did not observe that fact as a report telling that the vegetation was mainly of carbohydrates and of too little protein for warm-blooded bodies. On such soils, the fertility may be imbalanced so far as the plant's nutrition is concerned and thereby the plant products are apt to be imbalanced so far as their services in the nutrition for the animals is concerned. When those so-called "newer soils" are seeded to legumes for protein production, all crops behave physiologically like non-legumes, their pedigrees not withstanding. The deficiencies in the soil fertility make the plant practice a kind of deception. Plants, then, so handled are, nevertheless, a kind of hyprocrite. Their appearances in quantity may be deceptive of their low nutritional quality.

Unfortunately, we have looked at our lands in terms of only two dimensions, namely length and breadth. Under the campaign against soil erosion by the early Soil Conservation Service, we were introduced to a third dimension, namely, the depth of the surface, the living soil. We need to see also now, however, the fourth dimension, namely the inorganic and organic fertility as that represents the power of the land in the creation of the living forms of animals and man by way of that living soil.

The climaxes of the virgin vegetation, and even the natural recovery of vegetation on some of those soils which we have abandoned and turned back to Nature after we had worn them out, tell a significant fertility story if we can see the land in terms of soil and of that resource in its cycle. The virgin climax may be grass that feeds the cattle. It may be trees such as hardwoods that feed our deer. Or it may be the conifers that starve them. It may even be legume trees, like the mesquite, which cattle and other animals refuse to browse, save under threat of starvation.

Natural climaxes of vegetation represent various stages of soil development. At first that development is a case of soil construction, building up to the potential of the more complex proteins. More soil development under more rainfall and higher temperatures thereafter, represents soil destruction. With this there comes (a) the decline in the crop's nutritional output from proteins for growth, protection and reproduction, (b) less and less yield, (c) more pests and diseases, (d) vegetative reproduction rather than one by seeds, and finally (e) crop failures. In our use of the soil, we have too often disregarded its lesson about the health of any plant. Much less have we considered the term "health" so carefully discriminated as to emphasize those qualities of a particular plant species resulting on a particular soil because of a particularly well-balanced fertility. The seed catalog seems to decide what crops will be planted when the decision should rather be made according to the soil as nutrition for the crops that are expected, (a) to grow, and (b) to deliver nourishment for man or beast. As a consequence, under crops making higher feed values and taking more out of the soil more speedily, the drop in soil fertility was disastrous on even the fertile soils within the time of one human generation without any alarm for us. Both the quantity of crop and its quality as nutrients soon decline faster than the fertility of the soil indicates even if followed by chemical inventories.

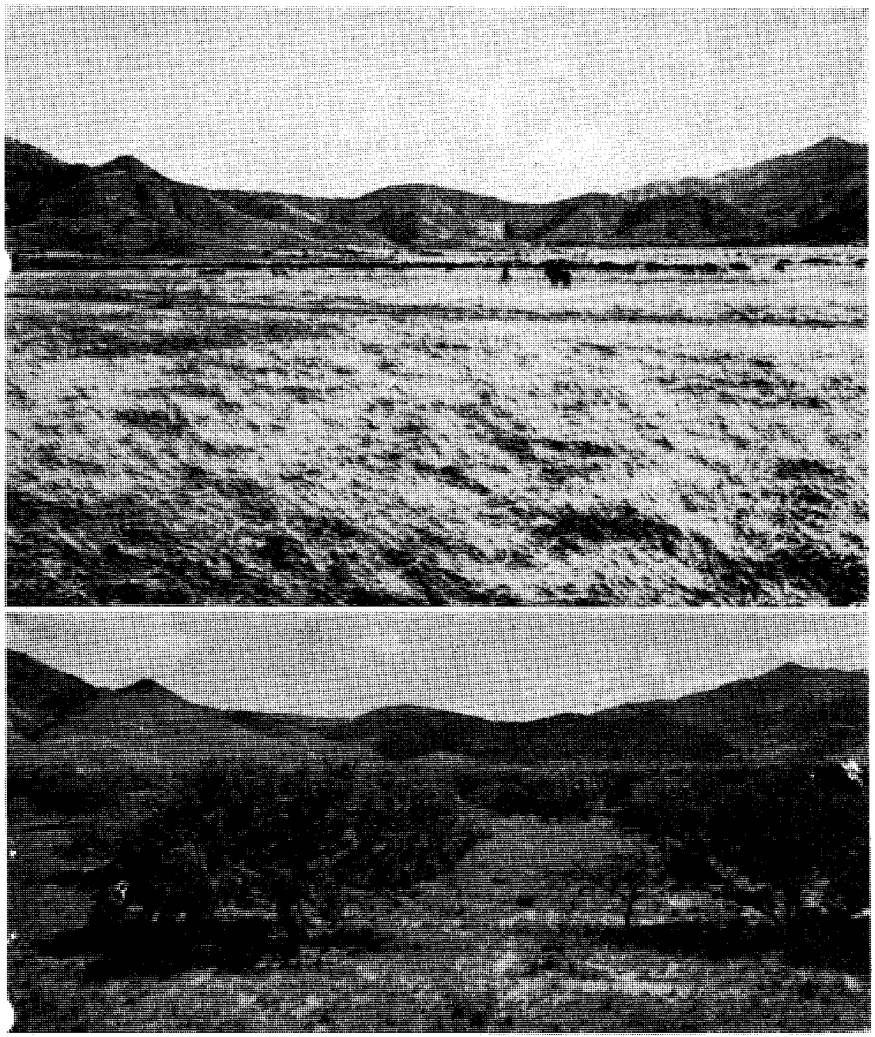

Figure II.—In 1903 (upper photo) the climax vegetation was a heavy, protein-rich grass crop in this Santa Rita Valley as the result of the build-up of its own organic matter. After the cattle kept removing the grass crop, the climax vegetation became mesquite bush.

(Lower photo, same position 1943. Courtesy U.S. Forestry Service.)

Quantity As Yield May Be Deceptive of Quality of Food

The declining yield as quantity of crops is readily recognized. But the decline in nutritional quality might be seriously ahead of a noticeable decline in quantity (of yield). The decrease in quality, therefore, is apt to go unrecognized. During soil exhaustion there are shifts in the ratios of the amount of nutrient elements in it due to consumption of the supplies of some elements relatively more rapidly than of others. This means shifts in the dietary balance of the plant's nutrition. Consequently, it means increases in the products of photosynthesis, namely the carbohydrates going upward, but a shift downward in the products of biosynthesis, namely, the proteins.

Some elements in the soil go out of balance with more seriously disturbing effects than others. Among these are the monovalent elements or the more soluble elements, especially, nitrogen and potassium. Then since calcium and magnesium, as divalents, are also more soluble, especially when they are in the form of salts of carbonic acid (bicarbonates), they, too, shift in their ratios to others in the soil and cause wide variation in the carbohydrate—protein ratio of the products grown within the crop. Thus the changing ratios of fertility elements are the cause of the changing nutritive ratios (carbohydrates to proteins) in the feeds we grow to make these represent the fattening and not the truly feeding of the growing animal, (including the human).

Such variations in the plant compositions are a part of the natural ecological pattern of crops on soils under construction by lower annual rainfalls and also on soils under destruction by higher rainfalls. Such is the result with fertility exhaustion either by the natural weathering processes or by intensive cropping. The case can be nicely demonstrated by single cropping continuously on a soil even in experimental tests. Here, then, are the deficiencies and imbalances in the soil fertility which compel the crop to practice its deception on those who judge the soils only by the amount of bulk that any crop might grow on them.

When we feed only to fill and to fool, we neglect the animal in terms of real health and natural protection against invasion by foreign proteins like the microbes. Should we be surprised, then, at the increasing animal "diseases" and degeneration, exhibited in failing conception and in the production of midgets or dwarfs as the resulting births without potential future growth? If we emphasize the production of crops only for fattening castrated males, naturally, we can not expect the animal species to survive. The streams of life cannot be expected to flow in spite of us when our attention is so completely focused on economics and technology in place of on the basic biological laws of nature, by which animals, plants, and microbes must live.

Incomplete Proteins Result From Infertile Soils

In the nutrition of plants, the ample presence of calcium has connected this element with protein production, particularly by the legumes. If we are to grow proteins, we lime the soils under higher rainfalls. But the soils must also provide potassium if the legumes are to make the sugar which the plant converts into proteins by its own life processes. Then also, the calcium and potassium must be in certain quantitative ratios if they are to balance the plant's own nutrition even for its production of the carbohydrates. Even legumes, grown on a soil low in calcium and magnesium, may behave physiologically as a non-legume. They may make mainly carbohydrate bulk and little protein.

Imbalances, then, in soil fertility as nutrition give plants which are unable to build proteins and the protein-like compounds, including the antibiotics, by which this type of growth protects itself. Diseases and pests then plague those same crops which in the virgin, ecological climaxes were protecting themselves when there were no commercial pesticide sprays and no similar poisons.

Recent researches suggest that nutrition of the plant through balanced soil fertility may be more of a prevention against fungi, bacteria, and insects than we appreciate. Studies in potato scab demonstrate the fact that correcting this tuber damage may be a matter of the fertility balance between calcium and potassium by which the resulting plant's own processes possibly bring

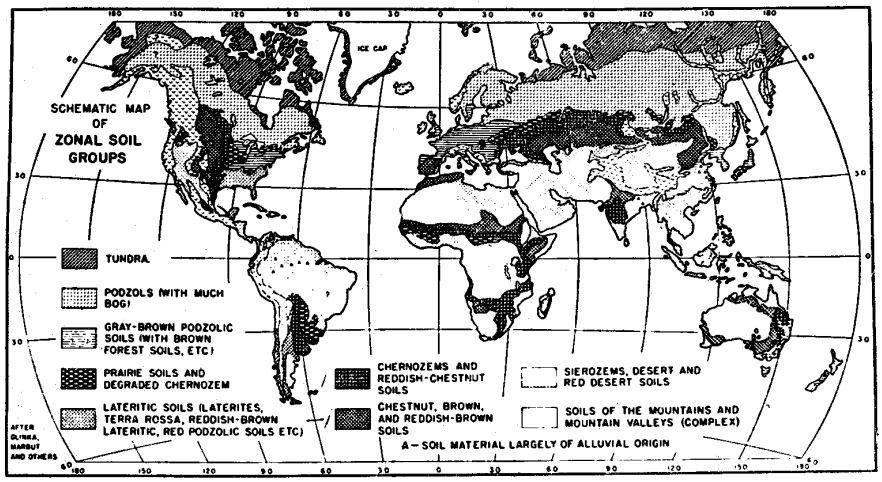

Figure III.—The soils that grow proteins, illustrated by the mid-continental United States with its Chernozems, Chesnut, and Prairie soils, are very limited in area according to the soil map of the world. The shortages of protein foods because of soil fertility deficiencies are more causally basic to political problems than we appreciate when "an empty stomach knows no laws."

copper, etc., from the soil amply as the antibiotic agents when the former two fertility elements are in the proper balance of ratios.

We are apt to emphasize the economics under the sale of poisons and sprays more than we are to indulge in careful studies of plant nutrition for prevention of diseases. That this is the situation, was illustrated at the scientific meeting only this past holiday season in the Agricultural section of the American Association for Advancement of Science. In their program dealing with "biological and chemical control of plant and animal pests" the first session covered recent advances in chemical control measures. Another part of the program was devoted to "inherent resistance to pests" including animal diseases, plant insects, and diseases of field and horticultural crops. In the twenty-four well-prepared papers which were presented at four sessions, it is significant to note that "one paper covered the relation of host nutrition to pest reaction." Unfortunately, as this program had it, only about four percent of our thinking goes to the concept that plants are sick from imbalanced or deficient nutrition and thereby become the victims of microbes in the form of fungi or bacteria and even of our insects, while the 96 percent of our thinking emphasizes the poisoning of the enemy rather than the building of healthy plants by fertile soils.

We fail to realize how the latter type of thinking may be a case of growing poor nutrition for ourselves and our animals as food instead of better nutrition by guiding the nutrition of the plant for its own health and protection against its diseases and enemies. We are slow to see that the soil must undergird our health. We are still slower to see the imbalances, the deficiencies, and the deceptions in our crops in relation to this old truth of good nutrition as the basis of good health, for any form of life.

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