

**LAND MANAGEMENT SCIENTIFIC RESOURCES GROUP:
STRATEGIC ISSUES**

Leader, Land Management SRG

Centro Internacional de Agricultura Tropical (CIAT)

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HISTORICAL BACKGROUND

In 1991, CIAT produced its Strategic Plan announcing the launching of a major research effort on resource management, additional to the existing efforts on germplasm development. This included the creation of four Programs within Resource Management: Land Use, Forest Margins, Hillsides, and Savannas. The Land Use Program incorporated the former Agroecological Studies Unit (created in 1989), and it was formally initiated in 1992.

As an outcome of the new Action Framework approved by the Board of Trustees, five Scientific Resources Groups were created in February 1994. The Land Use Program became the Land Management Scientific Resources Group (LM SRG).

Administratively, Scientific Resources Groups are not supposed to have projects of their own. The only exception was the LM SRG. As a consequence, the names of its projects as appearing in the Annual Report 1994 reflect cost-centers rather than the scientific thrusts of the Group. "Strategic Themes" will be used here to organize the activities of the Group.

The CIAT-wide External Program and Management Review, in its Report of February 1995, recommended that the LM SRG be transformed either to a Program or a Unit depending on the orientation that CIAT considers more appropriate to its future. It is expected that a decision will be adopted in the near future.

GOAL

The overall goal of the Land Management research is to improve the management of land resources in tropical America in a sustainable way.

APPROACH

Land use, and particularly agricultural land use, is a very dynamic activity in tropical Latin America, where one of the most rapidly changing agricultural frontiers in the world lie. The sustainability of food production is intimately tied to the forms of land use. However, land use in Latin America is also related to important problems of environmental degradation, from soil erosion to biodiversity loss, with local, regional and global impacts. Perhaps more than in any other part of the world, in Latin America sustainable development depends upon sustainable land use.

The basic research themes of the Group focus around the understanding and anticipation of land use changes, the determinants and impacts of land management, and their implications for technology development and diffusion. The major outputs are information and analysis that are useful for influencing policy-making and contributing to technology generation (the latter insofar as helping to identify the required technological "profile" for sustainable agriculture).

This requires the causal analysis of trends in land use for understanding and anticipating land use

dynamics and to identify root causes, systemic interlinkages and mechanisms and entry points for action and policy. It also involves the study of the spatial distribution of agricultural land use patterns in relation to ecological factors, understanding the role of cross-scale (micro-macro) interactions in land use dynamics, and the identification and development of policy-relevant indicators of sustainable land use incorporating aspects of both production and environmental quality and their evolution. The study of the patterns and dynamics of land use and the identification of indicators embrace not only the outcomes of land use but also the impacts of new technologies and policies on land use and the environment.

Based on these *studies*, policy alternatives for improved land use can be assessed, and new policies that contribute sustainable and productive land uses can be identified. The Group does not define policies, but it generates policy-relevant scientific information and assessment and it works with local, national, and regional decision-makers and with the International Food Policy Research Institute (depending on the project).

To this end, the Group is generating links with Governmental and Research Organizations in the areas of agriculture, the environment, and development planning in a number of Latin American countries, as well as with the private and ONG sectors. The Group also participates in the Interamerican Council for Sustainable Agriculture (ICSA) sponsored by IICA and the Earth Council.

A systems perspective is used overall. The research areas require an interdisciplinary core competence. At the moment, this is only partly achieved. The current core-financed composition includes a GIS specialist, an agricultural land use specialist, an agricultural anthropologist, and a systems analyst. A tropical ecologist is in the process of recruitment, and a resource economist will be recruited this year. This will complete the basic core competence of the Group. A policy analyst was included in the original design of the group, but this position is not currently available. This and other areas of expertise may be added in a non-permanent basis through the implementation of special projects.

The Group collaborates extensively with projects of other CIAT's Programs, Units, and Scientific Resources Groups.

SCALE AND GEOGRAPHICAL SCOPE

The scales involved belong mostly to the level of the farming system and above: landscape, agroecosystem, and region. Only in exceptional cases (namely the tropical climate database) has a global scale has been used.

The activities of the Group focus mainly on three target agroecosystems: savannas, hillsides and forest margins. Some of the projects have an ecoregional scope, and some are of a methodological nature.

CLIENTS

The major clients of the Group are policy-makers at the national and regional levels, and the NARD's and other CIAT's Programs that concentrate on technology generation and diffusion.

ORGANIZATIONAL STRATEGY

The organizational strategy that has been adopted involves:

1. To build upon the original capacity in spatial analysis of agricultural land use.
2. To gradually move from the previous emphasis on service activities to cooperative activities with other Programs and SRG's, and the NARD's, and at the same time, to generate a number of own projects.
3. To gradually broaden the scope so as to include the necessary ecological and socio-economic approaches, and to acquire tools and capacity for inter-sectoral simulation modeling.
4. To seek, whenever possible, external financial support for the launching of new priority research themes.
5. To develop cooperative linkages with a number of scientific or policy institutions in areas relevant to sustainability.

The Research Strategy will be indicated within the description of the major research themes.

STRATEGIC THEMES

RESEARCH THEMES

1. ANALYZING EXISTING TROPICAL LAND USE PATTERNS AT LOCAL REGIONAL, CONTINENTAL, AND GLOBAL SCALES.
2. UNDERSTANDING AND ANTICIPATING TRENDS IN LAND USE.
3. INDICATORS OF SUSTAINABLE LAND USE.
4. PERFORMING COLLABORATIVE RESEARCH IN GENETIC DIVERSITY WITH OTHER CIAT PROGRAMS AND UNITS

RESEARCH-SUPPORT THEMES

1. MAINTENANCE OF THE GIS LABORATORY FACILITY.
2. MAINTENANCE AND UPDATING OF THE EXISTING DIGITAL MAPS AND DATABASES.

RESEARCH THEMES

RESEARCH THEME 1. ANALYZING EXISTING TROPICAL LAND USE PATTERNS AT LOCAL, REGIONAL, CONTINENTAL, AND GLOBAL SCALES.

Rationale

It is widely recognized that, because of the current rapid economic changes, the pressures from the structural adjustment policies, and other reasons, the time-horizon of the political decisions adopted by the

governments of the region has become drastically shortened. This fact conspires against taking into account the ecological costs of agricultural development projects and policies, costs that often reach their peak in the medium and long term.

The problem is aggravated by the lack of scientific data cast in a form that allows comparisons among geographical areas and countries, the assessment of the production potentials for sustainable land use in relation to production obtained under current practices, as well as integrated estimates of the economic resources needed to implement a sustainable development pattern in the region.

One of the major limitations is due to the fact that agricultural production and yield statistics are usually provided according to political and administrative boundaries, bearing little or no relation to the ecological units determining some of the major productive opportunities and limitations. This situation seriously hinders the possibility of integrating ecological and economic considerations in the search for new sustainable production systems. An overall analysis of land use patterns in relation to environmental factors is therefore necessary at a range of scales and precision. This requires building on the existing CIAT spatial databases and identifying further sources of data to enable a characterization of the region and an ability to study and map sustainability issues at these scales. An understanding of land use dynamics is critical in incorporating the human factor in the analysis, hence socioeconomic data has to be incorporated in the spatial databases.

This theme concentrates on researching and understanding the relationships between existing land use patterns, ecological and agroecological zones, impacts of current land use on sustainability, and potential environmental opportunities for sustainable land use.

Current situation:

The Group has a strong installed capacity and a number of ongoing activities in relation to the identification and description of trends in land use, mostly in relation to field-based studies, GIS and geographical databases. GIS analysis has been performed both synchronically (at different places for the same date) and diachronically (comparing land use in the same area through time).

Future strategy:

To maintain and expand the studies and to cover also the ecoregional level (re. digital map of land use, resource degradation, poverty and ecology for Latin America; proposed cooperation with Bolivia, Brazil, Colombia, Venezuela and The Netherlands within the SSALLSSA -Strategies for the Sustainable Agricultural Land Use in the Lowland Savannas of South America- Project; possible installation at CIAT of the Dutch IMAGE 2.0 climate/land use model; cooperation with UNEP within the region).

Important highlights to date include:

Priority agroecosystems. The definition of the three priority agroecologies for CIAT, using a GIS approach involving environmental, social, and economic variables, as well as CIAT's commodity priorities. The process led to the selection of the cleared margins of rain forests, the well-watered hillsides, and the tropical savannas as priority areas for CIAT's resource management research. This constituted a significant contribution to CIAT's Strategic Plan.

Site Selection Cerrados Region, Brazil. A classification and site selection of the Cerrados region of Brazil to determine appropriate study areas for joint research with EMBRAPA and local agencies was completed. Data from the climate database and the land system study were used to provide images of climate, soils and terrain for the region. These were complemented by data

from the Brazilian agricultural censuses from 1970, 1975 and 1980. The census data were combined to produce a set of images showing average land use patterns and the trend in land use during the ten years. Some 38 images were combined using Factor analysis to produce 12 factor images, a statistical subsample was extracted from these and a two stage cluster analysis was used to produce 11 representative classes of cerrados demarcated by biophysical and land use patterns. These were used to characterize 12 potential study areas in respect of the areas of savanna represented in the region. The study was used in a workshop in Brasilia to select candidates for the final study area.

Research Prioritization and Site Selection for Forest Margins Areas, Brazil. A large scale characterization of parts of the Brazilian Amazon including Acre, Rondonia, Maranhon and Para, was carried out. Following the initial analysis the individual areas of forest margins were processed with secondary data on agricultural and pastoral production data. Satellite images for Para (Paragominas) and Acre/Rondonia were digitized and overlaid with digitized soil, geology and vegetation maps. The results were presented in a report which was used in consultation with CIAT's partners in Brazil to define the final study area. As a consequence of the studies, Acre/Rondonia was selected as the site for the Alternatives for Slash and Burn (ASB) Project and the Diagnosis of Agricultural Land Use in Southwest Brazilian Amazon Project described below.

Latin America protected areas. A digital coverage of legally protected areas, native reserves, and national parks for Latin America was prepared and published, including an environmental classification of those areas. Climatic, agroecologic and life zone maps were overlaid on the protected area coverage and an inventory of protected areas was produced showing their area for each environmental class. The inventory highlighted the fact that montane rainforest, dry tropical forests, highlands and agriculturally productive lands have diminishingly small areas undisturbed, and they are at a much higher risk than the larger tropical Amazonian rainforests.

Resource degradation and land use in Latin America. A new updatable digital map as an aid to planning for sustainable agricultural development. Agricultural land use statistics are compiled by administrative units and figures are aggregated for reporting. In Latin America the minimum disaggregation is often the municipio, canton or parish. Remote sensing can give a good basis for the subdivision of land use into the major classes of agricultural activity, but this is very expensive and so, at the continental level, is necessarily static. Local knowledge of the state of the agricultural system and of land degradation abounds but at present there exists no framework for coordinating this into a continental synopsis. At present the only integrated mapping of land type for the continent is the FAO Soils Map of the World at 1:5,000,000. This map is to be used as a basis for compiling the abounding local knowledge into an updatable GIS database that will give an overview of the state of agriculture in the continent not previously available. The information on land use and land degradation will be overlaid by the maps of natural ecozones, to detect ecological conflicts or opportunities. Socio-economic data will assist in the analysis of poverty and its environmental associations.

RESEARCH THEME 2: UNDERSTANDING AND ANTICIPATING TRENDS IN LAND USE

Rationale

There is a widening consensus in that many of the present patterns of land use in tropical America are destroying the ecological base for development, and at the same time generating social problems and gross economic inefficiencies.

While knowledge about individual causal factors affecting the rates, nature and consequences of land use has been accumulating, the complex interlinkages between the different types of factors (human and ecological) are much less understood. Yet, their interplay is what determines the total system's response. Attempts to change some causal factors in isolation have often been ineffective or, worse, they have backfired.

A systemic approach and the identification of different key situations could greatly help to devise new kinds of intervention to sustainability, based more in the simultaneous application of gentle actions along a whole causal circuit than on a massive intervention upon on isolated factor or set of factors.

Furthermore, if fast and drastic whole-system restructuring can occur in the systems determining land use (as suggested by the evidence arising from studies on the behavior of complex systems), then it becomes of practical importance to understand which are the factors or processes defining the likelihood of those deep changes. The degree to which those structural changes can be anticipated is also very relevant. Situations approaching the threshold of structural changes should be treated specially, both in technological and policy terms. The knowledge gained along the described lines could contribute to the generation of new styles of land use management.

The patterns of land use are influenced by many factors operating at different scales from the micro to the macro. This issue is not restricted to the problem of aggregation across scales, but it also includes the dynamical effects of the "vertical" cross-scale causal linkages. The treatment of the causal interactions between hierarchical levels in complex systems is a difficult methodological problem, but of great practical importance. The sustainability of land use may be influenced by events operating at different time and space scales, and far away from the fields. This is also considered essential both for the understanding of the role of the mutual interactions between the macro processes and the local patterns of land use, and for the articulation between the "top-down" and "bottom-up" approaches to sustainable agricultural development.

Current situation:

This theme is being pursued currently at different levels from the farming system to the agroecosystem levels. The Group carries out in partnership with the Tropical Lowlands Program the Project "Dynamics of Land Use". The Group is also contributing to this research theme through the field study of the behavior of rural producers in relation to land use and agricultural practices. Simple dynamical simulation modeling and scenario analysis of land use in Latin America and in the tropical Lowlands have been developed by the Group.

Future strategy:

1. To develop the Group's capacity to build up and use complex dynamic intersectoral simulation models (i.e. nonlinear computer simulation models calculating changes in time of the state of systems including biophysical, technological, socio-economic, and policy factors) as tools for understanding and anticipating land use trends and for assessing possible policy options, and to develop GIS-linked dynamic simulation models. For those purposes, cooperation with the University of Florida, Wageningen, RIVM, IIASA is being sought; the recruitment of a computer programmer/modeller has been launched; computer simulation models have been purchased or acquired through cooperation (e.g. the Advanced Computer Simulation Language; "M" Simulation Language from RIVM; "Polestar" scenario tool from the Stockholm Environment Institute); discussions are going on about the possible installation at CIAT of the IMAGE 2.0 climate/land use model.
2. To explore the application of the new Complex Systems theories (concerning self-organizing dissipative

systems operating far from thermodynamic equilibrium, hierarchical systems, structural re-organizations, chaotic behavior and strange attractors) to agroecosystem changes and the usefulness of the concept of agroecosystem health for agricultural research (re. Cooperation with the University of Guelph and participation in the establishment of a small international network of Complex Systems researchers).

3. To study the role of cross-scale interactions in land use dynamics; to this end, a proposal for a Rockefeller PostDoctoral Fellow to work on the cross-scale economic interactions in land use has been approved by CIAT. The cooperation with the University of Guelph also focuses on developing a framework for hierarchical agroecosystems analysis. A new project with the Hohenheim University has been approved.

4. To develop methodologies and to build up the capacity to perform land-use scenario analysis (systematic identification and exploration of unfolding chains of events and branching points leading to different future land use patterns) at the regional and national levels (re. Cooperation with UNEP -GEO Project-).

5. To incorporate fully the ecological and the economic expertise as part of the capacity of the group (through the recruitment of two SS).

Important highlights to date include:

Diagnosis of Agricultural Land Use in Southwest Brazilian Amazon. This research was directed to characterize and analyze processes of deforestation in Acre and Rondonia in order to then identify, test, and adapt alternatives to slash-and-burn agriculture that would effectively reduce rates of forest conversion. Activities included: (a) collection and synthesis of secondary data, (b) interviews of colonist-farmers and cattle ranchers, (c) GIS analysis of land use patterns over time, (d) field sampling and analysis of changing plant communities relative to different land uses and intensities of land uses, and (e) analysis and synthesis of results. It was apparent that deforestation is a function of policies supporting colonization, road building, direct or indirect incentives supporting creation of pasture land and cattle ranching, and the lack of disincentives for timber extraction. Recent lower rates of deforestation seem to be responding to changes in those policies. For areas with poor soils it may be impossible to slow deforestation by increasing productivity of rice, beans, cassava, and/or pastures, by improving fallows, or developing perennial crop based agroforestry systems. For the very limited areas with better soils, technological alternatives to slash-and-burn agriculture could be developed. Further work on the link between livestock and deforestation, including micro-macro linkages, is contingent on getting a PostDoctoral Fellow.

Strategies for Sustainable Agricultural Land Use in the Lowland Savannas of South America. Planning Study. The Planning Study for the project "Strategies for Sustainable Agricultural Land Use in the Lowland Savannas of South America" (SSALLSSA) was completed. with the formulation and submission of a 5-years project that is now being considered by the Dutch Ministry for Development Cooperation (DGIS), the same institution which supported it. The project purpose is to identify and assess strategic and policy options for the sustainable use of the lowland savannas of South America. The structure of SSALLSSA reflects a tripartite collaboration: at least one research team in each of four countries, a project team at CIAT and a project team in the Netherlands. The project was designed through a participatory process, and it was approved during a Workshop convened by CIAT. The Workshop was the culmination of a process which involved visits from CIAT scientists to agricultural, environmental, business and NGOs institutions of Bolivia, Brazil, Colombia and Venezuela, and the preparation of position papers by each of the participant countries. The Workshop had the participation of high-level

representatives from national agricultural research centers, agricultural ministries, universities, the private sector, and NGOs, and scientists from Wageningen and CIAT. The project is given high scientific and political priority by the countries of the region.

Simulations models of land use in the Cerrados and Forest Margins of South America. Simple simulation models of land use for the Cerrados and Forest Margins were implemented. The models calculate the transitions of between seven land categories in each agroecosystem, in a yearly time step. The models were run under alternative socio-economic and policy scenarios and the results were applied to the analysis of future trajectories of land use and their productive and environmental implications, for the Inter Program Project "Dynamics of Land Use" reported by the Tropical Lowlands Program.

Characterization of farmers' systems and participatory research. The Bean Program coordinates the PROFRIZA network with Colombia, Ecuador, Peru, Venezuela, and Bolivia as members. The Group collaborates in interviews for characterization of farmers' systems in participatory research in five to six sites in three or four countries, in order to understand the reasons determining farmer's land use. This research also focuses on characterizing and analyzing farmer maintenance of substantial diversity of bean cultivars (especially in Peru) with a goal of developing methods for *in situ* farmer-participatory conservation.

Stochastic rainfall models. Rainfall third-order Markov models for tropical areas have been developed which significantly improve prediction upon existing ones. Those models are essential for agricultural risk assessment, and they have been used by a collaborator in a major implementation for Burkina Faso, and interfaced to the Famine Early Warning System of FAO. Work is continuing on estimating the model parameters from data available in the climate database. This will allow the construction of integrated coverages and contribute to the mapping of risk in cropping systems.

RESEARCH THEME 3. INDICATORS OF SUSTAINABLE LAND USE

Rationale

The setting of policies for sustainable land use in tropical America requires some way of measuring, estimating and monitoring the degree to which the criterion of sustainability is being fulfilled. While some indicators of specific conditions exist, no satisfactory overall indicators of sustainable land use are yet available.

One major priority is to develop, test and apply a set of macro-level indicators of sustainable land use. This requires: a) developing a meaningful conceptual framework within which different classes of indicators can be identified (avoiding the pitfall of the shopping list syndrome); b) selecting and testing a set of specific indicators relevant for decision-making; and c) defining methods for using and combining the indicators in order to optimize their information value.

As sustainability is a systemic property rather than a property of any single component, synthetic as well as analytical indicators will be required.

Current situation:

The Group initiated activities in this research theme by preparing an interinstitutional background paper on Land Quality Indicators (developing a total factor productivity approach to LQI), organizing an international

Workshop at CIAT together with the World Bank (during which an initial identification of LQI for the tropical hillsides and savannas was made), organizing a CIAT-wide discussion on sustainability indicators at different levels of aggregation (resulting in the identification of common interests across Programs, Units and Scientific Resources Groups); one Pd.D. student is working at CIAT on indicators of soil sustainability for the tropical lowlands of Latin America, and a UNEP Consultant is now working at CIAT preparing a project proposal for sustainability indicators.

Future strategy:

On-going activities will be reinforced and negotiations with UNEP regarding the establishment at CIAT of a project for environmental and sustainability indicators for Latin America and the Caribbean are well underway. The project will foster a wide participatory network including national and regional organizations and experts, develop a regional framework, enhance national and regional capacity to generate and use environmental sustainability information, catalyze exchanges between producers and users of sustainability indicators, and produce a bi-annual report on the state of and progress towards, sustainability in Latin America and the Caribbean. This will not only represent a major step forward, but it will also make available new sources of data to CIAT.

At a more theoretical level, it is expected that the envisaged activities in relation to Complex Systems could suggest new systemic indicators of sustainable level use.

Important highlights to date include:

Land Quality Indicators. A participative process of definition of a CIAT-wide framework and research strategy on indicators of sustainable agriculture was launched. A document on Measurements and Indicators of Sustainability was produced by an interdisciplinary and interinstitutional team CIAT, CIMMYT and GASE (an environmental NGO). An international workshop on Land Quality Indicators (LQI) for the Lowland Savannas and Hillsides of Tropical America was implemented jointly with the World Bank. LQI were discussed and proposed for the two agroecosystems. As a follow-up to the Workshop, proposals for activities supported by the Bank have been prepared, and are being discussed with the Bank.

Assessing indicators of land quality for sustainable agricultural development in the Latin American hillsides and savannas. Many soil characteristics have been proposed as indicators of land quality. Of these the soil organic matter is a prime candidate: soil degradation is almost always accompanied by loss of organic matter. However organic matter loss usually occurs at the same time as the degradation; it is thus of little predictive value. The biological activity of the carbon pool may indicate incipient soil degradation before it becomes difficult to reverse. This ongoing research is looking at the amount of soil carbon in different pools. Highly labile carbon can be readily oxidized, whereas stable carbon is left untouched by certain oxidants. The ratio of the two measures can be used as an index of soil biological activity. The study attempts to correlate such measures with more readily identified visual clues. If this is successful these early signs may be detected by remote sensing.

World trade in plant nutrients. A large proportion of the exports of the developing countries are agricultural or forestry products. These products carry with them the basic plant nutrients N P K. This study looks at the balance of trade in terms of these nutrients. World trade figures for all agricultural and forestry products were taken from the FAO publications and data tapes. Tonnages of product were converted into elemental equivalents of N P K and mapped. Fertilizer trade figures were obtained from IFDC and are mapped for comparison. Preliminary observations show that the obvious sink for these elements is the developed world. Europe is particularly

noticeable in this. India clearly shows the benefit of the Green Revolution: in 1967 it was a net importer of plant nutrients in products, by 1985 it had become a strong exporter. Many African nations are strong exporters and the outward flow is not balanced by fertilizer imports.

RESEARCH THEME 4: PERFORMING COLLABORATIVE RESEARCH IN GENETIC DIVERSITY WITH OTHER CIAT PROGRAMS AND UNITS

Besides collaboration in projects in Resource Management Research, collaboration with projects in the Germplasm Division has also been significant. Cooperation in the issues of germplasm spatial distribution and germplasm environment mapping has involved the development of some specialized techniques. CIAT is in an excellent position to apply advanced techniques of GIS and environmental classification to the problems of characterization and maintenance of genetic diversity. The coexistence of expertise in GIS and in germplasm research is a quite unique comparative advantage of CIAT.

Current situation:

The level of cooperation with other CIAT's organizational units in Germplasm Research is currently high and widely recognized.

Future strategy:

To develop additional databases to include germplasms and its environment, and to develop methods for interfacing genetic diversity and spatial information.

Important highlights to date include:

Phaseolus vulgaris core collection. The Germplasm Research Unit in CIAT holds over 27,000 accessions of *P. vulgaris* complete with characterization and provenance data. However, many users find the costs involved in accessing the full collection of this valuable resource to be prohibitive. One way to solve this is to make a stratified sampling based on the environment from which the accessions came. Using the CIAT climate database and the digital version of the FAO 1:5,000,000 soils map an environmental classification was developed based on the specific factors relevant to genetic diversity in the cultivated species. Using this scheme the accessions in the germplasm collection were classified and a structured sampling was used to select individuals for the Core Collection.

Mapping of the environments of wild relatives of crop plants. The Group has developed a powerful technique of climate comparison based on the 12 point Fourier transform. A method of using these transformed climate data to produce a probability density mapping of climates similar to the collection sites of wild relatives of *P. vulgaris* held in the germplasm collection has been developed. This work has identified new important areas for germplasm collection. Location data for wild cassava species are at present being processed in collaboration with the World Conservation Monitoring Centre (WCMC) in Cambridge and further environmental similarity research will shed light on the diversity of genetic material in this species.

Latin America rice distribution. The distribution of rice was needed for development of a rational environmental classification of the crop in Latin America and to guide research priority setting. The distribution was mapped in two stages. A first approximation was constructed using available secondary information, mainly from agricultural census data. Data on production figures and hectares planted were plotted automatically on coverages of municipio boundaries, where

available, and by hand otherwise. The resulting distribution was digitized. The maps produced were sent out to collaborators throughout Latin America. The maps were returned to CIAT and recompiled into the 'second approximation'. The resulting distribution was overlaid with the environmental classification based on the CIAT databases and a breakdown of the rice growing environments of the continent was compiled.

RESEARCH-SUPPORT THEMES

1. MAINTENANCE OF THE GIS LABORATORY FACILITY and 2. MAINTENANCE AND UPDATING OF THE EXISTING DIGITAL MAPS AND DATABASES.

Current situation:

The GIS Lab has reached a satisfactory state, being well equipped in terms of hardware and software to perform the current and planned activities. Maintenance and updating of digital maps and databases is going on.

Future strategy:

Those two fundamental research-support themes will be maintained as ongoing permanent activities, requiring both human and financial resources.

NEW INSTITUTIONAL CONTACTS

A major effort to create a network of new contacts with research institutions, NGOs and international projects related to sustainable development and land use is being implemented. Some of those contacts resulted in CIAT becoming a UNEP Collaborating Centre for International Environmental Assessment, Reporting and Forecasting, and in CIAT and the University of Guelph signing a general Letter of Agreement for cooperative activities. New institutional contacts (additional to the habitual ones such as the University of Florida, the Wageningen Institutes, the World Bank, the InterAmerican Development Bank, the Ministries of Agriculture in Colombia and Latin America, the Agricultural Research Institutes, etc.) have already been established with:

- The Inter-American Group on Sustainable Development of Agriculture and the Natural Resources.
- The International Geosphere-Biosphere Programme (IGBP) and the Human Dimensions of Global Environmental Change Programme (HDP), in relation to their joint core project on land-use/cover change (LUCC), and IGBP/DIS on soils database.
- The Earth Council, Costa Rica (International NGO).
- The United Nations University, Tokyo.
- The International Institute for Applied Systems Analysis, Austria.
- The Ministerio de Medio Ambiente, Colombia.
- The Instituto Geográfico Agustín Codazzi, Colombia.
- The Colegio Verde (NGO), Colombia.
- The University of Kassel, Germany.
- The Hohenheim University, Stuttgart, Germany.
- The National Geophysical Data Centre, Boulder, Colorado.
- The World Conservation Monitoring Centre, Cambridge, U.K.
- The United Nations Environment Programme (UNEP). Headquarters (Nairobi) and the Regional Office

for Latin American and the Caribbean (Mexico, D.F.).

- The University of Washington, Seattle.
- The University of Georgia, GIS Laboratory, Athens, Ga.
- The University of Guelph, Canada.
- The Dutch National Institute of Public Health and Environmental Protection (RIVM)
- The Economic Commission for Latin America and the Caribbean (ECLAC).
- Various Governmental, Non-Governmental, and Private Sector institutions in Latin America in relation to the SSALLSSA Project and the Environmental and Sustainability Indicators Project.