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MANAGING SOILS UNDER TROPICAL CONDITIONS

Some Underlying Concepts

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Usually when one hears a title about soil management he thinks about the ways that we manipulate soils to improve or increase yields of some crop. That is, we think about drainage of wet lands, irrigation of dry lands, the kinds and amounts of fertilizers to add, seed bed preparation, weed and insect control, the harvesting of a crop, and rotations that may be beneficial in an area.

I want to briefly comment on some other concepts that such a title brings to my mind, partly because they depart from the traditional meanings suggested above.

1. The first concept is that of a soil under tropical conditions.

There are many ways to classify or group soils. To speak about tropical soils implies that we have discovered some very compelling reasons for grouping these soils together. What is it that permits us to make such a sweeping generalization? In reading about the experiences of others and from a very limited contact of my own, it appears that soils in the tropics and sub-tropics are very diverse. I do not find it useful for most purposes to think about tropical soils. I do find it useful to think about soils in tropical regions.

Diversity of soils occurs because they are the result of climate and biota as modified by local topography, acting on a parent material throughout some period of time. These soil forming factors and their effects on soil processes can be subdivided into many segments. The unique combinations of these segments result in many specific kinds of soils whose properties differ from one another.

The geographic distribution of the soil forming factors in the tropics has given rise to more diversity of soils than in any other zone of the world. I am suggesting that as soil scientists we must be quite explicit with our use of words if they are to convey the concepts that we wish to convey. In the past, we used the general term "tropical soils" and it reflected our lack of understanding. Today we speak about specific kinds or groups of soils that occur in the tropics. For me there are no tropical soils; however, there are many, many kinds of soils of interest in tropical regions.

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2. Another concept brought to mind is about problems of soil management.

There are very few general principles of soil management that can be applied to soils of the tropics that you would not also use for soils in other regions. But it is extremely important that we search for and understand those principles that are additionally significant to some soils in the tropics. There are certain sets of conditions in some tropical areas that do not readily permit the transfer of technology. These are the conditions or the problems which we are trying to understand better so that an appropriate technology may be developed for these special conditions.

There is a relatively simple concept about an ideal soil for farming. It is a soil that drains freely but not too rapidly, it permits good root growth, it has adequate moisture and nutrients, it does not erode excessively, it is easy to till, and it will produce economic yields under the applied technology. There are possibly three ideal soils in the world, and people are still looking for the other two and a half. Yet if we use the conceptual model of an ideal soil as a reference, then we can list the properties or conditions that are not permitting us to obtain the desired results. It is possible to compare or contrast any specific soil condition to that of an ideal arable soil. The magnitude of difference indicates the challenge, and a reduction of this difference is one measure of our success in obtaining the desired effects. There are some soil and environmental limitations very distant from the ideal and often it is not economically feasible to overcome such limitations. Soils with excess salinity, soils with frozen layers at shallow depths, and permanently innundated soils are but a few examples. Thus, we can use a model of an ideal soil to help us state our own objectives more clearly and precisely. It also allows other people to better understand our purposes and methods of approach to the solution of management problems.

3. The next concept deals with the scope or breadth of management.

Management is a way of doing something to produce a desired effect. Although our main concern is usually the production of food and fiber, there are many other kinds of soil management that need to be considered.

To produce crops economically on a commercial scale, and make the products and by-products available to consumers, requires goods and services in support of such an agriculture. There is a need for trucks, farm machinery, gas, oil, seeds, fertilizers, insecticides, and so forth. These goods and services are provided by non-farm people. They live in villages and towns and they have additional social and economic needs that, in part, may depend on the management of soil resources. For example, there is a need for buildings, streets, cities, sanitation systems, water, and roads to other centers, and so these people also depend on soil as a resource.

Even if is possible to produce the biggest, the best, the highest quality product, it may rot in the field or be destroyed by pests during storage if marketing, processing and retailing are ignored as part of the agricultural development of a region.

The concept of soil management should, therefore, never be that of a simple mechanistic manipulation of the soil to increase yields. It is better to surround this nucleus and to expand the concept to include the wise management of soils in tropical areas relative to society and its needs and resources. We are all aware that to build a road is to invite overnight occupation, but to develop an agriculture requires an integrated network of transportation, communication and skillful use of technology.

Soil is a resource; it may be used to produce foodstuffs, it may be used to support a road, it may provide foundation for buildings and cities, and it may even be protected for future use. Consequently, there are many kinds of management skills needed to promote and obtain the wise utilization of our soil resources.

4. Another concept relates to the management of knowledge.

If everyone manages his "conuco" to his satisfaction, what more do we ask? Why this concern for management? Of course, it is because of the social conscience of men and of mankind to improve the standard of living of all, not of just a few. Yet, if you develop a marvelous system of improved management, what will you do with that knowledge?

As an agricultural scientist with a social conscience you want to extend this knowledge, to help others, to avoid duplication of trial and error, and to continue along some pathway called progress.

The transfer of technology and knowledge is dependent on similarities. We look for similarities of climate, of crops, of insects, of machines, of seeds, of soils--yes, we must also look for similar soil conditions.

What soil properties do you wish to know about, to judge their similarity? Any given soil has thousands of attributes but obviously some are more useful than others for assessing similarity. One test of the selection of the right properties is whether or not a transfer and use of a technology produces the desired effect. This procedure of testing has been one of the most costly events recorded in the history of agriculture.

Soils that occur together have many similar characteristics due to the limited range of variability of soil forming factors at the geographic location. As we go farther away from a specific site there are changes in the soil forming factors, notably climate, biota, and parent materials. At some point we accept the changed conditions as a different soil system. Correlation and generalization of soil data and its associated responses to management practices are made easier by classifying and grouping some of the more important properties.

There are many ways to classify soils and each system is as adequate as it fulfills its own objectives. Often a comparison between systems can only

be made if we know the methods or operations by which the information was obtained. That is, every system of classification is based on definitions and concepts that are in turn based on specific procedures to obtain information. If the operational procedures or methods are different, the definitions and concepts will be different, and the systems will appear to be unrelated.

It is, therefore, very important to understand the basic concepts and ideas behind any kind of classification system. For example, there are many concepts of "heavy soils" in the world, and about as many different ways to manage them for crop production. If you understand the concepts, the definitions and the operational procedures of each, then you can possibly duplicate any one of them at will.

The transfer of technology and the sharing of knowledge about management of soils of tropical areas depends in large part on two things:

(1) an adequate description and definition of soils, and here I am using soils as an integral part of the ecological environment, and
(2) an adequate description and definition of the management practices and responses.

As we come close to these objectives, there are a large number of generalizations that can be made, both from a soils standpoint and also from the management standpoint.

Not one of us has an absolute command of the interrelationships that likely are involved in providing perfect solutions to practical problems in agriculture. We only know small parts of the knowledge that needs to be assimilated and managed. Consequently we see an increased thrust to utilize the capability of computers as storage and retrieval systems.

Each of us in our own way tries to make generalizations from our specific observations. We hope that these are sufficient to help other people understand better their observations and experiences. We all desire transfers of knowledge or technology that will be useful, will be meaningful, and will increase the chances for survival of mankind in this world.

5. The last idea that I want to mention is related to the concept of similarity which is so necessary for transfer of knowledge. It is the concept of soil survey as one of the most efficient and effective means of promoting significant transfers of technology and other knowledge.

The more useful soil classification schemes are those which serve two main functions. The first function is to help us organize nature into a generalized framework of recognition. It allows us to see relationships among and between kinds of soils throughout the world. It becomes a standard of reference for identifying, naming, and grouping sets of soil characteristics. In effect, it is a compilation of much of the knowledge of soil science.

The second function of soil classification is to serve a soil survey program. A soil survey not only identifies and names soils, it shows the distribution pattern of soils and provides the location and extent of different kinds of soils. The reports of soil surveys enable us to incorporate the available data and the available interpretations for each soil unit. The data usually are physical, chemical, and biological facts that characterize the soils. The potential interpretations are, indeed, numerous. Some are measured, others are provided by correlation of similarities to nearby areas, and a few are based on geralizations of only several characteristics. But always, they are related to the well defined basic units of classification.

A good soil survey provides other scientists with sufficient information for them to assess the degree of similarity. There is information about soil climate, soil biota, soil parent materials, topography of soils, and relative age of soils. Each combination is an integrater of past and present conditions, and it serves as the basis for predicting future changes and responses to use. In addition, there is a map to indicate where the predictions are most likely to have a high probability of success.

Those governments which have recognized the value of soil survey and have truly supported such activities have recorded rather phenomenal success in the improvement of agriculture. The transfer of knowledge and technology, both old and new, has been rapid and efficient. The progess of regional and national planning has also been increased.

A well defined, well correlated soil survey has served and will continue to serve, as one of the best bases for establishing and designing special research needs related to the use of our soil resources.

In summary, I wish to re-emphasize only one point. To wisely manage a soil under tropical conditions it is important to know the soil that is to be managed. To transfer knowledge and technology of soil management it is important to be able to predict where such transfers probably will be successful. Again the solution to the problem is similar. If soils are known in other places you can assess the probability of an effective transfer of knowledge.

Thus, it is an understanding of soil resources that provides a point of departure for investigations, and a point of return for application, of solutions to management problems of soils under tropical conditions.

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