Chapter 9. ADAPTING SEED-BASED AGROTECHNOLOGY TO LOCAL CONDITIONS: SOME GUIDELINES

Agronomists and farmers everywhere are keenly aware of the need for new crop varieties and cultivars to improve production. However, they are often faced with the problem of judging the suitability of a variety, which has proven superior elsewhere, for a local climate and soil condition. The Land Systems Map and data base provide a convenient geographical orientation of climate, landscape, and soil parameters for this purpose. Because the majority of agronomists live in rural areas without access to computer facilities, the data base, using summarized formats, has been published as Volume 3, *the Computer Summary and Soil Profile Descriptions of the Land Systems. Part* I summarizes the landscape and soil features of all the land systems mapped, as detailed below. Part 2 is a selection of meteorological data sets taken from the Hancock et al. (1979) collection, which may be used to help approximate climatic conditions in any given land system. Part 3 records a range of typical soil profiles to provide an in-depth guide to help with the visualization and interpretation of soil properties.

This chapter explains how these data may be used for local agricultural planning.

Transferring Technology Based on Land Systems

The comparison of land systems is a useful starting point for the transfer of seed-based agrotechnology throughout the region. Their environmental descriptors also provide a basis for the more selective introduction of promising cultivars from other parts of the tropical world, with known climate and soil conditions. Unfortunately, the presence of biotic factors, including pests and diseases, against which an otherwise promising cultivar may have little or no resistance, is not always known; such may exclude the use of those cultivars in a given land system or even more an entire continent, as is the case of cassava varieties with no resistance to African mosaic disease.

Within certain limits, it may be possible to develop agronomic practices for local climate-soil environment to take advantage of promising cultivars adapted to apparently different environments elsewhere. Climates must be considered in relation to the type of crop being grown. For perennial crops, the annual climatic patterns should coincide. On the other hand, for short-term annual crops, the seasonal and monthly characteristics are paramount. Consequently, annual crops are often grown successfully in regions with very different overall climatic patterns. What is important is to try to match the water-balance, energy regimes, day lengths, and so on, to ensure that the local climatic conditions during the life cycle of the promising cultivars are compatible with those in which they were originally developed.

Of the nonbiotic factors affecting the successful introduction of promising cultivars, perhaps the most tricky to assess is the ability of local soils to meet their nutrient needs without the use of uneconomic applications of soil amendments. This is particularly true in the underdeveloped, acid-infertile soil circumstances, where the specific traits desired in a cultivar may be tolerance to excessive aluminum (see Appendix 2) and low phosphate availability.

Enhancing Soil Fertility Information

It might be emphasized that although much information can be deduced from small-scale maps, including the land systems maps, these maps are scale limited; consequently, in the absence of detailed soil studies, it will often be necessary for agronomists to enhance the soil information for any particular area of interest.

The careful evaluation of soil survey data can help the agronomist "zone-in" on what are likely to be probable soil nutrient problems. Visual crop deficiency symptoms seen in any area also help. In fact, the presence or absence of the minor and trace element constraints recorded in the landsystems printouts in Volume 3 were often confirmed by observing visual symptoms on crops. In his study of the tropical lowlands of Bolivia, Cochrane (1973) paid particular attention to the identification of visual deficiency symptoms on Dwarf Cavendish bananas (see Photo Plate 32).

For many undeveloped areas, especially where soil fertility has been little affected by the incorporation of soil amendments, the value of a soil survey can be enormously enhanced, with a minimum of effort, if a number of soil profiles, or even topsoil samples, can be described and sampled. This will permit the statistical comparison of soil nutrient levels over a given soil unit. Cochrane (1969) has shown that 12 to 18 topsoil samples, spaced over a relatively constant soil unit, will provide an adequate population in a statistical sense, to calculate means, standard deviations, and correlations between soil chemical properties; these are meaningful for helping to understand soil fertility. By this procedure, outlined in Appendix 3, unnecessarily repetitive soil sampling is avoided, and soil analytical time can be profitably spent in carrying out as complete a set of analyses as possible. Most routine soil survey sample analyses are restricted to describing the more "permanent" soil properties. The case of total mineral analyses occasionally excepted, they rarely provide complete major, minor, and trace element analyses as now commonly carried out for soil fertility investigations. In fact, the lack of minor and trace element analytical data throughout the region surveyed was particularly disappointing. Part of the reason for this is historical. In the past, minor and especially trace element analyses were difficult and costly. The advent of atomic absorption spectrometry in the 1960s changed this situation. Unfortunately, old habits die hard.

The methodology developed was tested in the context of the present work on land system No. 201, in which the ICA (Instituto Colombiano Agropecuario)-CIAT Carimagua agricultural station is located, and results are recorded in Appendix 3. The results of identifying soil toxicity problems, probable nutrient deficiency problems, and possible nutrient problems compare well with the actual findings from CIAT's experimental work over the past 12 years. The approach advocates a breakaway from normal dogma concerning the collection of soil samples for fertility analysis, which involve making artificial composite samples from 12 to 20 subsamples.

Field Trials

Although soil information can be considerably enhanced by a relatively minor amount of work, field trials must still be carried out to quantify the nutrient needs of promising crop cultivars. Unfortunately, in many lesser developed circumstances, progress is often slow and recommendations incomplete.

In supplying fertilizer recommendations for the new generations of crop and pasture plant cultivars with a degree of tolerance to soil toxicities and low nutrient levels, it is necessary to use proven, comprehensive, but time-saving methods to establish recommendations. In many tropical lands, in addition to soil toxicities and major nutrient deficiencies, limiting factors may include minor or trace element deficiencies or imbalances; consequently, the methodology adopted must provide a means of identifying these problems as quickly as possible. In this respect, Cochrane (1979) has shown that within a time span of less than 2 years, he was able to identify both minor and trace elements in field-proven conditions in Santa Cruz, Bolivia.

This methodology, which involves the monitoring of field trials through comparative tissue analyses, has been recorded in Appendix 4. The philosophy of the approach aims at starting field trials as soon as possible and maximizing information by subjecting tissue analysis data taken on a plot by plot basis, at a predetermined stage of crop growth to the same statistical analysis as yield data.

Summary

The land-systems data base provides a geographical and technical base to guide the successful transfer of seed-based agrotechnology both throughout the region and from other parts of the tropics. Nevertheless, technologies developed elsewhere must be proven in the local circumstance. The technique suggested for enhancing the soil fertility information to help with the selection of treatments in field trials and the comparative tissue analysis methodology suggested for maximizing information from such trials are both particularly relevant to tropical areas with limited research facilities.

The use of the land-system data base and complementary agronomic techniques should lead to the selection of high yielding crop varieties with farm-effective fertilizer recommendations for a given ecosystem, more speedily and much more cheaply than has been the norm in the past. It should also contribute to the more successful conservation and use of the soil resources in tropical South America.