7.3. GEOSOIL and "Arboles de decision": Decision support tools to make recommendations on land use and management practices in the Colombian Llanos, based on soil characteristics. Case study in Puerto López, Meta.

Objectives

- ?? Develop a simple methodology to allow farmers, extension agents, and agricultural project promoters apply knowledge developed through agricultural experimentation to data from soil maps or soil samples, to issue recommendations for the sustainable use and progressive improvement of soil qualities
- ?? Present an example of this methodology for the municipality of Puerto Lopez that can be repeated in other municipalities, or even for entire departments
- ?? Provide decision makers in the municipality of Puerto Lopez, which is where the government plans on focusing many agricultural development projects, with a tool to prevent unsustainable use of soil resources

Methodology

The GEOSOIL database was created in Microsoft ACCESS, allowing the storage of soil characteristics of points or soil types in a map. The biophysical limitations of the soils of the Colombian Llanos had previously been conceptualized into a decision tree (Hoyos et al., 2001[1]). A subset of GEOSOIL was created, containing only the relevant fields for the application of this decision tree. This subset was called ARBOLES.

Decision rules were programmed in visual basic inside ARBOLES, to allow diagnosis and recommendations to be issued regarding its data. These rules can be edited to include local knowledge or other considerations, and new fields can be created to include the relevant data to apply them. For the recent soil maps of the municipality of Puerto Lopez, soil characteristics were compiled into GEOSOIL and ARBOLES, for each of the soil types composing each of the land unit types.

We articulated GEOSOIL and ARBOLES with the digital map of land units that we integrated in the SPRING GIS developed by INPE, for the display of results. We generated grid coverages of soil characteristics from point measurements stored in GEOSOIL for portions of the Puerto Lopez municipality, through the geostatistical module of the SPRING software. Decision trees are then applied as a set of decision rules on these grid coverages. We applied threshold values of indicators of soil quality to various field-measured soil conditions in the GEOSOIL database, to allow a diagnosis.

Results

Only a limited number of land use types are adapted to the soils of the Llanos Orientales. Nevertheless, in the altillanura (high plains with flat topography), it is possible to

[1] Hoyos, P.; Amézquita, E.; Thomas, R.; Beaulieu, N.; Rubiano, Y. 2001. Propuesta de un árbol de decisiones para el uso potencial y productivo de los suelos de la altillanura plana bien drenada. Internal publication, CIAT, Cali, CO. 1 CD-ROM.

transform soil properties and to create an “arable layer”, thus extending the spectrum of potential uses of the land. By applying management practices adapted to the textural group and the slope, the depth available for root growth can be increased, and soil fertility. This gradual improvement begins with the introduction of deep rooting pastures alternated with annual crops, and gradually includes agroforestry systems and perennial crops.

The land characteristics that are used in the decision rules are textural class (clayey, intermediate, and sandy), slope, and depth available for rooting. These are compared to the requirements necessary for a given land use type or management practice.

For each soil type, the first decision is made with regard to the type of texture because, contrary to other soil properties, it cannot be modified or adapted through management practices. According to the type of soil texture, the next decision will be taken with respect to the slope, and then the last with respect to the rooting depth. For each possible decision, or “terminal node”, of the decision tree, a recommendation is made with regard to possible production systems and management practices. The range of possibilities becomes richer as the depth available for rooting is improved by management practices that allow the construction of an arable layer.

As mentioned in the methodology, soil characteristics entered in the database tool (Figure 36) can either result from measurements in the field or from the data associated with a soil map. The resulting recommendations correspond to each individual soil type. Given that land units in soil maps generally correspond to associations of various different soils, each occupying a given percentage of the land unit, recommendations cannot be mapped directly. In our maps of recommendations, the polygon corresponding to a land unit is assigned to the most restrictive cropping system that can be used in more than 60% of the area. It is implied that less restrictive systems can be used in those areas. It is also possible to produce maps of the level of restriction regarding texture, slope, and rooting depth, indicating the most restrictive decision category that corresponds to at least 60% of the land unit. The data related to soil maps include only the rooting depth before any management, and recommendations need to be adapted in areas where such practices have resulted in an improvement of soil characteristics. These also have to be adapted in areas where accelerated degradation of soil properties, such as soil erosion or compacting, has been observed resulting from inappropriate management.

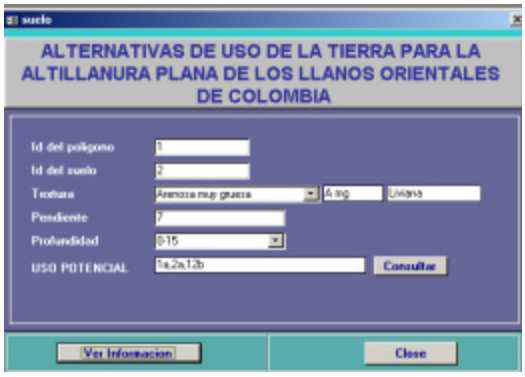

Figure 36. Decision support tool for making recommendations on land use and management practices in the Colombian Llanos, based on soil characteristics using Microsoft Access database software.

The database can be used as a decision support tool. It is versatile and could even be modified to include other land characteristics, such as climatic limitations or accessibility, provided new decision rules are established, and the data necessary for their application are available.

The final version of this tool will be submitted to field control at the end of 2002 with collaborators in CORPOICA, and the necessary adjustments will be realized. It will also be tested with the five village communities with which we are working towards the development of their community agricultural development plan. Then, it will be distributed to municipalities and municipal units of technical assistance in agriculture and livestock (UMATA).

Outputs

Recent development of maize varieties for acid soils, by CIMMYT and other institutions, has increased the interest of the Colombian government in developing this crop in the *Altillanura*, especially along the highway between Puerto Lopez and Puerto Gaitan, (an area included within the municipality of Puerto Lopez). If included in rotations with pasture, in soils with the adequate characteristics, and appropriate management conditions, maize cultivation can lead to an improvement of soil characteristics and sustainable crop systems. Otherwise, it can lead to a severe degradation of soil physical properties. Because agricultural project developers solicit CORPOICA scientists for advice, they wish to be able to direct these projects towards the appropriate geographical areas. They, and the UMATAs, also need a tool, such as CULTICORE, to be able to make simple recommendations using the results of long-term experiments in the altillanura. We expect the use of this tool to help prevent abuse in the use of the soils of the Llanos and to orient farmers towards sustainable agricultural practices.

The application of decision trees with farmers will also be useful to focus needs for more research on soil improvement practices. Undoubtedly, it will also lead to an adaptation of the decision rules to include the knowledge of farmers.

Contributors: Yolanda Rubiano, Marcela Quintero, Jaime Jaramillo, Nathalie Beaulieu; Edgar Amezquita, Phanor Hoyos, María Fernanda Jiménez (PE-2)

Collaborators: Jaime Bernal (CORPOICA); Dimas Malagón Castro (Subdireccion de Agrología, Instituto Geografico Agustin Codazzi [IGAC], and Universidad Nacional de Colombia).