# AMBASSADOR COLLEGE

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## INTRODUCTION TO SOIL PRINCIPLES

Productive farming is based on the law that life comes only from pre-existing life. Soil fertility is a LIVING PROCESS. Living organisms provide for living plants which in turn provide living food to support the life of animals and men.

Mr. Herbert Armstrong approved and appointed a committee to look into and reevaluate our agriculture problems and questions. Much valuable study and research had already been done, and other study and experiments were being carried on by staff members of the Colleges.

The purpose of the committee was to meet, discuss and consolidate the thinking and findings of all and present the material at a coming conference.

By "putting our heads together" and comparing information we found some beginning and basic steps to proper, tangible agriculture methods.

### Results of Experiments and Studies at Big Sandy

We feel a real breakthrough in changing from artificial to natural methods of farming is that of being able to shorten the length of time required to economically make the switch.

The soil beneath our feet is a marvelous and miraculous creation. There are three basic constituents of soil which much be in balance if health-sustaining crops are to be produced. These are: minerals -- dirt and rock particles which form the foundation of "skeleton"; organic matter, which is decomposed excretions and the dead remains of plants and animals; and a community of living organisms. The organisms convert both the minerals and the organic matter -- or humus -- into plant food.

When soil is out of balance through use of poisons, soil life is killed and most of the minerals of the soil are "locked up" and unavailable for use of plants. The object of soil redevelopment is to restore this natural soil life and balance and thus release the potential productivity. Chemicals and poisons have been forced into our soils, resulting in mass slaughter of its living organisms.

There are three basic constituents of soil which must be in balance if health-sustaining crops are to be produced. These three are: 1) the dirt or rock particles which form the foundation or "skeleton"; 2) the organic matter -- wastes or dead remains of plants and animals; 3) and a vast community of living organisms.

A way has now been made possible to begin restoring this living culture of soil organisms at a much speeded-up rate which will in turn help speed soil rebalancing. This is not a panacea to soil restoration. It is, however, an important aid in accelerating the process. Proper tillage methods, organic matter, land rest, proper use of natural rock fertilizers, good management are still a must.

Here are some of the results after six months of "restoration." At the time of the conference we had taken crops from two fields and the garden area with other crops still in process. The first crop harvested was a 27-acre field of silage sorghum. We had planted leftover seed of this same crop planted on the same field the preceding year (1965). The 1965 crop grew to approximately three feet in height, turned a yellowish-red color and grew no more. This was baled for hay and produced only 12 tons. In February 1966, we ran soil tests and found an unbalanced condition, the soil being highly acid and almost void of life. We applied 2,000 pounds of crushed limestone per acre, a heavy application of the bacteria culture, and disced it in. About a month later we applied 500 pounds of "organic," and 500 pounds of diatomaceous earth per acre and disced it in.

The crop raised this year was quite different. It grew 14 to 15 feet high, had a beautiful green color, and produced 260 tons.

However, most soils would not be as expensive to condition as ours. We had only loose sand as a base. Many soils already have sufficient minerals and need only organic matter to produce living organisms and a natural balance.

Another interesting result was with our milo crop. Our neighbor across the road planted his crop "at just the right time," a good three weeks before we did. He used heavy amounts of chemical fertilizer. For a while his crop looked, and was, way ahead of ours. We were pressed for time and were able to apply only the soil bacteria culture. When harvest time drew near, both crops looked similar from the road, maybe his looked better. The difference was quite revealing when we began to harvest. We had gotten two or three "unseasonal" showers which helped us greatly. Mold formed between the berries on his milo and as it ripened the mold turned to a black, dusty blight. When harvested it was lightweight and made 12 bushels per acre. The berries on ours were large, bright, firm and made 41 bushels per acre.

Our wheat and oats were harvested after the conference. According to our local county agent, wheat is not grown in this area. Our wheat made 31 bushels per acre, and the oats made 45 bushels per acre. These would not be outstanding quantities in some areas of the country, but for an area that doesn't grow wheat it is pretty good.

Society has promoted highly specialized occupations not only in the fields of the arts, business, technical science and industry, but just as much as in the field of agriculture. Educators in this field gloss over and depress the need for diversification and true fundamental knowledge.

Since the conference much has been learned concerning the ecology -- or environmental balance -- of plants in relation to each other, to the soil, to animals -- and their relative values. This is basic in that proper soil, plant and animal ecology maintain the soil and begin to build new soil once it has been restored to a balanced state. It takes the interrelationship and interdependency of all facets of the field of agriculture to finally produce healthy human lives.

## What Is Soil?

The soil is not, as many suppose, a dead, inert substance merely supplying mineral elements and providing a place for plants to anchor their roots. A healthy soil is full of living organisms.

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The difference between sick soil and healthy soil is BALANCE -- in essence, LIFE. A lack of organic matter, with a subsequent lack of micro-organisms will throw soil out of balance. Soil is out of balance when most of its minerals are "locked up." This occurs when there are not enough soil bacteria to change the minerals into food for plants.

The object of soil redevelopment is to restore soil to its natural former balance and thus release the potential productivity of the stored-up minerals. A balanced soil is one that has the correct amount of minerals, organic matter and living organisms to produce the kind, variety and amount of vegetation for which it was created.

Many think a balanced soil is one with a "pH" level (degree of acidity or alkalinity of soil) of 7. A soil with a pH of 7 is simply a neutral soil, but not necessarily a balanced one.

The soil has varying degrees of acidity and alkalinity. Many types of plants need varying pH levels (some 7, some other than 7) to produce healthy, quality plants. However, an abundance of humus will enable plants to tolerate different pH levels.

## The Soil Particle

The soil under our feet is not solid! It is actually a layer of billions of grains, or soil particles, ranging in size from finest clay

particles smaller than 1/2000 of an inch in diameter to coarse sand particles up to 1/12 of an inch across, some of which are decomposed rock.

A continuous supply of minerals is being made available as long as the soil is in balance. According to some authorities, the supply of minerals in the soils covering the earth is inexhaustible. But, only the living faction of the soil, the microbes and earthworms, can make these minerals available in the right balance for healthy and health-sustaining crop growth.

Each of the tiny mineral particles in the soil is covered with a tight-fitting film of oxides, water, and bits of organic matter. This film provides a habitation for the teeming life in the soil underfoot.

To show the tremendous capacity the soil has for containing organic matter, and the fantastic surface area of the soil particles on which multitudes of organisms live, notice this example! One ounce of soil, sampled at Britain's Rothamsted Experiment Station, was found to have surfaces adding up to 250,000 square feet, about six acres!

When we notice the awesome capacity of the soil for life, it becomes apparent that we need to farm in such a way as to allow these organisms to carry on their natural functions of providing soil fertility! Soil life isn't something insignificant or trivial! This life is the difference between vibrant health and wretched degenerative disease in the plant, animal, and human realms.

## Organic Matter

In healthy soil, each particle of dirt or mineral matter is coated with organic matter.

Organic constituents of the soil are obtained from living and dead plants and animals, plant roots, green manure crops, animal manure, crop residues, fungi, bacteria, worms, and insects. The importance of organic matter in the soil cannot be stressed too strongly.

Organic matter supports the soil's living organisms; aids in the bringing of insoluble soil minerals into solution and holding them; improves the physical condition of the soil; increases water-holding capacity; improves aeration; regulates soil temperature; and serves as an important source of nitrogen and other plant food elements. It also reduces erosion and increases productivity. Normally the more organic matter a soil contains, the healthier it is.

When rains come, soils with ample organic matter soak up the water. Where organic matter is lacking, water runs off the land wasted, and carries topsoil with it, producing erosion. No mineral mass, regardless of how fine its particles, can absorb as much water as does an equal weight of organic matter, for the mineral can hold water only on the surfaces of the particles. Most of the crop land in the United States has suffered moderate to severe erosion.

Organic matter is about 50 percent carbon. Carbon acts as a buffer to excessive acidity or alkalinity and helps keep the soil sweet and maintains conditions most favorable to good plant growth.

As organic matter decays in the soil, the most bulky product of this decay is carbon dioxide gas. This gas disolves readily in soil water to produce carbonic acid -- a natural reagent for dissolving plant nutrient elements from the mineral particles and making them available to plants.

Organic decay, through the working of soil bacteria and soil acids, unlocks minerals and makes them available for plant usage. There is usually little shortage of plant minerals in most farm soils.

Much of our land has been seriously depleted of organic matter chiefly because of improper cultivation, erosion, and the use of chemical fertilizers, herbicides and insecticides. Large, unnecessary losses in organic matter are caused by "burning over" land and by burning crop residues. We cannot improve and maintain the productivity of our soils without regularly replenishing the organic matter!

Practices of maintaining and replenishing organic matter include: 1) growing sod, cover, and green manure crops; 2) the proper use of weeds; 3) conserving and applying manure and composts; 4) conserving and applying crop residues; 5) controlling erosion; 6) right tillage practices; 7) and the replacement of soil bacteria. Applying the first four principles automatically replaces soil bacteria, or the process can be speeded up by applying bacteria as a liquid culture. A major key to maintaining soil balance is ample organic matter.

## The Living Soil

A healthy soil is very much "alive" and dynamic, teeming with bacteria, actinomycetes, fungi, molds, yeasts, protozoa, algae, worms, insects, and other minute organisms which live mostly in the top few inches of the soil.

This hive of living things in the soil, the eaters and the eaten, adds up to incredible numbers. The bacteria alone may range from comparatively few up to three or four billion in a single gram of dry soil. In good soil the bacterial matter, living and dead, may weigh as much as 5,600 pounds per acre.

The fungi may add up to a million in a gram of dry soil, weighing over 1,000 pounds to the acre.

Among the most important of the soil-making crew is the humble earthworm. He is nature's own plow, chemist, cultivator, maker and distributor of plant food. Humus-rich soil easily supports a worm population of 26,000 per acre. Worms eat inert minerals and organic matter and mix these digested minerals with their bodily secretions. Each year they deposit as much as 10 to 20 tons of castings on the surface of an acre!

Worm castings are shown to contain 40 percent more humus than the surface soil. They are a humus factory manufacturing vast amounts of balanced plant food. The Connecticut Experiment Station shows that the casts of earthworms are five times richer in combined nitrogen, seven times richer in available phosphate, and eleven times richer in potash than the upper six inches of soil. Depositing castings is only a part of the good that earthworms do. They pull organic matter down under the soil, and by their digestive juices break it down into a form usable to the plants. They burrow down to eight feet or more below the surface and bring up rich minerals that plants need. The burrows improve aeration of the soil, permit the penetration of surface water, and help facilitate the downward growth of roots.

"Myriads of small creatures spend parts of their lives in the soil; ants, beetles, wasps, spiders, and many others. About 95 percent of the roughly one million insect species spend part of their lives in the soil." (Living Earth by Farb, p. 5).

The activity of these creatures combines to carry on the work of plowing, mixing, and fertilizing as they add their remains to the land. If these living organisms use up all their food supply, billions of them die or become inactive. The life processes in the soil slow down until further stores of food are added. As in most of nature's activities this whole life cycle in the soil becomes a self-regulating system, an organized community, adjusting its numbers to the food supply so long as it is undisturbed by outside forces.

While the soil lives, stored-up energy is constantly being used for food by the teeming hive. A good soil's health is actually a matter of life and death to the plants and animals that live on its surface. Our health is also dependent on its health.

## Why Soil "Wears Out"

Soils become "worn out" when they no longer contain sufficient organic matter to maintain an adequate population of soil organisms to make mineral nutrients available to plants.

As virgin land is plowed up, the increased oxygen made available greatly stimulates the bacterial crews into breaking down the organic matter at a more rapid rate. Unless organic matter is returned to the soil in the form of crop refuse, animal wastes, compost, cover crops, etc., the supply of organic matter is eventually used up.

In nature we find a variety of plants growing together and animals wandering about eating a selection of herbage and pausing here and there to "pay their dues." Plant and animal litter accumulate together on the surface to compost and decay, feeding the micro-organisms a balanced diet and making a health-sustaining humus-rich soil.

Without food, the population of soil microbes (millions per gram in healthy soil) diminishes and no longer makes available sufficient nutrients to grow crops.

## Symptoms of Sick Soil

Healthy soil, as we have seen, requires a balance of minerals, organic matter and living organisms. When this balance is disrupted, low-quality, disease-ridden, insect-infested crops, which do not sustain health in man or beast are the result. This is caused by allowing the organic matter to become depleted and by poisoning the soil with wrong types of fertilizers which destroy the living organisms.

Sick soil becomes hard, difficult to work. It fails to absorb rainfall. Erosion is the result. It becomes either too acid or too alkaline and vital trace elements are "locked up," and thus become unavailable to plants.

Sick soil produces sick plants which produce sick animals and humans. Thus sick soil becomes largely responsible for the increasing worldwide plagues of disease that are threatening mankind in this age.

## How to Revitalize Sick Soil

To heal sick soil and bring it back into profitable production of high-quality, health-sustaining crops, it is necessary to stop using the farming practices which have caused the trouble.

We have successfully rejuvenated some soil in three to four months on the college farm in Texas and harvested good crops the following season without using any artificial fertilizers. The cost was less than half the expense of using artificial fertilizers.

There is always the question, "where to begin?"

The first step is to determine as much as possible where your soil presently stands, so a plan of action can be formulated. A soil test is helpful here. It will give a guideline to the available N-P-K (nitrogen, phosphate, potash) and the pH level. As mentioned before, organic matter is the key to soil balance. This should always be increased. A soil test will help tell you what is "locked up."

For example, if the soil is too acid, organic matter and ground limestone will bring it back into the growing range so soil organisms can multiply rapidly and begin to work efficiently.

Soils low in phosphorus or potash may need an application of ground rock phosphate or potash rock. Since one application of these minerals lasts for a number of years, in most cases the soil organisms will begin to liberate sufficient supplies from the earth itself so further applications will not be needed.

Nitrogen-fixing bacteria (rhizobia) live in nodules on the roots of legume plants such as clover, peas, peanuts, soybeans, cowpeas, vetch, and alfalfa. These bacteria are capable of adding as much as 200 pounds of nitrogen to an acre of soil each year.

Nitrogen can also be added by applying manure and compost. Most nitrogen of plant and animal remains is locked up and must be liberated by the living bacteria.

Still other forms of nitrogen-fixing bacteria make nitrogen available to a plant directly from the air.

## Tillage Methods

The methods and practices used in preparing the soil for planting have a considerable effect on the natural processes going on in the soil to produce fertility.

Many different types of plows and other tillage implements are on the market but not all are equally efficient in putting the crop's refuse and organic matter where it will do the most good. Disc plows, rotor tillers, chisel plows, and that type are very useful and effective. They chop and mix crop residues into the topsoil which aids greatly in the process of decomposition.

The moldboard plow, however, is quite different. This type plow turns under and buries all protective mulch material in a layer several inches below the surface of the earth. It packs the surface trash into a narrow layer subject to great pressure both from the weight of the soil above and the wieght of the tractor and machinery passing over it. This pressure produces heat which "burns up" this material rather than allowing it to decay or ferment (which is the natural and beneficial process). This "burning" creates harmful acids and reduces the production and availability of beneficial nitrogen.

Still further, the compacted layer of trash serves to create a barrier which prevents moisture from "wicking" from the subsoil below to the roots of the plants growing above. It hinders the roots of the plants from finding the moisture that lies below. At the same time, the earth above the compacted layer is left bare to all the processes of wind and water. This creates a condition of drought between the surface of the soil and the compacted layer of organic material below.

In some few cases the use of a moldboard plow may be effective to break up a very hard soil to permit the mixing of organic material to improve the hardened condition.

Proper tillage practices leave a mulch on or chopped into the soil's surface. This prevents the evaporation of rainfall, vastly increasing the soil's ability to absorb and hold water. It aids greatly in controlling the blowing or washing away of the soil, and produces best conditions for a steady rate of decay -- a moist seed bed and plant food supply.

## Restoration

The system of rehabilitation we have described recognizes the fact that the average farmer is economically forced to grow a revenue crop from his land while he is restoring it.

Through proper tillage methods, cover cropping, and the application of soil bacteria, diatomaceous earth (mineral source), "organic" (organic and mineral source), we were able to produce two quality crops in a year on our experimental plot from once poor, sandy soil.

In our greenhouse we presently have tomatoes that weigh one-half pound to one and one-half pounds of excellent quality. Our soil was on its way to normality in less time than it could have been under conventional organic methods.

Costwise - production expenses of natural farming are less, and should be.

This system of soil development employs the methods which are designed in nature to rejuvenate topsoil, simply speeding up the process. One inch of topsoil residue per year can be established if these natural principles are followed properly.

This process achieves a kind of resurrection in which dead soil once again becomes alive!

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